Toward Intelligent Interconnect Fabrics

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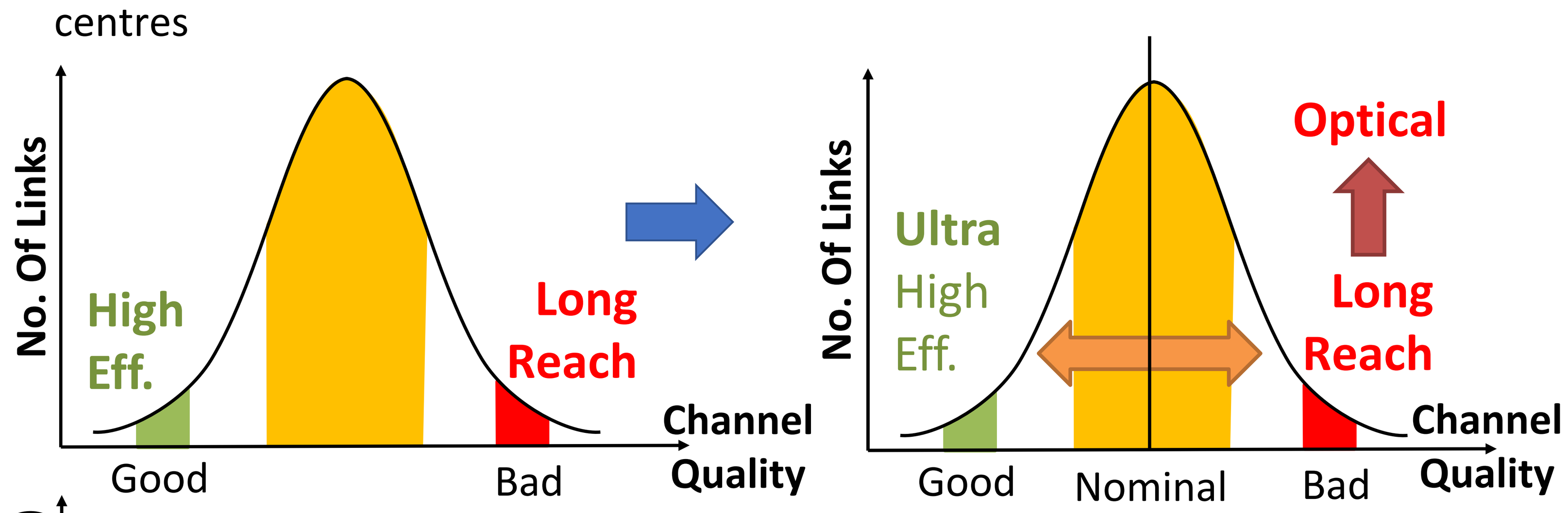
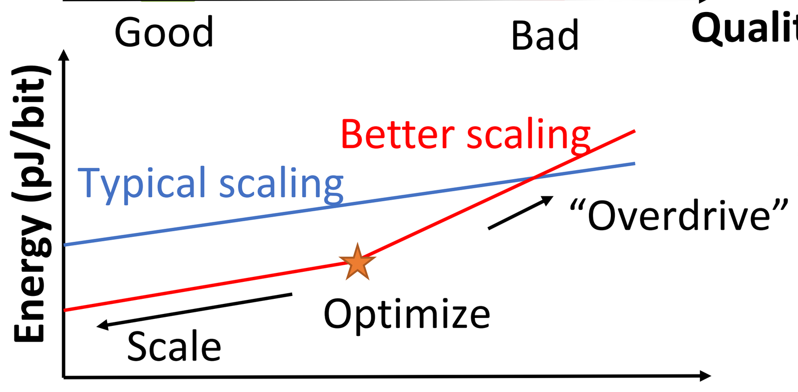
Currently:

