FEC Latency Considerations

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Overview

- Evaluate the additional latency introduced if FEC is implemented outside of the MAC ASIC.
  - As required by :
    - SR4, CR4, PAM-N Multilevel coding schemes,
    - Existing legacy hosts that don't support 802.3bj NRZ FEC
- I have heard concerns raised that implementing FEC outside the MAC may be impractical due to added latency
  - So let's quantify what is possible in a vanilla 40nm TSMC CMOS process

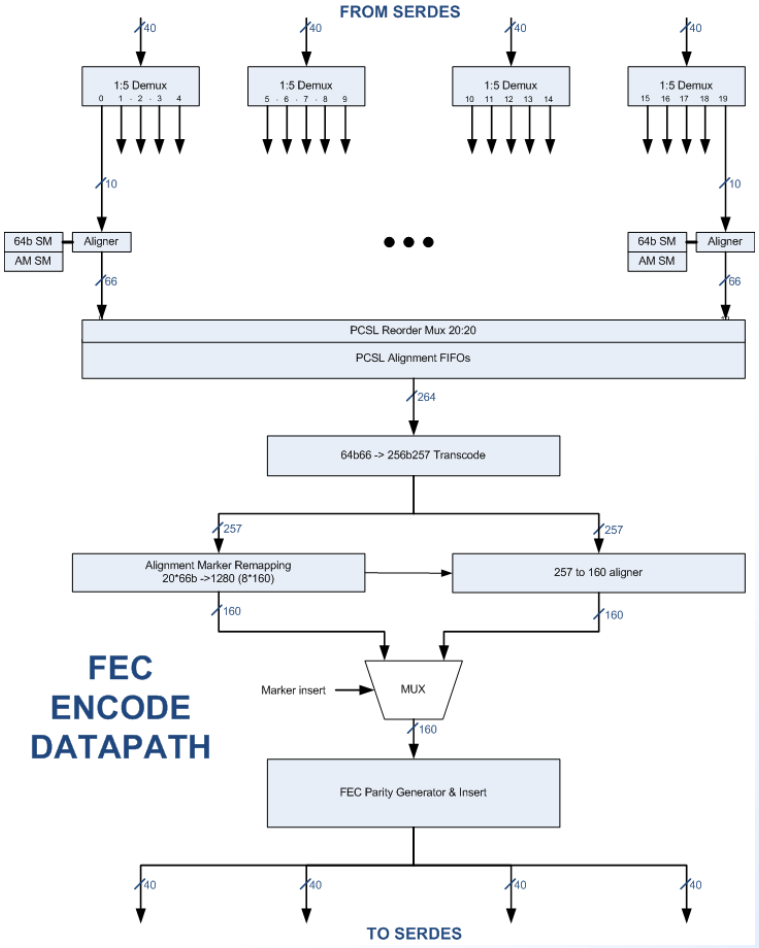
Assumptions

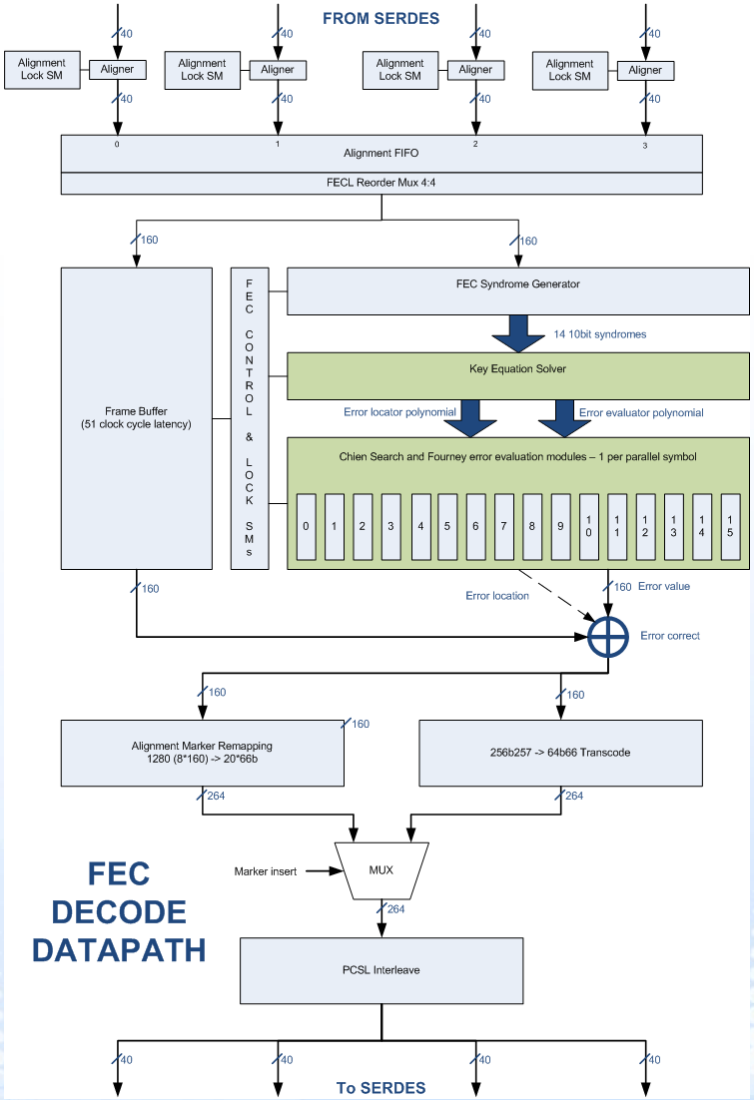
- Static skew due to optics in a 802.ba/bm link only needs to be removed once
  - If it is removed by a FEC PCS in a module it won't be removed again by the PCS in the MAC ASIC
  - No double-counting !
- So latency due to Static skew removal in a FEC PCS should not be counted as part of the latency "cost" of implementing a FEC PCS
- 802.3bj KR4 FEC

An implementation

- Prototype FEC datapath RTL, synthesized to a 40nm TMSC CMOS library
- 644Mhz datapaths (160bit @ 100Ge)
  - 1.5515ns clock cycle

Block Diagrams





FEC encoder Latency

- Latency breakdown
  - 64b66b Alignment, FIFOS, and PCSL ordering
    - 6 clock cycles (excluding static latency provision)
    - 9.3ns
  - Transcoding & mapping
    - 2 clock cycles
    - 3.1ns
  - Parity generation
    - 2 clock cycles
    - 3.1ns
- Total encode latency = 15.5ns
- Latency Delta vs FEC on MAC = 12.4ns

FEC decoder Latency

- Latency breakdown
  - FEC Alignment, FIFOS, and FEC ordering
    - 9 clock cycles
      - excluding static latency provision, but including dynamic skew
    - 14ns
  - FEC error correction datapath
      - Syndrome generator, Key Equation Solver, Chien/Fourney
    - 51 clock cycles
    - 79.1ns
  - Transcoding & mapping
    - 2 clock cycles
    - 3.1ns
- Total decode latency = 96.2ns
- Latency Delta vs FEC on MAC = 17.3ns

Conclusions

- The additional Latency introduced by implementing the 802.3bj FEC outside of the MAC can be less than 30ns
  - Encoder delta plus Decoder delta = 12.4+17.3 = 29.7ns
- The additional latency caused by implementing FEC on a module is not a show-stopper.
  - It is practical to implement FEC outside the MAC
  - PCS latency concerns should not preclude the use of different FEC coding for optical links