Security Level:

De-skew Method for 100G EPON Downstream Channels

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Version: V1.0(20160708)
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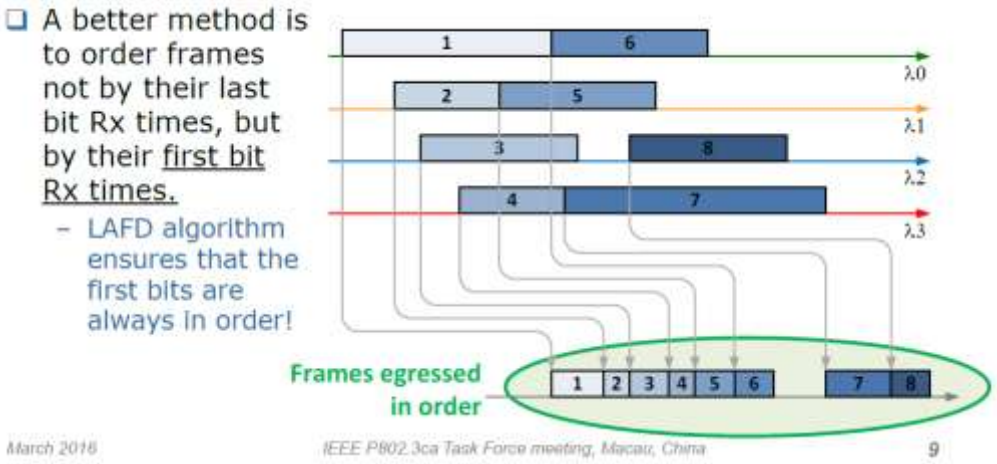
Outline

- Background
- Proposed method to de-skew 100G EPON downstream channel bonding
- Summary

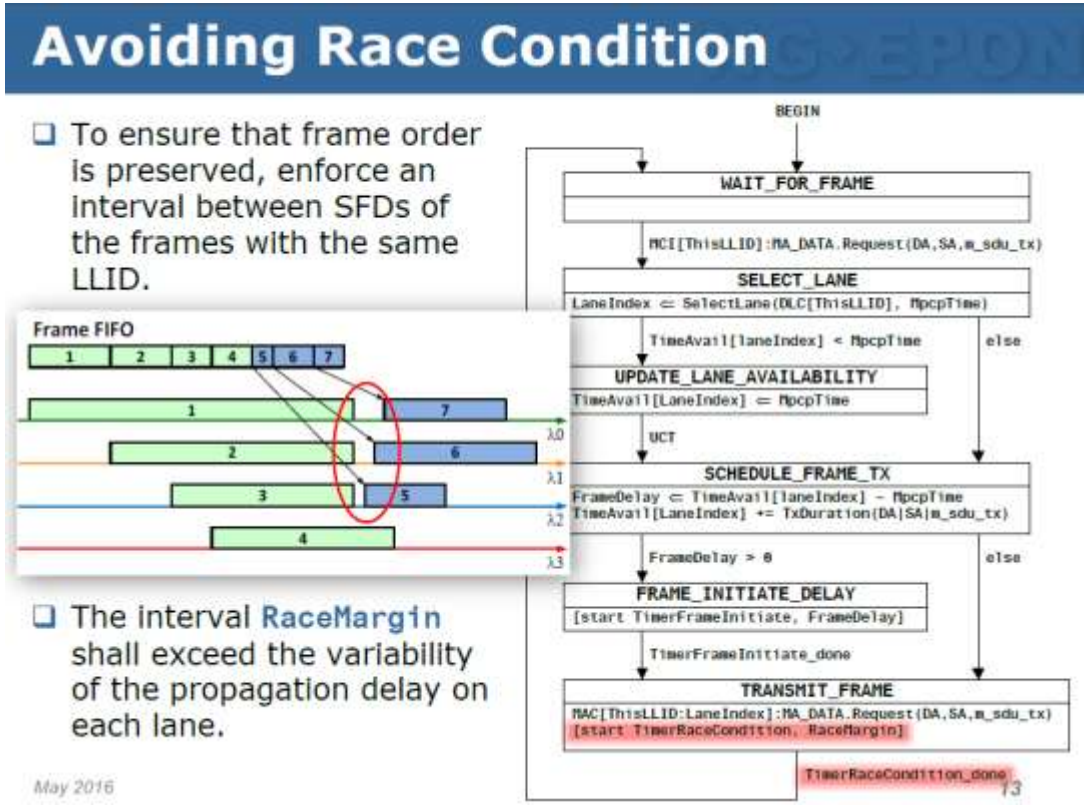
Background

- In Macau meeting, the “MPCP+” method for downstream bonding was agreed as baseline (Motion #6).
  - http://www.ieee802.org/3/ca/public/meeting_archive/2016/03/kramer_3ca_2a_0316.pdf
  - It proposed to reorder the frames by the first bit Rx times of the frames.



