EPON Protocol over Coax

TDD Cycle

Steve Shellhammer (Qualcomm)

June 2013

Description of TDD Cycle

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

- The values of these time segments needs 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

$$s = 2 \times 10^8\ m/s = 200\ m/\mu s$$

- Round Trip Time

$$RTT = \frac{2d}{s} = \frac{d}{100}\ \mu s$$

Guard Time

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

d (m)	RTT (µs)	RF Switching Time (µs)	Guard Time (µs)
200	2	2	4
500	5	2	7
1000	10	2	12

- 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 a few choices for the resolution of the guard time

Number of Clock Periods	Time (µs)
128	0.625
256	1.25
512	2.5

- 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