40GBASE-T Power Scaling

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Assumptions

- Modulation is 10GBASE-T with 4x symbol rate
  - 3.2Gbaud 128-DSQ PAM with (2048,1723) LDPC coding
  - Per zimmerman_3bqah_02_1213.pdf
- Channel is 30m 2-connector of CAT-8
  - Primary analysis driven by IL and delay dispersion
- Process is target for analysis is 14nm FinFET
  - Area scales by 25% from 28nm
  - Power scales by approximately 50% from 28nm
    - This 50% number is an aggregate of process analysis from two different foundaries, and accounts for re-pipelining digital for wider bus widths, etc.

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AFE Scaling

- AFE runs 4x faster = 4x power as no technology scaling for analog
  - 30% of AFE power is clock distribution
- Power scaling assumptions from 28nm versus ENoB:
  - Same as 10G: 3.4x
  - 1 bit less than 10G: 2x
  - 2 bits less than 10G: 1.3x
- Based on Larsen July presentation showing 31 dB IL for CAT-8 channel:
  - translates into 1 bit less ENoB than 10GBASE-T
  - latest Cat-8 channel specifications have 3 dB less IL
- Detailed analysis agrees with basic results in grimwood_3bq_01_1113.pdf (1.3 to 1.5x 10GBASE-T)

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Digital Power Scaling

- Digital Filter Scaling
  - 30m @ 40GBASE-T increases effective tap-length of echo cancellation 20% versus 10GBASE-T
    - Significant portion of filter area is for echo cancellation
      - Increased importance of echo relative to where it was in 10GBASE-T
  - Base result at 40GBASE-T in 14nm is 2.16x power than 10GBASE-T in 28nm
- FFE and FEXT cancellers should be fine with existing 10G tap lengths
  - NEXT canceller may need to increase depending on channel reflection points
- Balance of Digital:
  - Canceller lengths remain similar to 10GBASE-T
  - Remaining digital scales by 2x the power

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Restricted Echo Cancellation

- Opportunity for improvement:
  - "Restricted" or "Sparse" Echo
  - Cancel echoes only from a subset of taps

- Moving to "restricted" echo cancellation could potentially cut echo-canceller power by 75%
  - Assumption is that since we are in a two connector datacenter model, we may be able to utilize the fact that there are limited points of reflection to simplify the equalization
  - Still requires fast response to areas of bending on cable

- This would give a 40GBASE-T filter power increase of 1.44x

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Overall Power Scaling Relative to 10GBASE-T

Totals	Full Echo Cancellation	Restricted Echo Cancellation
1 bit less ENOB	205%	183%
2 bits less ENOB	178%	156%

- Strawman gives estimated 40GBASE-T power of 1.6 to 2.1x today's (28nm) 10GBASE-T at introduction
  - Includes 10GBASE-T area/power requirements
- Time to market aided & risk lowered by large reuse of 10GBASE-T technology
  - Material changes in baud/signaling unlikely to buy much

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