- However, the propagation delay of DS channels is different for each channel, due to different fiber lengths and wavelengths. What is worse, this inter-channel skew may change dynamically because of temperature variation or wavelength drift. This inter-channel skew may cause the first bit arrival times to be out of order.

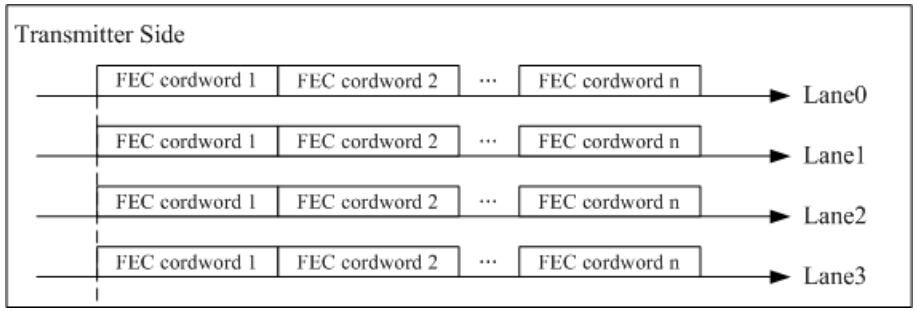
Background-cont'd



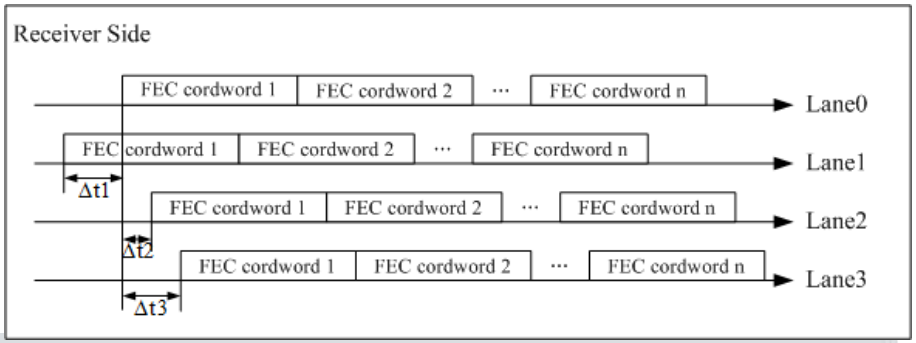
- In the Whistler meeting, RaceMargin is suggested to increase the interval between bonded Eth frames to address the variability of the propagation delay on each channel at a cost of some bandwidth loss.
  - Assume 5m differential fiber length between multiple wavelengths which results in about 25ns or 625 bits variability of the propagation delay and 500bytes average frame size, RaceMargin with 625 bits will induce 15% bandwidth wastage in the worst case.

Skew measurement based on FEC codeword alignment

- De-skew based on FEC codeword alignment:
  - Keep FEC codewords of different channels aligned at transmitter side;

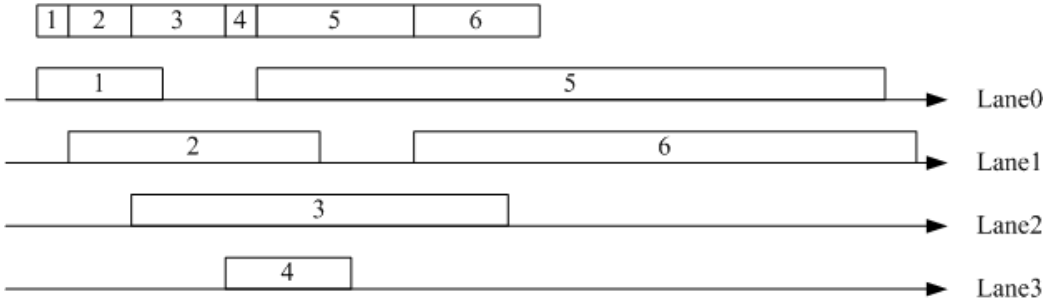


  - Measure the skews based on the arrival times of the FEC codewords.

