MPCP – Timing Model

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Updates From Baseline

- Laser control interface
- Guard band equation - informative
- Guard band for OLT ↔ ONU clock drift
- PHY ↔ MAC jitter constraint
- Time information loss fault mechanism
Laser Control Interface

- There are two options for laser control interface:
  - MAC control asserts a signal
  - MAC control will set laser control using an internal register
    - The transceiver can read this value using an unspecified interface
Guard Band Definition

- OLT must maintain a guard band between transmissions from different ONUs to accommodate:
  - OLT ⇔ ONU clock drift
  - ONU laser turn on and turn off
  - OLT receiver locking
  - Implementation jitter
  - Fiber length changes
  - State machine synchronization
The equation should be used to analyze the contributors to guard band, in order to set limit where needed

\[ T_{\text{guard-band}} = T_{\text{clock-drift}} + \]
\[ \max(T_{\text{laser-on}}, T_{\text{laser-off}}) + \]
\[ \text{AGC delay} + \]
\[ \text{CDR acquisition delay} + \]
\[ 2 \times \text{mac\(\rightarrow\)phy jitter} + 2 \times \text{phy\(\rightarrow\)mac jitter} + \]
\[ T_{\text{thermal-drift}} + \]
\[ 2 \times \text{clock resolution} + \]
\[ \text{comma sync time} \]
Guard Band Equation (cont.)

\[ T_{\text{clock-drift}} = \]
\[ \max(T_{\text{grant length}}, \]
\[ T_{\text{max between downlink timestamp}}) \times \]
\[ \max \text{OLT} \leftrightarrow \text{ONU clock ppm difference} \]

\[ T_{\text{thermal-drift}} = \]
\[ T_{\text{max between uplink timestamp}} \times \]
\[ \text{Maximal thermal gradient} \times \]
\[ (T_{\text{upstream propagation delay}} \times \]
\[ \text{Upstream propagation gradient} + \]
\[ T_{\text{downstream propagation delay}} \times \]
\[ \text{Downstream propagation gradient} \) \]
Guard band for OLT ↔ ONU clock drift

- The clock drift between OLT and ONU has a significant contribution to guard band size
- A strict limit should be set
  - Suggested value is between 20nSec and 50nSec

- For example, a value of 40nSec could be reached by setting the following parameters:
  - Time stamp every 4mSec and +/- 5ppm
  - Time stamp every 200uSec and +/- 100ppm
PHY ↔ MAC Jitter Constraint

- **PHY → MAC** jitter is accounted twice in guard band
- **MAC → PHY** jitter is also accounted twice
- **A small constraint must be guaranteed:**
  - Suggested value 20nSec to 50nSec
Fault: Time Information Loss

- When an ONU loses time information, it may interfere with neighboring ONUs’ transmission
- The misbehaved ONU’s transmissions may not be received, causing collisions
  - OLT will not succeed at detecting which ONU is at fault
- The situation is made worse by slow-reacting OLT software implementation

- A mechanism for detecting ONU time information loss at ONU should be defined
Detection Mechanism

- Define TD as difference between TL (local PON clock) and TS (received timestamp value)
  - TD is calculated whenever a valid MPCP message is received.
- If ABS(TD) >= 5 \* T_{guard-band-jitter} \rightarrow Move to reset state
- Allowed jitter is the part of guard band equation susceptible to jitter:
  \[ T_{guard-band-jitter} = \]
  \[ T_{clock-drift} + 2 \* \text{mac} \rightarrow \text{phy jitter} + 2 \* \text{phy} \rightarrow \text{mac jitter} + T_{thermal-drift} + 2 \* \text{clock resolution} \]
Further Work

- Need to finalize laser control interface
- Need to finalize reset state – soft or hard
- Waiting for inputs from PMD group to fine tune constraints