Response to Editor's Note in Clause 94.2.2.3

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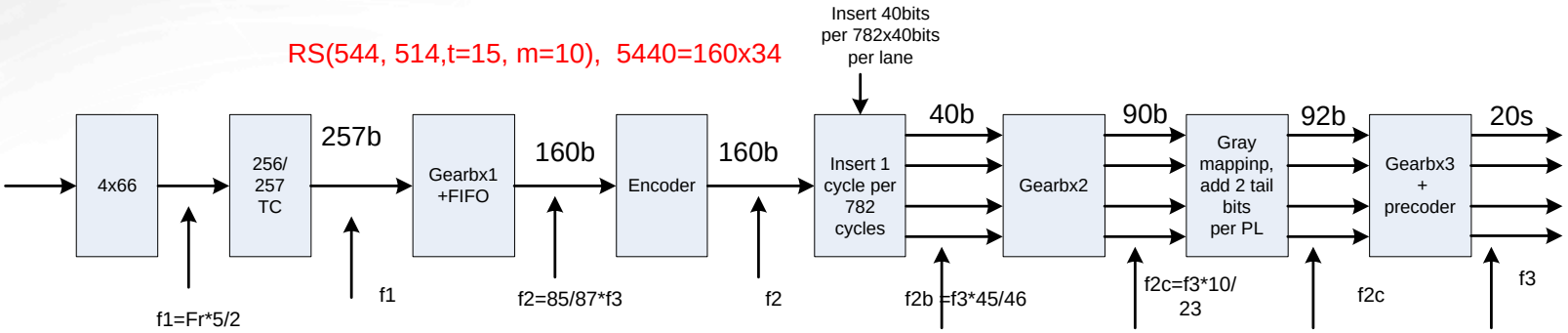
Introduction

- With 100GBase-KP4, we insert 40 bits per physical lane for every 23 FEC blocks (5440/4 bits per FEC block per lane). We then insert 1 PAM4 symbol per 45 PAM4 symbols. However, the data transmitted between two alignment marker groups are not multiple of 23 FEC blocks.
- Thus it will be very helpful if PMA overhead (OH) bits can be used for data synchronization.
- In the work, we specify the default data patterns for these PMA OH bits for each physical lane (PL).
- If it becomes really necessary, we can make these patterns programmable through autoneg.

Why Care Synchronization



- Regular data enter the TX flow at left most side, PRBS data for training enter the flow at (almost) right most side.
- TX switching from training mode to data mode can hardly guarantee cycle accurate due to different clock domain.
- Mode switching happened in digital domain (e.g., 40b/cycle) at Tx side. But data are received at analog domain (e.g., 2 bits per cycle) at Rx side. It is hard to guarantee alignment among 4 lanes right after training.

PMA OH Patterns

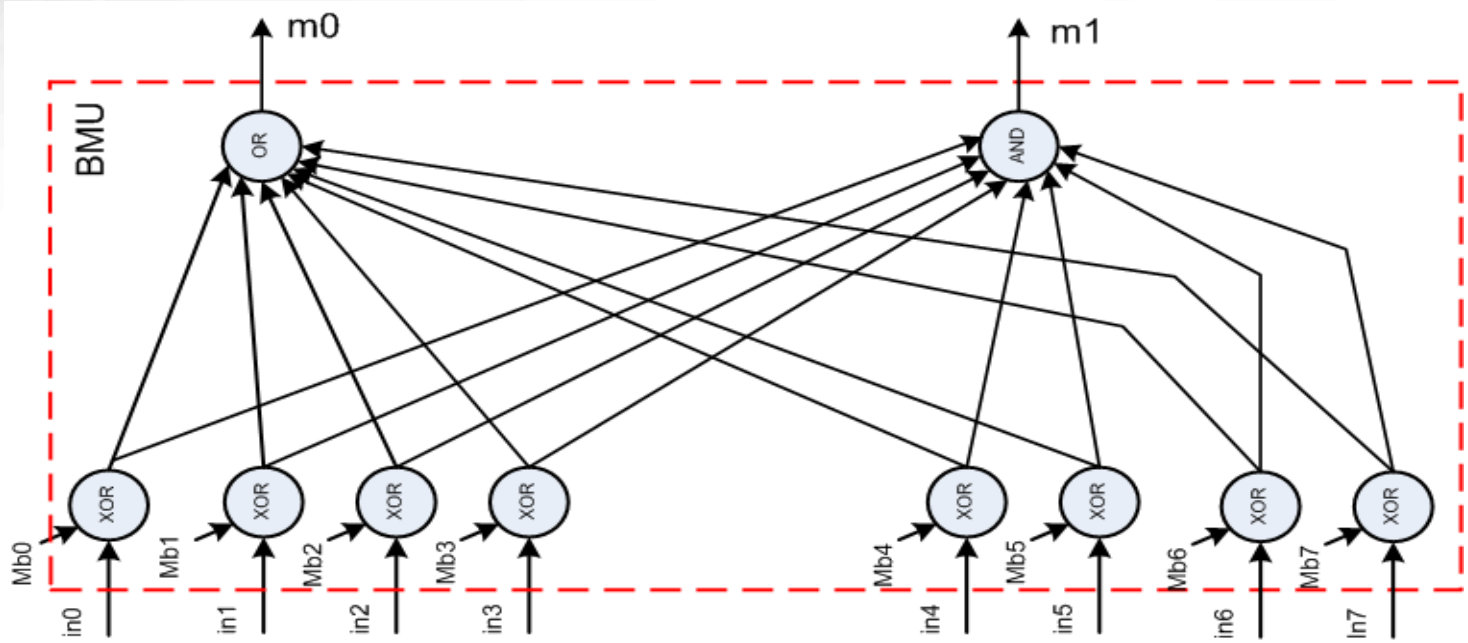
- Define a 10-b DC balanced data pattern A=8'b0110_0110
- Define a 10-b data pattern B=8'b1001_1001, B=inverse of A.

- After Gray mapping, Ag=8'b0111_0111; Bg=8'b1101_1101;
- It can be proved that regardless of initial state, the output from precoder after receiving input of Ag or Bg will consist of exactly 4 different PAM4 values, e.g., {2, 1, 3, 0}. So it is balanced from PAM4 symbol perspective.

  - PAM OH for PL0: {A, A, B, B, A}
  - PMA OH for PL1: {A, B, A, B, A}
  - PAM OH for PL2: {B, A, B, A, B}
  - PMA OH for PL1: {B, B, A, A, B}

- Defining OH bits as above can significantly simplify hardware implementation for block match with those data patterns. In fact, we only need compare incoming data with data pattern "A" (to be continued in next slide).

Block Match



- A block match for 40-b will be based on 5 segments of 8-b match. The above diagram shows how to detect if a 8-b data segment matches with “A” or “B”.
- If {m1, m0} = 2’b00, it means a match with “A”
- If {m1, m0} = 2’b11, it means a match with “B”
- If {m1, m0} = 2’b01, it implies a 8-b non-match.
- In this case, we can greatly simplify 40-b block matching logic.

Final Comments

- Defining PAM OH patterns as above can guarantee the output PAM4 symbols are well-balanced after Gray mapping and precoding for PMA OH portion regardless initial state for precoding.

- However, DC-balanced binary sequence (e.g., PRBS sequence) may not guarantee output of a balanced PAM4 symbol sequence after Gray mapping and precoding.