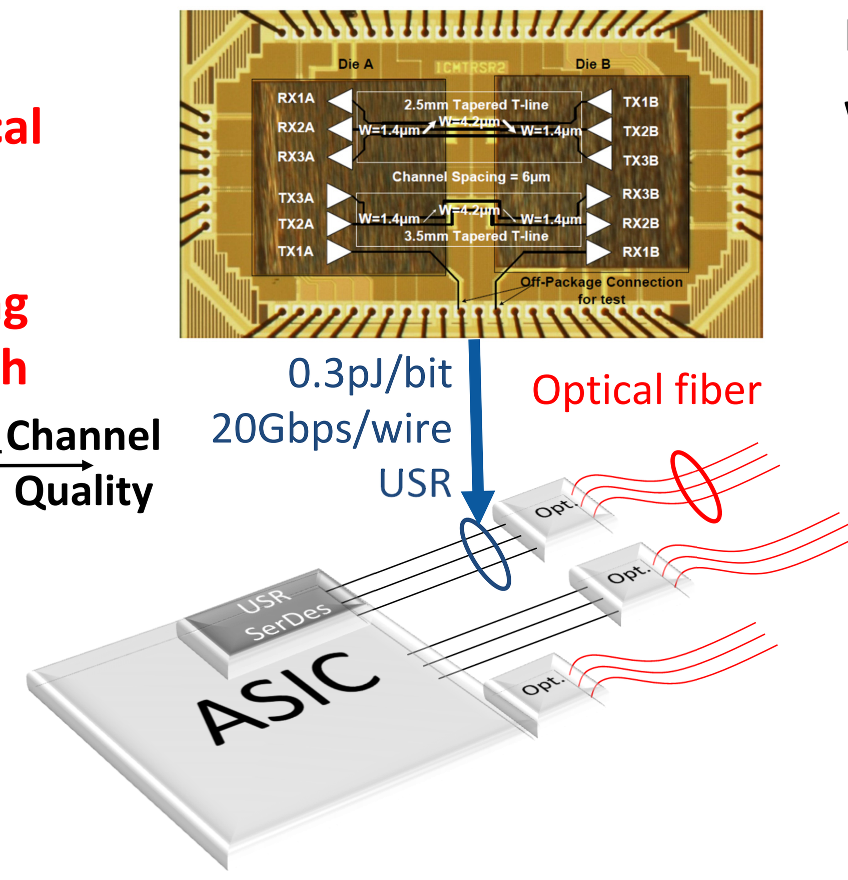
- There is a tremendous diversity of interconnect channels within data centres





- The diversity promises to increase further with the emergence of new interconnect paradigms: USR and optical

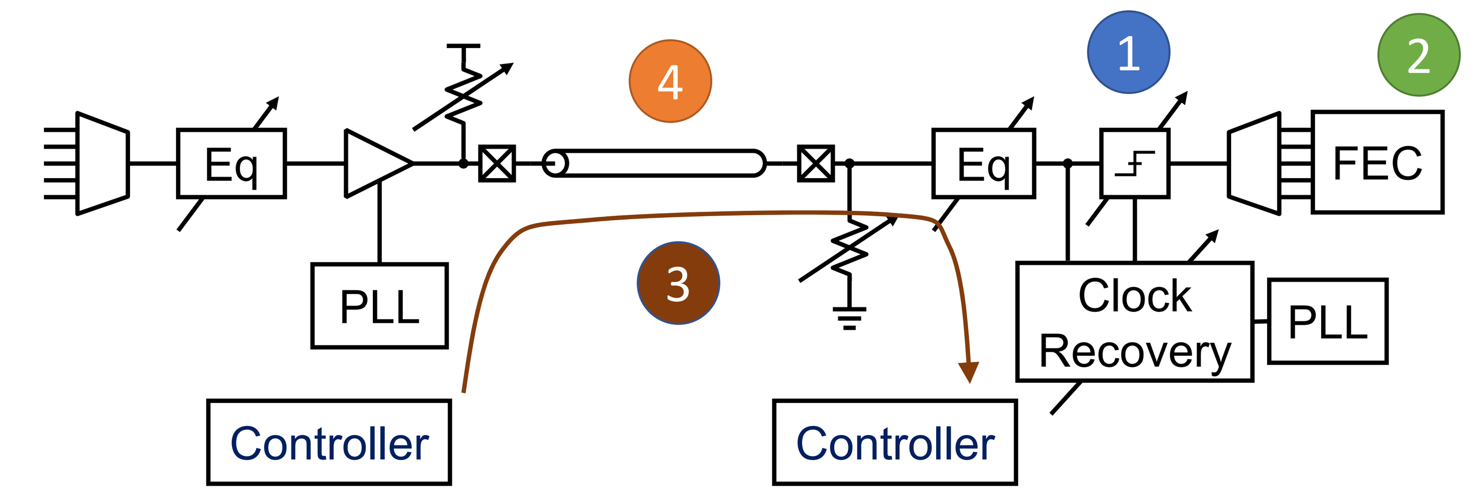
[Dehlaghi et al, JSSC, 2018]

