Further Analysis about PCS and FEC Configurations

Zhongfeng Wang and Ali Ghiasi

IEEE 802.3 400GE Study Group Meeting
Sept. 2013, York, UK

Introduction

- This presentation summarize pros and cons of using 80 PCS lanes vs. 16 PCS lanes for 400GbE.

- It further provides analysis about distance and data pattern selections for Alignment Markers.

80 PCS vs. 16 PCS

- With 80 PCS lanes
  - Pros:
    - Compatible with 100GbE PCS
    - Easy process with MLG to transport up to 40 independent 10GbE
    - Can directly reuse bj FEC
  - Cons: some hardware overhead in MUXing logic for lane reordering as well as data de-skewing.

- With 16 PCS lanes
  - Pros: simpler muxing logic in lane reordering and data de-skewing.
  - Cons:
    - More difficulty to support 10 physical lanes
    - Need change Alignment Marker distance to reuse bj FEC, which will cause extra complexity in receiving 100G or 40G PCS traffic.

Comaprison and Analyses

- No substantial differences between 2 options from implementation perspective.
- If using 80 PCS lanes, those muxing and deskrewing logic can be largely simplified by using group-based Alignment Marker patterns.
- If using 16 PCS lanes, can use 50G data rate to transport 40G traffic.

- Generally speaking, using 16 PCS lanes is relatively simpler for reorder and deskew.

Possible Changes If Using 16 PCS Lanes

- Align Marker Distance:
  - As discussed in [1], AM distance needs to be a multiple of 10 in order to reuse 802.3 bj FEC.
  - In 100G and 40GBase-R, there're a total 16384 66-b blocks between two consecutive AM blocks per virtual lane.
  - A natural option is to make it as 16400, a multiple of 10, 66-b blocks per AM span. This was discussed in the following presentation:

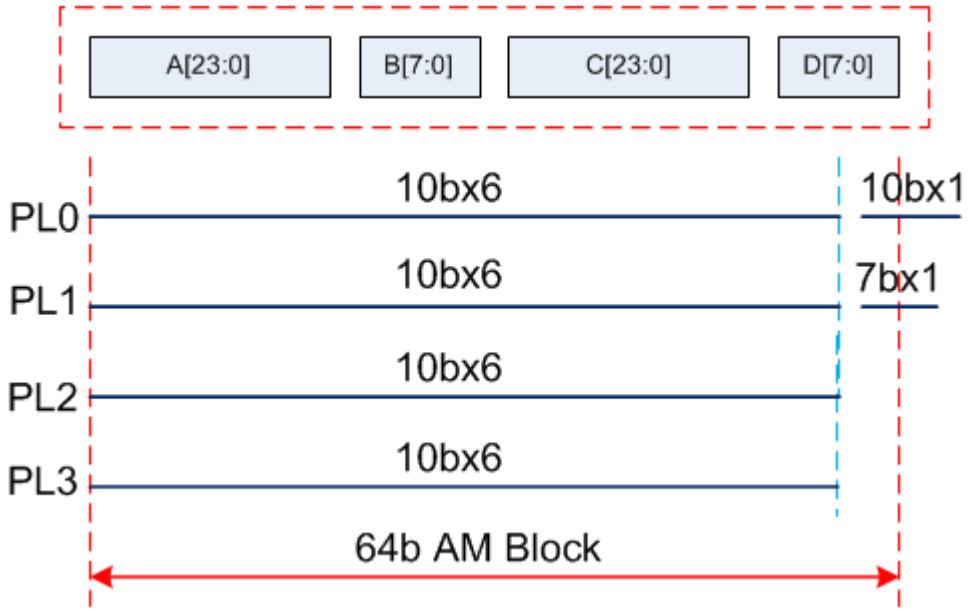
http://www.ieee802.org/3/400GSG/public/adhoc/logic/aug20_13/begin_01_0813_logic.pdf

- Since GCD(16384, 16400)=16 , GCD(16384, 16000)=128, GCD(16384, 16640)=256, either 16000 or 16640 should be a better number for the AM distance.
  - If using 16000 as distance, every 125 AM spans from 40G/100G data stream become 128 AM spans in 400G stream.
  - If using 16400, every 1025 AM spans in 40G/100G data stream are converted to 1024 AM spans.
  - If using 16640 (preferred), every 65 AM spans from 40G/100G data stream become 64 AM spans in 400G stream.

[1] Z. Wang and A. Ghiasi, "400GE Lane Configurations and FEC Options," IEEE 400GbE Study Group meeting, July, 2013, Geneva, Switzerland.

Possible Changes with 16 PCS Lanes (II)

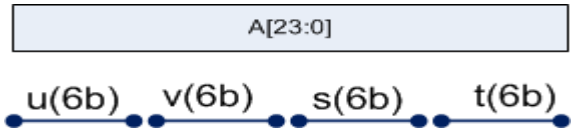
- AM Group in Transcoding
  - If FEC encoding is done over 100G data rate (e.g., in order to reuse bj FEC), then 4 AM blocks per AM group after transcoding and data distribution to 4 physical lanes (PLs) should look like the following diagram, where remaining 10b plus 7b in the right column can be any binary data pattern.



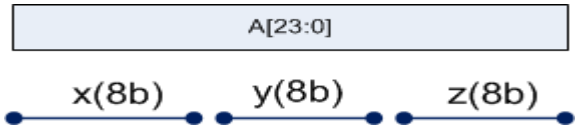
  - Note: C and D are bit-inverse versions of A and B, respectively.

Alignment Marker Data Patterns

- Parallel detection of 16 AM blocks can be very expensive in hardware.
  - Assume bus width=64bits per PL.
    We need (48bx64par x16 AMx16 lane) XOR gates
    + (47x64par x16x16 lane) OR gates > 2 M NAND gates.
- A tradeoff may be made between “randomness” and “regularity”
  - e.g., we force 24b data pattern of A (refer to page 5) to be as follows:
    {u or ~u, v or ~v, s or ~s, t or ~t} (total of 16 combinations)
    In this way, we can reduce complexity of parallel detection drastically.



  - e.g., we can also force 24b data pattern of A to be as follows:
    {x or ~x, y or ~y, z or ~z}
    and we have 2 different options for x, y, and z, respectively.



Remarks

- If reusing bj FEC is not required, other options may include:
  - RS(m=16, t=7) or RS(m=16, t=14), coding across PLs. No need to change AM distance.
  - RS(m=12, t=7) or RS(m=12) t=14), coding across PLs. AM distance can be changed to 16128 or 16512 when using 16 PCS lanes.
  - For more details, see reference [1].

[1] Z. Wang and A. Ghiasi, "400GE Lane Configurations and FEC Options," IEEE 400GbE Study Group meeting, July, 2013, Geneva, Switzerland.

Summary

- We have summarized pros and cons of using 16 PCS lanes vs. using 80 PCS lanes
- We have suggested improved AM distances to allow reusing bj FEC to allow compatibility with 16 PCS lanes
- We have shown what AM blocks should look like after transcoding
- We also suggested tradeoffs between randomness and regularity in choosing AM data patterns