10Gbps US option for 25G asymmetric PON

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May,2017

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Introduction

In this contribution, we present a 10G US option for 25G asymmetric PON, which follows the same spec. defined for the 25G US option.

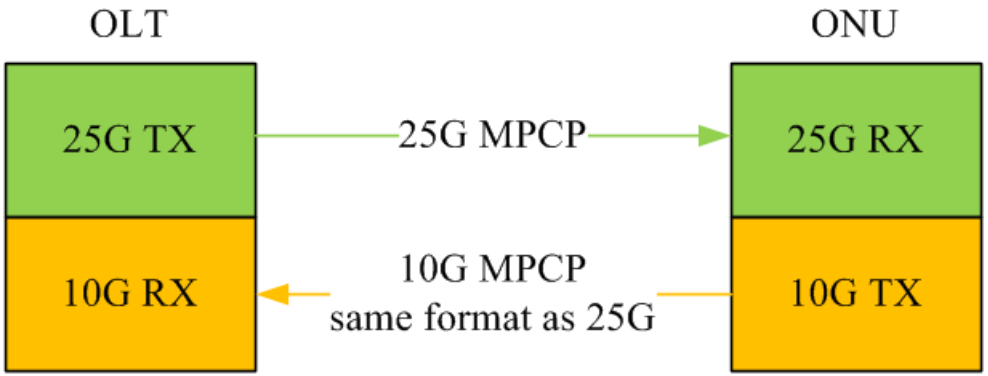
We show that this option is able to address all issues proposed in krammer_3_ca_1_0417_12G.pdf, whose assumption is the 10G US option should reuse the standard defined in 802.3av.

This 10G option does not need much additional standard works as it requires the same spec. as 25G US option. Furthermore, it keeps the valuable feature defined in 25G PON, such as multiple LLIDs, higher timing accuracy, envelope framing and fragmentation. Meanwhile, it is able to reuse existing 10G upstream optical modules.

MPCP proposal

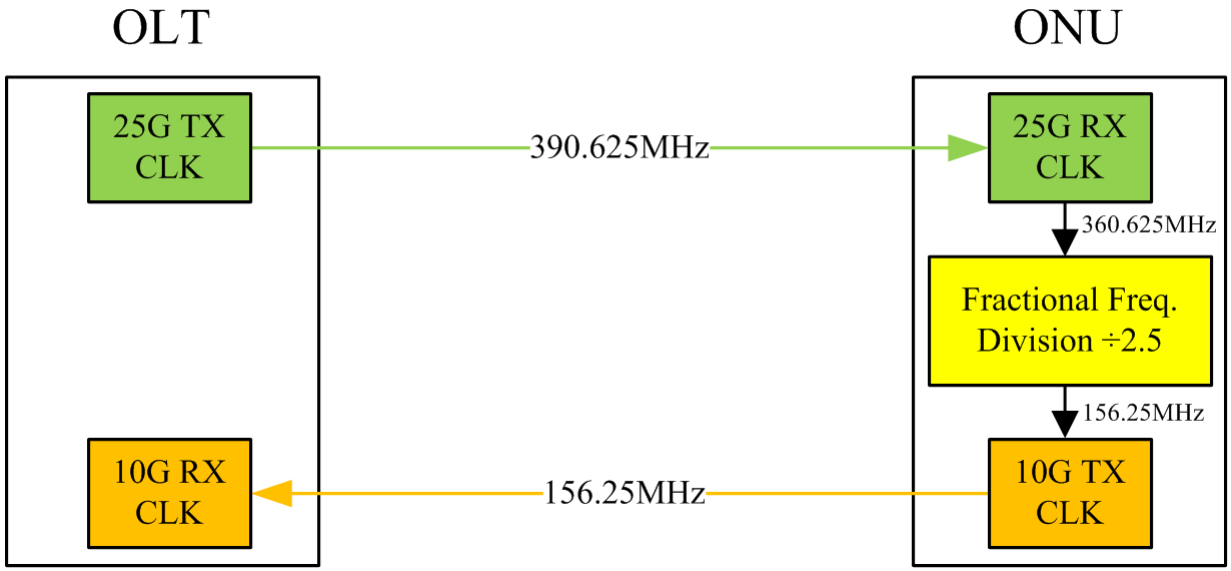
The 802.3av defined US option is hard to reconcile with 25G architecture. In 802.3av, each MPCP message is addressed to individual LLIDs, whereas each MPCP message in 25G PON is related to only one PLLID, as presented in krammer_3_ca_1_0417_12G.pdf .