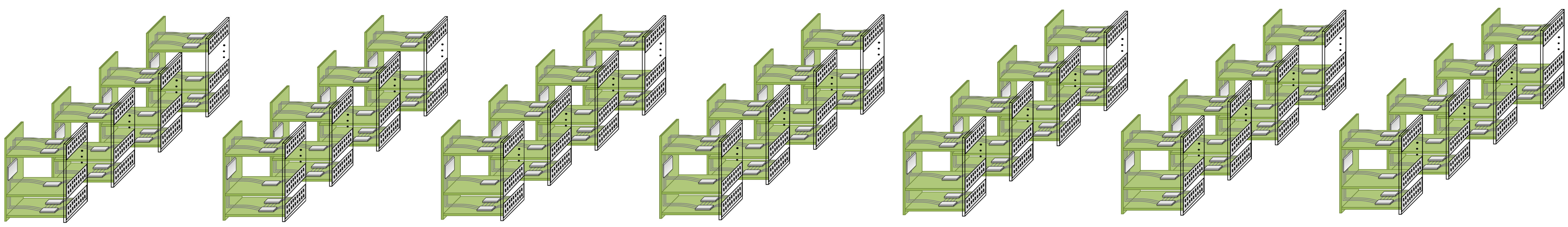


- Optimizing performance over this wide diversity of channels requires some combination of
  - Tailored transceiver circuits
  - Power-scalable transceivers

Future Vison: Interconnects with intelligent physical layers that autonomously optimize themselves to meet dynamically varying performance demands while minimizing overall power consumption

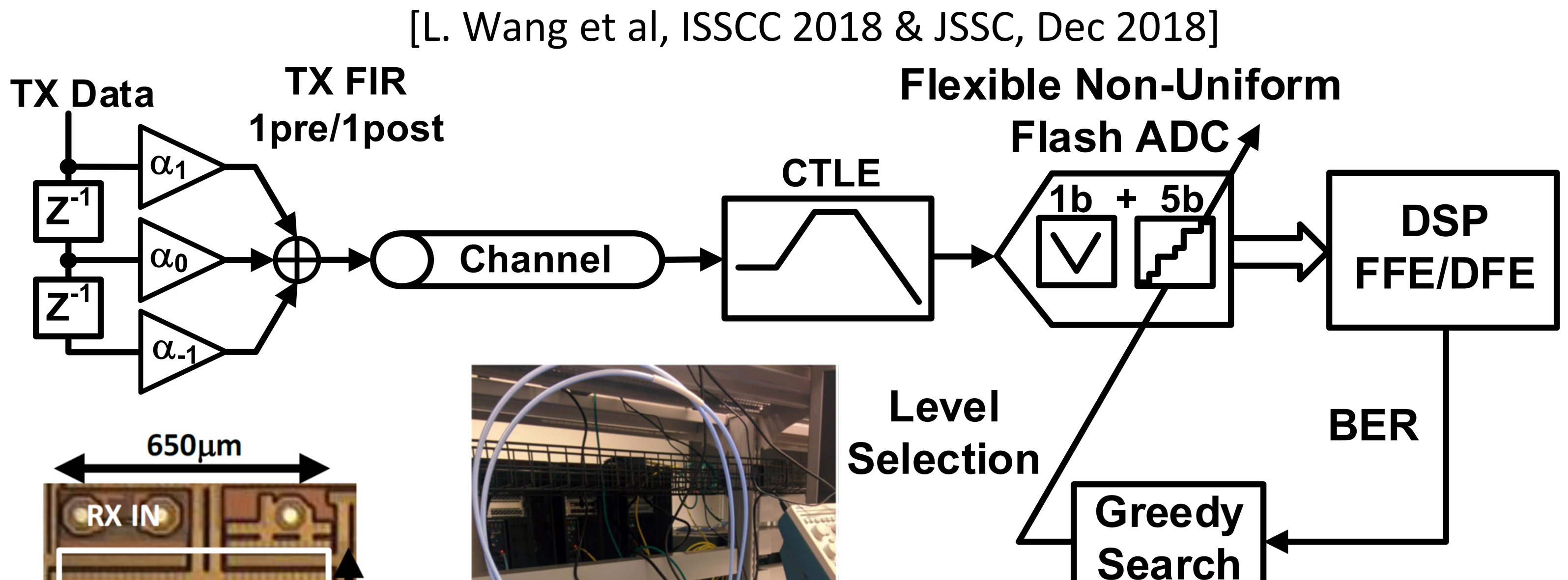
- Research projects under this vision detailed in the boxes below:

