TDD Cycle

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Description of TDD Cycle

• The TDD cycle consists of four time segments
  ◦ Downstream (DS)
  ◦ Upstream (US)
  ◦ Two Guard Times (GT)

<table>
<thead>
<tr>
<th>DS</th>
<th>GT</th>
<th>US</th>
<th>GT</th>
</tr>
</thead>
</table>

• The values of these time segments need to be configured at the CLT
• This values of these time segments will be sent over the downstream PLC
• It may be possible to reconfigure these values over the OAM
TDD Cycle Descriptor

- We need to be able to describe the TDD cycle so it can be configured at CLT, communicated over PLC and possibly over OAM.
- We need to decide on the range of values these time segments can take on and in what units we measure them.
Guard Time

- The guard time needs to be at least as long as the sum of two times
  - RF switching time for the device to switch from transmit to receive or from receive to transmit
  - The round trip time (RTT) from the CLT to the CNU and back
- RF switching time of 1 to 2 µs is reasonable
- The RTT depends on the length of the passive network.
- Let $d$ be the distance from the CLT to the CNU in meters
- Speed on coax is approximately
  \[ s = 2 \times 10^8 \text{ m/s} = 200 \text{ m/µs} \]
- Round Trip Time
  \[ RTT = \frac{2d}{s} = \frac{d}{100} \text{ µs} \]
Guard Time

- Range of RTT values
  - Use 2 µs for RF switching time. Need to finalize this value based on input from PHY Team

<table>
<thead>
<tr>
<th>d (m)</th>
<th>RTT (µs)</th>
<th>RF Switching Time (µs)</th>
<th>Guard Time (µs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>500</td>
<td>5</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>1000</td>
<td>10</td>
<td>2</td>
<td>12</td>
</tr>
</tbody>
</table>

- We need to determine the maximum distance between a CLT and a CNU for a TDD network, based on the TDD channel model
- The GT should be an integer multiple of the duration of the 204.8 MHz clock period
Guard Time

- Since we want the guard time to be an integer multiple of the sample period, we have a few choices for the resolution of the guard time.

<table>
<thead>
<tr>
<th>Number of Clock Periods</th>
<th>Time (µs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>128</td>
<td>0.625</td>
</tr>
<tr>
<td>256</td>
<td>1.25</td>
</tr>
<tr>
<td>512</td>
<td>2.5</td>
</tr>
</tbody>
</table>

- It seems like 1.25 µs is sufficient resolution.
Recommendation

- Allow configuration of the following values of the guard time in µs
  - 3.75, 5.0, 6.25, 7.5, 8.75, 10.0, 11.25, and 12.5
- If fewer possible configuration were needed we could select only four values (2.5 µs resolution)
  - 5, 7.5, 10 and 12.5
**Downstream Time Interval**

- The DS Time Interval should be a multiple of the symbol duration (including the cyclic prefix)
- We need to specify a minimum number of symbols and a maximum number of symbols in the DS time interval
- Symbol duration (excluding cyclic prefix)
  - 4K FFT: 40 µs
  - 8K FFT: 20 µs
- Cyclic prefix values (pietsch_3bn_02_0313)
  - 0.9387, 1.25, 2.5, 3.75 and 5 µs
Downstream Time Interval

- Range of Downstream Time Intervals
- To avoid high overhead from the guard time we want to have

\[ T_{DS} \gg T_{GT} \approx 10 \, \mu s \]

- To avoid high latency we want to have

\[ T_{DS} \ll 1000 \, \mu s \]

- May not be possible to meet both of these requirements in a single configuration
Downstream Time Interval

- Want to allow the operator the ability to configure the downstream time interval to allow for trade-off between latency and overhead
- There may be networks were latency is critical and higher overhead will be allowed
- There are also networks where latency is not so critical and lower overhead is preferred
Limits of Downstream Time

- **Minimum Downstream Time**
  - Something in the neighborhood of 80 µs seems like a lower limit. This is 4 symbols for the 8K FFT and 2 symbols for the 4K FFT
  - Are there PHY limits on the minimum number of symbols between guard times?

- **Maximum Downstream Time**
  - For networks where latency is less important we want longer values of the downstream time
  - Something in the neighborhood of 640 µs seems like an upper limit. This is 32 symbols for the 8K FFT and 16 symbols for the 4K FFT

- Discussion?
Upstream Time

- Should the allowed values of the upstream time be the same values allowed for the downstream time?
Conclusion

- Introduced the description of the TDD cycle
- Recommendations and Discussions on the possible values of the Guard Time and the downstream and upstream time values
- Specify the Guard Time in multiples of a time unit of 1.25 μs or 2.5 μs
- Specify the downstream and upstream time in multiples of the symbol duration (symbol plus cycle prefix)
- Discussed some limits of the downstream and upstream times