Improved ACT Link Synchronization for Crystal-less Camera Links

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Outline

- A method for link synchronization has been introduced in
    - https://www.ieee802.org/3/dm/public/0325/Razavi_Zherebtsov_Ragnar_01_03_10_2025.pdf
- This presentation serves as a follow-up based on the feedback received

Reminder on Link Synchronization in 802.3dm

- The goal of link synchronization is to synchronize the startup process
- In a pre-determined network, such as that of a vehicle, PHYs stay in the link synchronization state for a very short period
- The camera receiver for 117MHz is very simple
- It is not efficient to use a specialized detector
- Attaining link synchronization is challenging in the crystal-less mode, where clock variations can be as high as 20%

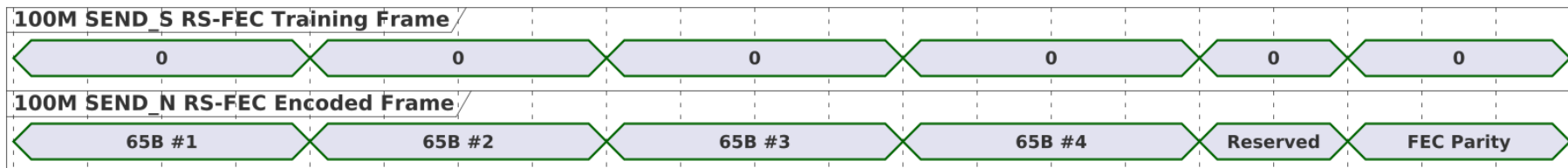# Continues signal for link synchronization

Low Data Rate (LDR) TX
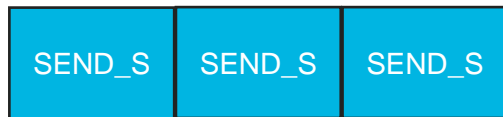
| SEND_S	SEND_S	SEND_S

High Data Rate(HDR) TX

LINK_SYNC

1. LDR TX transmits the LDR SEND_S
2. HDR TX sends LYNK_SYNC after detecting LDR SEND_S
3. LDR TX moves to training when detects HDR SEND_S
4. HDR TX moves to training after LINK_SYNC was sent

LDR SEND_S, and HDR LINK_SYNC

100M SEND_S RS-FEC Training Frame

| 0 | 0 | 0 | 0 | 0 | 0 |

100M SEND_N RS-FEC Encoded Frame

| 65B #1 | 65B #2 | 65B #3 | 65B #4 | Reserved | FEC Parity |

- LDR SEND_S consists of a series of zeros scrambled by the data-mode's scrambler
- LDR SEND_S employs differential Manchester encoding, using the same coding as LDR SEND_T, and SEND_N

- The HDR LINK_SYNC signal replicates the LINK_SYNC signal sent in 802.3cy by the follower,
  - Occurring 16 times as [3.5 SEND_S frame followed by a quiet time]

Link Synchronization Detector in LDR Receiver
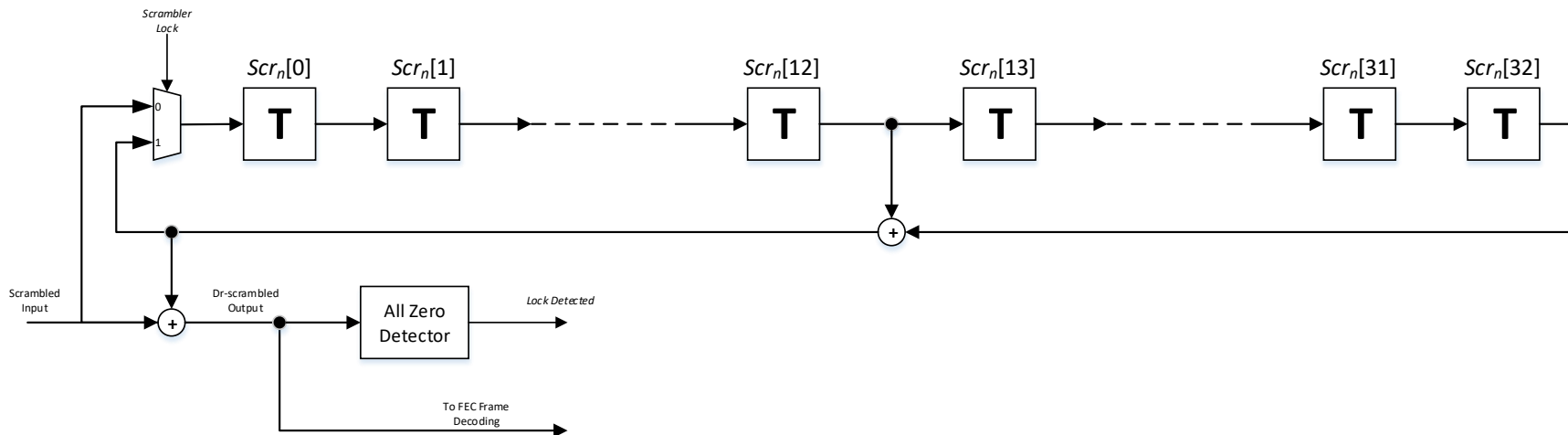
The link sync detector uses the excising side stream scrambler to lock on to the scrambled zero sequence. Initially the "*Scrambler Lock*" control signal is set to zero, but once lock is detected it is set to one and the scrambler stays locked from then on.

Continuous Link Sync: Benefits

- A more compact and simplified link synchronization detector

- In crystal-less mode, the circuitry used for timing recovery in data mode can also be used for coarse timing recovery in link synchronization

- A simplified link synchronization state machine

Continuous Link Sync: Concerns

- **reliability of the analog front-end**

  - The analog front end may degrade or get damaged due to reflections when the cable is disconnected

  - This issue is also relevant when using a sparse link synchronization signal, like those found in 802.3ch/cy

    - This is already part of consideration for analog front-end design

  - The automotive network functions as a pre-determined network(no loose links)

- **Increased power consumption during link synchronization**

  - The duration of link synchronization constitutes only a fraction of the overall link lifetime

  - A low data rate transmitter consumes relatively less power compared to other components

Looking forward to hearing any other concern or any input on these concerns

Conclusion

- A new synchronization method has been proposed for 802.3dm

- Thank you for ongoing feedback and comments

- Looking forward collaborating on this subject