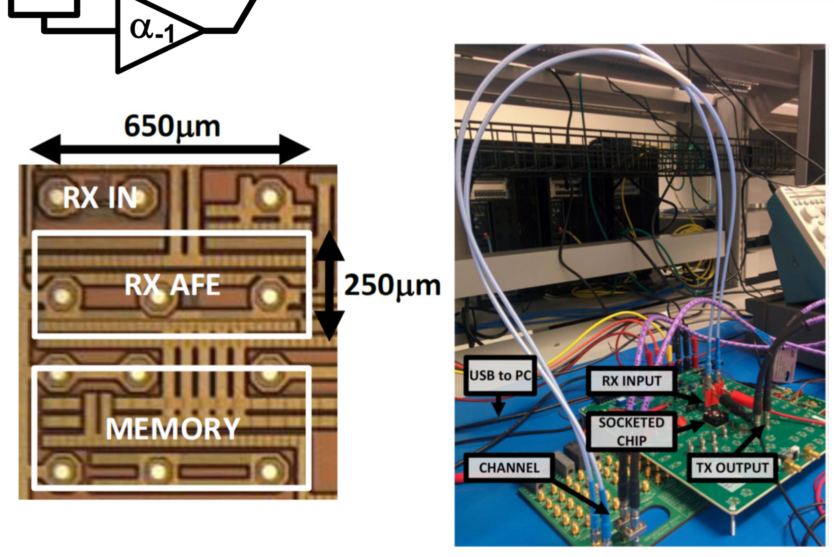




1 64Gb/s 4-PAM Receiver with Adaptive Non-Uniform ADC in 16nm FinFET

[L. Wang et al, ISSCC 2018 & JSSC, Dec 2018]

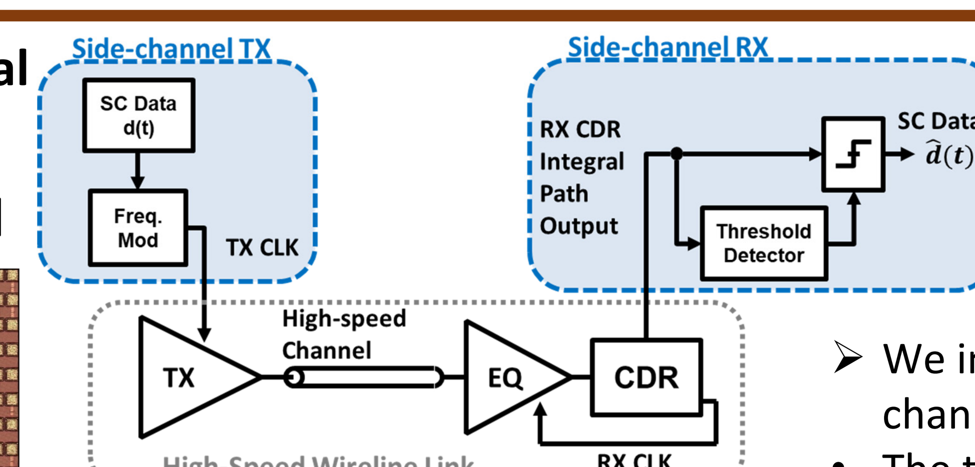




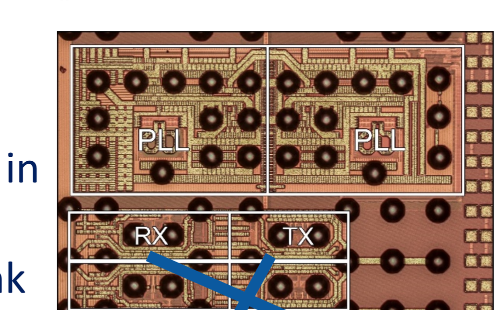
- Rx front-end with power-scalable non-uniform ADC
- Evolutionary algorithm used to optimize the front-end quantization levels

