IEEE 802.3dm

Differential Manchester Encoding, Frequency Spreading, and Precoding

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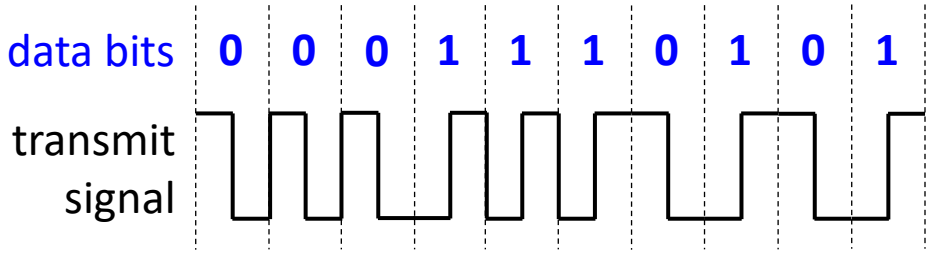
Overview

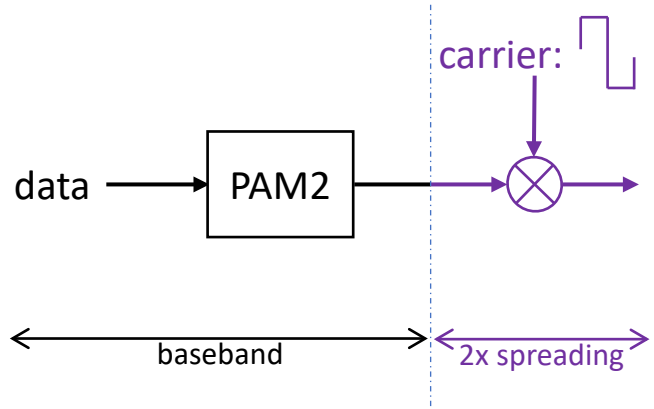
- Asymmetric concurrent transmission (ACT) includes Differential Manchester Encoding (DME) in the upstream transmitter
- Manchester Encoding is a basic form of spectral spreading that simplifies the upstream receiver, the AC-coupling and power delivery circuits
- Comparing to basic Manchester Encoding (ME), DME is known to double the bit error rate
- This presentation shows that, in contrast to ME, DME includes an implicit precoder which helps with equalization in receiver

Manchester Encoding

- Manchester encoding (ME) is the simplest form of spectral spreading with spreading factor of 2



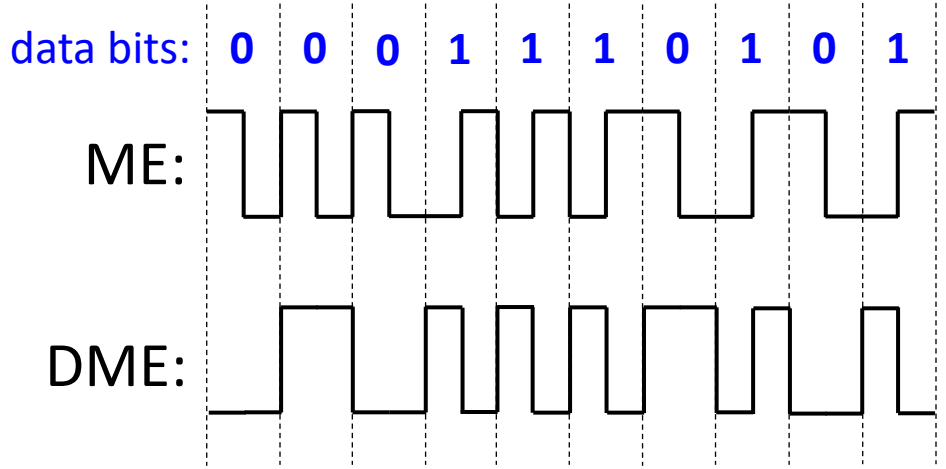
- It offers all benefits of frequency spreading (sedarat), including spectral shaping
  - ME forces a null at DC reducing the effect of baseline wander