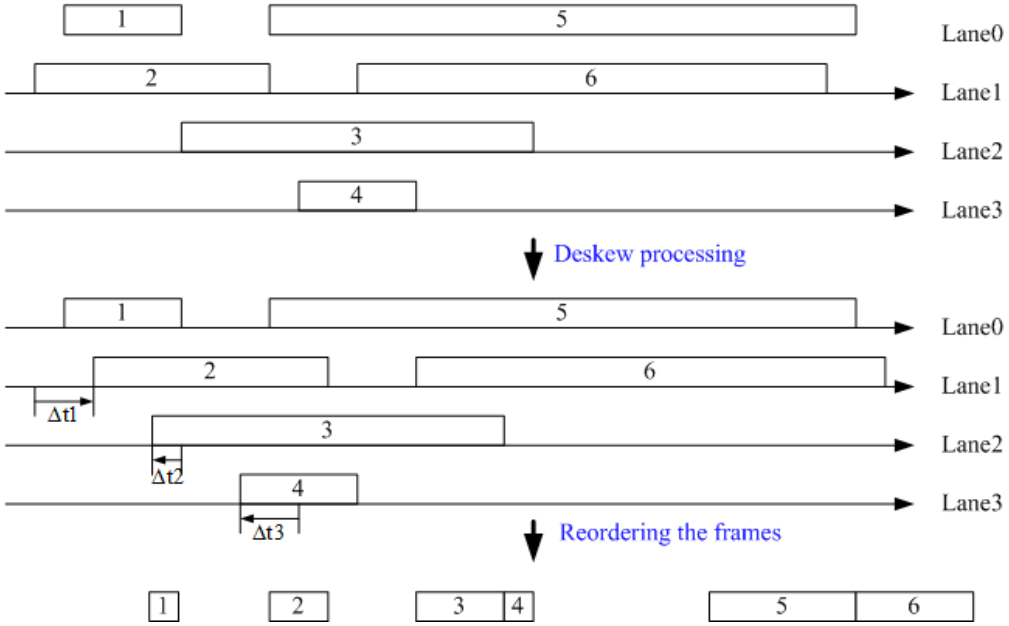


De-skew progress at the receiver side

- Timing at the transmitter side:

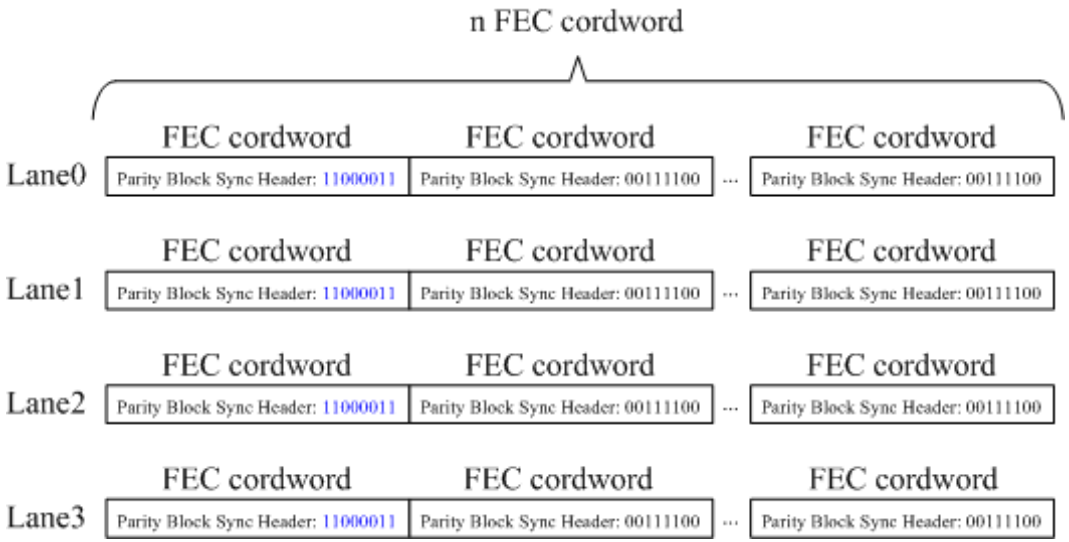


- De-skew processing at the receiver side:



Scale up the measurement scope

- Method can deal with skews of +/- 0.5 of a codeword length.
  - In the case of RS(255,223) FEC code with line coding of 64b/66b, that amounts to +/- 40 ns.
- Periodically inserting a special FEC parity block sync header pattern (e.g., using “11 00 00 11” as the parity block sync header pattern which is the inverse of that used by 10G EPON RS(255,223)) as the skew measurement marker in every n FEC codewords can scale up the measurement scope to microseconds



Summary

- This de-skew method based on FEC CW alignment can address the inter-channel skew issue in the range of ±40ns(255*8bits*0.04ns/bit/2) times without any bandwidth loss.
- Using a special FEC codeword parity block sync header pattern as the skew measurement marker in every n FEC codewords can scale up the capability.
- We only need to slightly change related PCS state diagrams to make it workable.

Thank you

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