WF on channel codes for NR short block length eMBB data

AccelerComm, Ericsson, Orange, IMT, LG Electronics, NEC
Background

Agreement at RAN1#86bis:

• The channel coding scheme for eMBB data is LDPC, at least for information block size > X

• FFS until RAN1#87 one of Polar, LDPC, Turbo is supported for information block size of eMBB data <= X
  – The selection will focus on all categories of observation, including overall implementation complexity, regardless of the number of coding schemes in the resulting solution (except if other factors are generally roughly equal)

• The value of X is FFS until RAN1#87, 128 <= X <= 1024 bits, taking complexity into account

• The channel coding scheme(s) for URLLC, mMTC and control channels are FFS
BLER performance on first tx

Required SNR for 4-QAM and BLER=1.0%
...at lower BLER

Required SNR for 4-QAM and BLER=0.1%

- Information Blocksize

<table>
<thead>
<tr>
<th>Information Blocksize</th>
<th>Es/N0 (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-4</td>
</tr>
<tr>
<td>200</td>
<td>-2</td>
</tr>
<tr>
<td>400</td>
<td>0</td>
</tr>
<tr>
<td>600</td>
<td>2</td>
</tr>
<tr>
<td>800</td>
<td>4</td>
</tr>
<tr>
<td>1000</td>
<td>6</td>
</tr>
<tr>
<td>1200</td>
<td>8</td>
</tr>
<tr>
<td>1400</td>
<td>10</td>
</tr>
<tr>
<td>1600</td>
<td>12</td>
</tr>
</tbody>
</table>

- Required SNR for 4-QAM and BLER=0.1%

- R=0.20, Huawei LTE Turbo (MLM-8) R1-1611256
- R=0.33, Huawei LTE Turbo (MLM-8) R1-1611256
- R=0.40, Huawei LTE Turbo (MLM-8) R1-1611256
- R=0.50, Huawei LTE Turbo (MLM-8) R1-1611256
- R=0.67, Huawei LTE Turbo (MLM-8) R1-1611256
- R=0.89, Huawei LTE Turbo (MLM-8) R1-1611256
- R=0.20, Ericsson Enhanced Turbo (MLM-8) R1-1611325
- R=0.33, Ericsson Enhanced Turbo (MLM-8) R1-1611325
- R=0.40, Ericsson Enhanced Turbo (MLM-8) R1-1611325
- R=0.50, Ericsson Enhanced Turbo (MLM-8) R1-1611325
- R=0.67, Ericsson Enhanced Turbo (MLM-8) R1-1611325
- R=0.89, Ericsson Enhanced Turbo (MLM-8) R1-1611325
- R=0.20, IMT Enhanced Turbo (MLM-8) R1-1613029
- R=0.33, IMT Enhanced Turbo (MLM-8) R1-1613029
- R=0.40, IMT Enhanced Turbo (MLM-8) R1-1613029
- R=0.50, IMT Enhanced Turbo (MLM-8) R1-1613029
- R=0.67, IMT Enhanced Turbo (MLM-8) R1-1613029
- R=0.89, IMT Enhanced Turbo (MLM-8) R1-1613029
- R=0.20, IMT Enhanced Turbo (MLM-8 L-32) R1-1612308
- R=0.33, IMT Enhanced Turbo (MLM-8 L-32) R1-1612308
- R=0.40, IMT Enhanced Turbo (MLM-8 L-32) R1-1612308
- R=0.50, IMT Enhanced Turbo (MLM-8 L-32) R1-1612308
- R=0.67, IMT Enhanced Turbo (MLM-8 L-32) R1-1612308
- R=0.89, IMT Enhanced Turbo (MLM-8 L-32) R1-1612308
- R=0.33, Ericsson Polar (SCL-8)
- R=0.40, Ericsson Polar (SCL-8)
- R=0.50, Ericsson Polar (SCL-8)
- R=0.67, Ericsson Polar (SCL-8)
- R=0.89, Ericsson Polar (SCL-8)
- R=0.33, Huawei PC-Polar (SCL-8) R1-1611255
- R=0.40, Huawei PC-Polar (SCL-8) R1-1611255
- R=0.50, Huawei PC-Polar (SCL-8) R1-1611255
- R=0.67, Huawei PC-Polar (SCL-8) R1-1611255
- R=0.89, Huawei PC-Polar (SCL-8) R1-1611255
BLER performance on subsequent tx
...at lower BLER

**Required SNR for 4-QAM and BLER=0.1%**

- 1st tx
- 2nd tx
- 3rd tx
- 4th tx

**Information Blocksize**: 0, 200, 400, 600, 800, 1000

**Es/N0 (dB)**: -6, -4, -2, 0, 2, 4

**Required SNR**
- R=0.17, IMT Enhanced Turbo (MLM-8) R1-1613029
- R=0.33, IMT Enhanced Turbo (MLM-8) R1-1613029
- R=0.67, IMT Enhanced Turbo (MLM-8) R1-1613029
- R=0.17, IMT Enhanced Turbo (MLM-8 L-32) R1-1612308
- R=0.33, IMT Enhanced Turbo (MLM-8 L-32) R1-1612308
- R=0.67, IMT Enhanced Turbo (MLM-8 L-32) R1-1612308
- R=0.17, Huawei PC-Polar (SCL-8) R1-1611255
- R=0.22, Huawei PC-Polar (SCL-8) R1-1611255
- R=0.33, Huawei PC-Polar (SCL-8) R1-1611255
- R=0.67, Huawei PC-Polar (SCL-8) R1-1611255

*Note: BLER stands for Block Error Rate.*
Observations

- Enhanced turbo (MLM-8) has similar complexity to LTE turbo (MLM-8), which is widely implemented.
- Enhanced turbo (MLM-8) offers superior BLER to LTE turbo (MLM-8).
- Enhanced turbo (MLM-8) offers superior BLER to polar (SCL-8).
- Enhanced turbo (MLM-8) offers similar BLER performance as first transmission of rate-compatible PC-polar (SCL-8).
  - Initial investigations suggest that enhanced turbo (MLM-8) offers superior BLER performance in subsequent transmissions.
- Enhanced turbo (MLM-8) has a steeper BLER curve than PC-polar (SCL-8).
- Enhanced turbo naturally offers rate compatible IR-HARQ.
Proposal

Turbo code is adopted for information block size of eMBB data $\leq 1024$

Note: if some system design constraints are found during the work item, it may be desirable to revisit the value of 1024