Differential Manchester Encoding

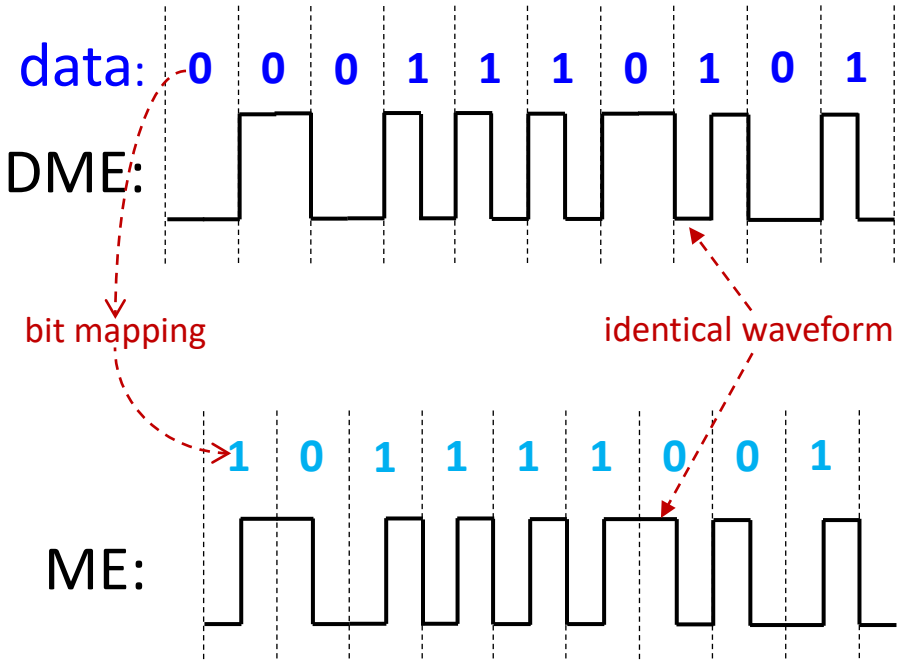
- Differential Manchester encoding (DME) is a variant of the basic form of Manchester encoding (ME)
- ME properties:
  - guarantees a transition in the middle of each transmit symbol
  - ME symbols depend only on the current data bit
- DME properties:
  - guarantees a transition at symbol boundaries
  - DME symbols depend on the current data bit and previous symbol

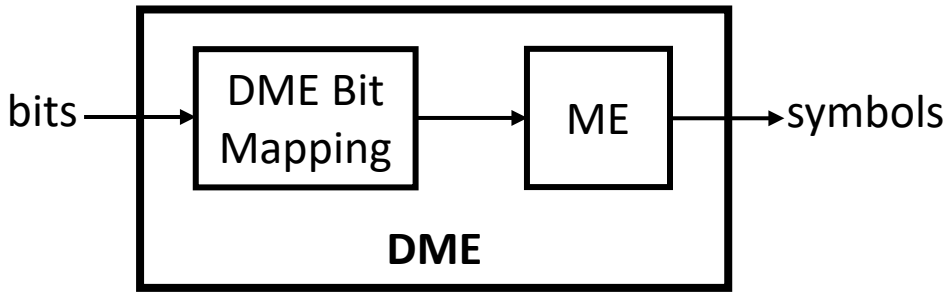
    ➔ One symbol error at the receiver may spread to two error bits!