To bridge this gap, the 10G US option is recommended to share the same MPCP spec. with the 25G upstream. That is, multiple LLIDs will be supported by both 10G and 25G upstream. The PLLID is used to convey MPCP and OAM related messages. ULLIDs will be assigned in the manner of per service flow per link ID, increasing the QoS flexibility.



Loop timing proposal

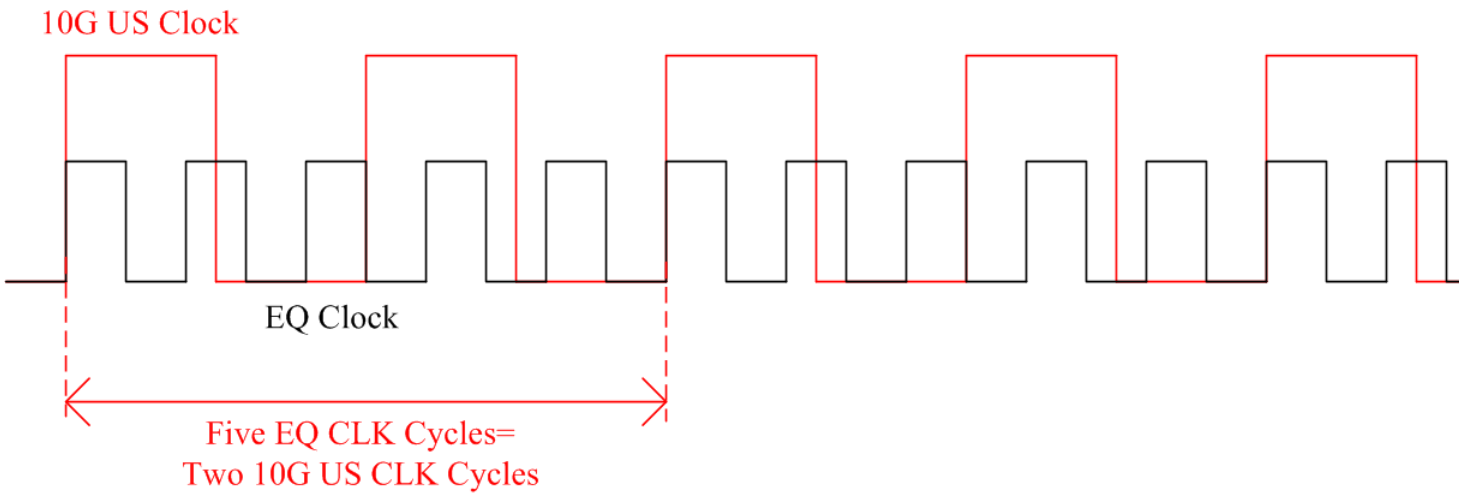
For 25Gbps downstream, the ONU's clock is locked to 390.625MHz, where each clock cycle is equal to 2.56ns, i.e., EQ. In the 25G asymmetric ONU TX side, the clock frequency is 156.25MHz, which can be derived from the downstream clock with a fractional frequency factor of 2.5.



Asymmetric timestamp proposal

In the downstream, the EQ clock cycle is 2.56ns, but the 10G upstream has a clock cycle of 6.4ns. How to reconcile two different clock cycle to maintain the same timing?

