Proposals for coherent PMDs in P802.3dj

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Supporters

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Introduction

• During the May 2023 Interim meeting, a series of straw polls was conducted on the direction of the two coherent PMDs in 802.3dj.

• Results on Straw Poll 16 showed clear interest on sharing the logic layer specification for 800GBASE-LR1 and 800GBASE-ER1.

  **Straw Poll #16:**
  I support 800GBASE-LR1 and 800GBASE-ER1 sharing common logic (PCS/FEC)
  Y: 49, N: 19, NMI: 8, A: 26

• Results on Straw Poll 17 then showed a preference for using a type II FEC, KP4 + BCH FEC as the logical layer for 800GBASE-LR1.

  **Straw Poll #17:**
  I am supportive of the direction of maniloff_3dj_01a_2305 (slides 4-12) as the baseline FEC proposal for the single wavelength 10 km 800Gb/s optical PMD.
  Results: Y: 44, N: 13, NMI: 13, A: 34

• The results from these straw polls suggest it to be worthwhile to investigate the performance of KP4 + BCH FEC for 40 km distances over SMF, so that sharing common logic between 800GBASE-LR1 and 800GBASE-ER1 can be enabled.

• This presentation provides further considerations and associated proposals on 800GBASE-LR1 and 800GBASE-ER1 specifications.
Channel loss requirements

- **stassar_3dj_optx_01a_230427**, presented during the optics ad hoc on 27 April, provided considerations on channel loss for 10 km and 40 km distances.

- For 10 km distances the TF could consider losses in the range of 4.6 dB (C-band) to 6.3 dB (O-band).

- For 40 km distances the TF could consider the following losses (building on the considerations in **stassar_3dj_optx_01a_230427**):
  - In the case the TF would wish to make specifications for 40 km engineered links (as in existing in-force clauses):
    - 18 dB for O-band applications
    - 11 dB for C-band applications
  - However if there is a stronger preference to construct channel specifications for non-engineered links, add 2 dB for patch panel connectors:
    - 20 dB for O-band applications
    - 13 dB for C-band applications

- The authors suggest to use the channel loss assumptions to investigate the performance of KP4 + BCH FEC for 800GBASE-ER1

- The authors also suggest to assume C-band operation for 40 km distances, making FEC gain requirements significantly less than for O-band operation.
Investigation on FEC Performance in 40 km 800 GbE coherent link

**Conditions assumed in the simulation**
- Wavelength: C band 1550nm
- Fixed-wavelength laser, both ECL & DFB laser were considered, with linewidth up to 2MHz
- Optical Tx/Rx Devices: 3dB bandwidth ~60GHz
- Noise due to in-module amplifier was considered for 40km case, EDFA/SOA at the Tx

**Link conditions assumed in the simulation**
- Channel insertion loss for 40 km: as suggested in previous slide:
  - 11 dB, C-band for engineered link
  - 13 dB, C-band non-engineered link.
- CD/DGD/PDL/LOFO:

<table>
<thead>
<tr>
<th>Spec</th>
<th>LR</th>
<th>ER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>typical</td>
<td>worst</td>
</tr>
<tr>
<td>CD(ps/nm)</td>
<td></td>
<td>200*</td>
</tr>
<tr>
<td>DGD(ps)</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Rx PDL Tolerance(dB)</td>
<td>1.5</td>
<td>2</td>
</tr>
<tr>
<td>LOFO(kHz)</td>
<td>±1500</td>
<td>±3600</td>
</tr>
</tbody>
</table>

*: same as in manilloff_3dj_01a_230206
+: In force IEEE specifications have 10.3ps for 40km applications
## Simulation result

### LR performance

- **ROP (dBm)**: 23, 22, 21, 20, 19, 18
- **BER (10^1)**: 1.0, 0.1, 0.01, 0.001, 0.0001

<table>
<thead>
<tr>
<th>ROP (dBm)</th>
<th>OB2B</th>
<th>LR典型+300kHz</th>
<th>LR最差+2MHz</th>
<th>ER典型+300kHz</th>
<th>ER最差+2MHz</th>
<th>ER最差+2MHz+OA</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFEC@BER=2E-2</td>
<td>-20.98</td>
<td>-20.92</td>
<td>-20.48</td>
<td>-20.46</td>
<td>-19.72</td>
<td>-19.56</td>
</tr>
<tr>
<td>KP4 + BCH @BER=1.1E-2</td>
<td>-19.8</td>
<td>-19.75</td>
<td>-19.24</td>
<td>-19.25</td>
<td>-18.41</td>
<td>-18.21</td>
</tr>
<tr>
<td>Difference in ROP (dB)</td>
<td>1.18</td>
<td>1.17</td>
<td>1.24</td>
<td>1.21</td>
<td>1.31</td>
<td>1.35</td>
</tr>
</tbody>
</table>

### ER performance
Rough power budget for 40 km C-band solution

<table>
<thead>
<tr>
<th>Parameter</th>
<th>ER1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber link length</td>
<td>40 km</td>
</tr>
<tr>
<td>Channel Insertion loss (max), for C-band</td>
<td>13 dB</td>
</tr>
<tr>
<td>Optical path power penalty (max)</td>
<td>1 dB</td>
</tr>
<tr>
<td>Optical power budget (max)</td>
<td>14 dB</td>
</tr>
<tr>
<td>Chromatic dispersion (max)</td>
<td>800 ps/nm</td>
</tr>
<tr>
<td>Average Tx output power (min)</td>
<td>-3 dBm</td>
</tr>
<tr>
<td>Rx sensitivity (min)</td>
<td>-17 dBm</td>
</tr>
</tbody>
</table>

Possible to fulfill such a power budget with current coherent solutions
Assessment of suitability of KP4 + BCH FEC

- On the basis of the presented analysis we conclude that a KP4 + BCH FEC provides more than sufficient gain to support channel losses up to at least 14 dB.

- Therefore we believe that there is no need for a very strong FEC, like OFEC, for an SMF distance of 40 km when a frequency in the C-band is used. Such a very strong FEC, designed for operation over demanding long distance DWDM links, would only introduce disadvantages, like higher latency and power consumption.

- This is the first IEEE 802.3 project where coherent technology is being proposed for non DWDM, conventional/grey Ethernet applications and as such a KP4 + BCH FEC scheme, being a textbook scheme without IP limitations, would be very suitable.

- We are at the brink of introducing coherent technology in relatively short distances and it would be a fundamental mistake to use (because of convenience) an FEC scheme specifically designed for demanding long distance DWDM links, which generally require edge technology.
Proposals

- For both LR1 and ER1 specify KP4 + BCH FEC
- For ER1 specify a single frequency in the C-band to support a worst case channel loss of 13 dB
- For optimum flexibility and commonality specify also single frequency in the C-band for LR1 to support a worst case channel loss of 5 dB
Thank you!