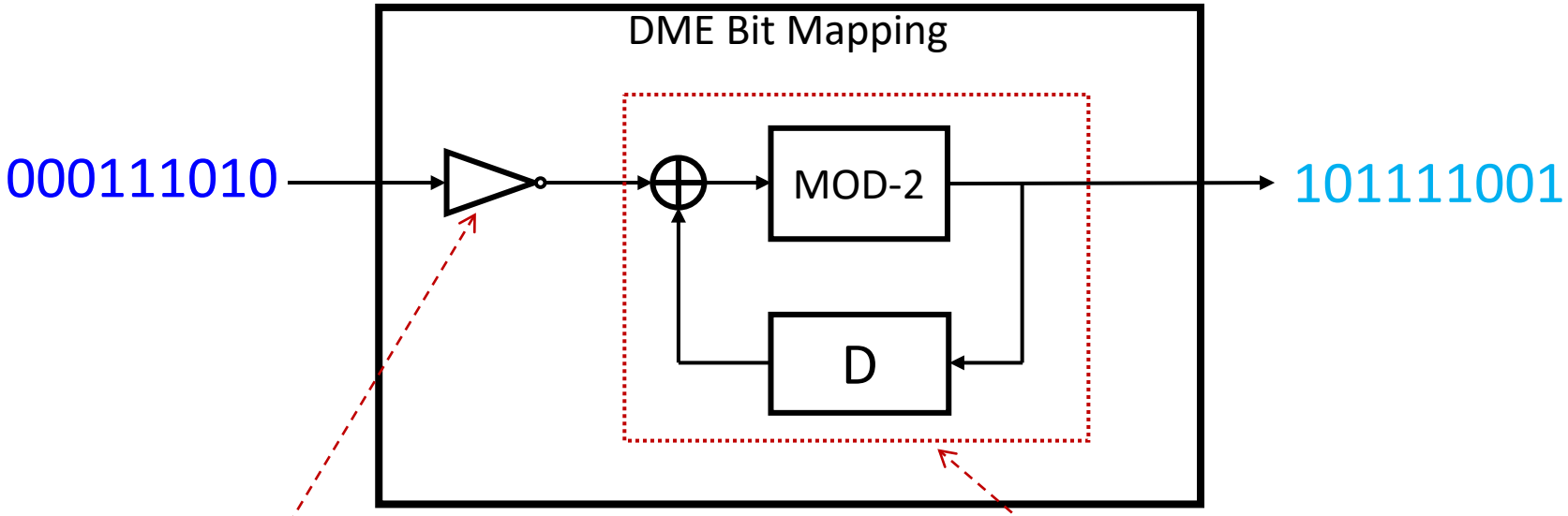
Deriving DME From ME

DME function is equivalent to ME preceded by a special form of bit mapping





DME Bit Mapping



Polarity inversion:
Reversible at the receiver and inconsequential

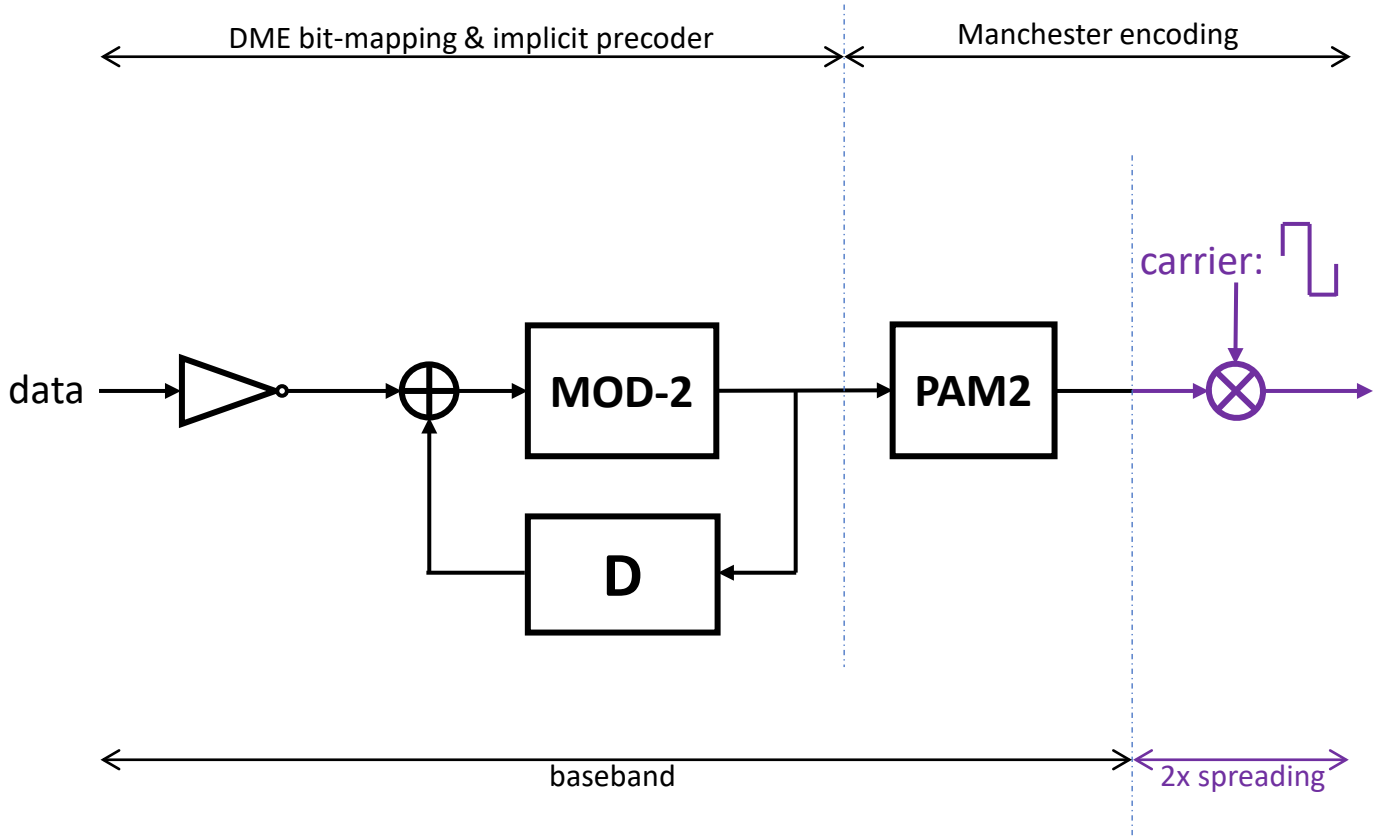
Nonlinear precoder:
A widely-use technique to assist with equalization and to reduce DFE error propagation

Transmit Nonlinear Precoding

- Transmit nonlinear precoding is studied for and adopted in several 802.3 specifications for the additional benefits in equalization

- A brief and partial list of contributions and standards:
  - 802.3bj - subclause 94.2.2.6: parthasarathy, bliss
  - 802.3bs: hegde
  - 802.3cd - subclause 135.5.7.1: hegde
  - 802.3ch - subclause 149.3.2.2.20: souvignier
  - 802.3ck: zhang, lu
  - 802.3cy: sedarat

DME: Equivalent Transmit Path



Summary

- Differential Manchester encoding proposed for upstream direction includes spectral spreading and implicit nonlinear precoder
- The implicit precoder enables additional design choices for equalization for the upstream receiver
- This perspective on DME operation offers a path to consider other widely-used options for precoder such as $(1 - D^2)$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Thank You