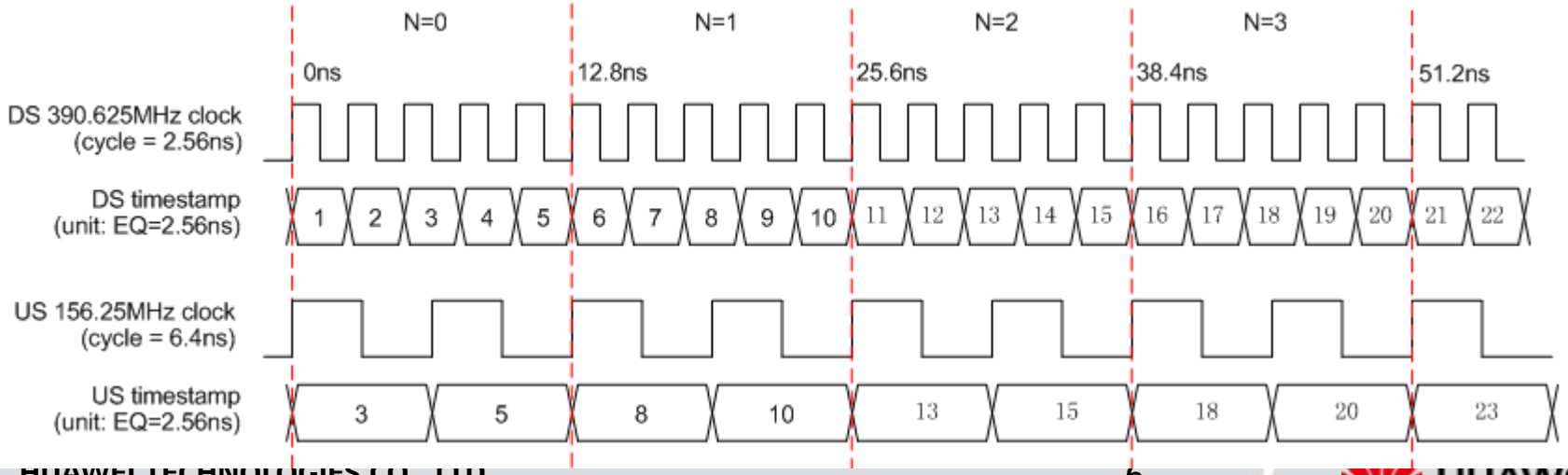
- The 10G US uses 156.25MHz as it timestamp clock with the time unit of EQ rather than 6.4ns
- Two 156.25MHz clock cycles are equal to five EQ clock cycles



Next, how we do?

Asymmetric timestamp proposal-cont.

- Partition five EQ clock cycles into two portions: each part contains 2.5 EQ clock cycles which are one 156.25MHz clock cycle
- The first portion is timestamped with (3+N*5) EQs and the second is ticked by (5+N*5) EQs, where N indicates the numbering of 5 EQ periods
- The timestamp of 10G US is aligned with the downstream time within each five EQ clock cycles
- Due to the phase mismatch between the downstream and upstream clocks, the maximum timing error is 6.4ns, which can be tolerated by setting a proper upstream clock drift value



Fragmentation & FEC proposal

Fragmentation is not supported by 10G EPON. In 802.3ca, this valuable feature is introduced to increase the bandwidth utilization efficiency. The 10G US will inherit this from the 25G upstream.

Enhanced FEC and low overhead line code are highly suggested for 25G links. For 10G US, it has the following two options:

FEC & Line Code option	Pros	Cons
Enhanced FEC+ low overhead Line Code, e.g., 128B/129B	☐1dB/2dB optical coding gain improvement, leading to lower cost 10G optical modules ☐Reuse the FEC & Line code blocks with the 25G upstream ☐No additional standard work	☐Around 500Mbps total bandwidth reduction for the 10G upstream caused by more FEC overhead, compared with 10G EPON [1]
RS(255,223)+64B/66B	☐No less than the US bandwidth efficiency in 10G EPON	☐Different FEC and Line Code encoder/decoder from the 25G upstream

[1]. Assume the enhanced FEC with a code rate of 0.83

Comparison on all plans

Function	802.3av defined 10G	10G with the same format of 25G	12.5G [2]
MPCP	Single LLID	Multiple LLIDs	Multiple LLIDs
Loop Timing	÷6.25	÷2.5	÷2
Timestamp Unit	TQ=16ns	EQ=2.56ns	EQ=2.56ns
Data Unit	20Byte	8Byte	8Byte
Fragmentation	Do not support	Support	Support
FEC/Line Code	RS(255,223)+64B/66B	RS(255,223)+64B/66B OR Enhanced FEC+ low overhead Line Code	Enhanced FEC+ low overhead Line Code
Envelope Framing	Do not support	Support	Support
Optical module	Reuse 10G optical modules (TDM coexistence with 10G EPON)	Reuse 10G optical modules (TDM coexistence with 10G EPON)	Probably Not

[2]. krammer_3_ca_1_0417_12G.pdf

Conclusion

10G US following the same spec. defined for the 25G upstream shows that

- **Less standards work**
  - – The same PMA/PCS/MPRS/MPCP specification as in 25G upstream
  - – Only clock is different
- **Reuse of existing IP blocks**
  - – Use the same data path for 25G (same envelope framing, timestamp, GATE & REPORT MPCPDUs, etc.)
- **Reuse of software**
  - –Everything between 25G and 10G is identical except the clock rate
- **Reuse of 10G optical module**

Thank you

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