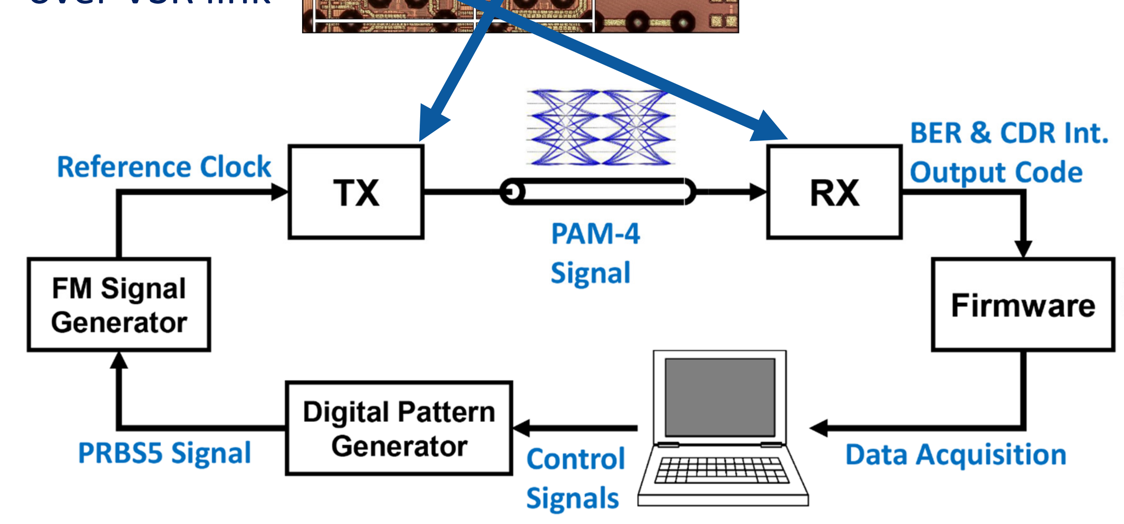
3 FM Side-Channel for Physical Layer Co-Optimization

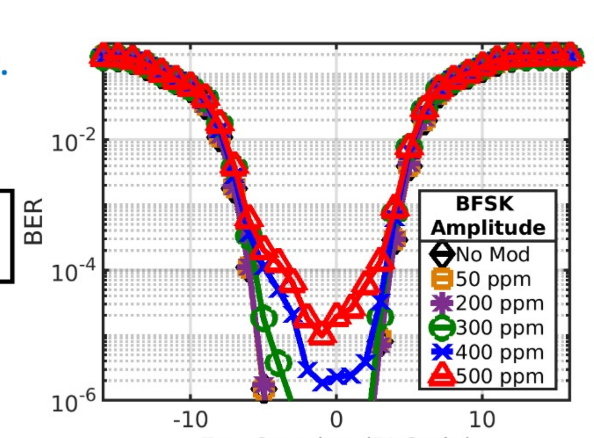
[Y.F. Zhang et al, SSC Lett., 2020]



60Gbps 4-PAM Demo in 7nm FinFET over VSR link





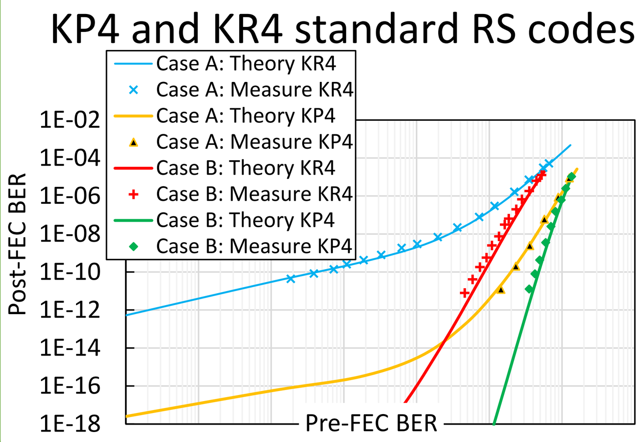


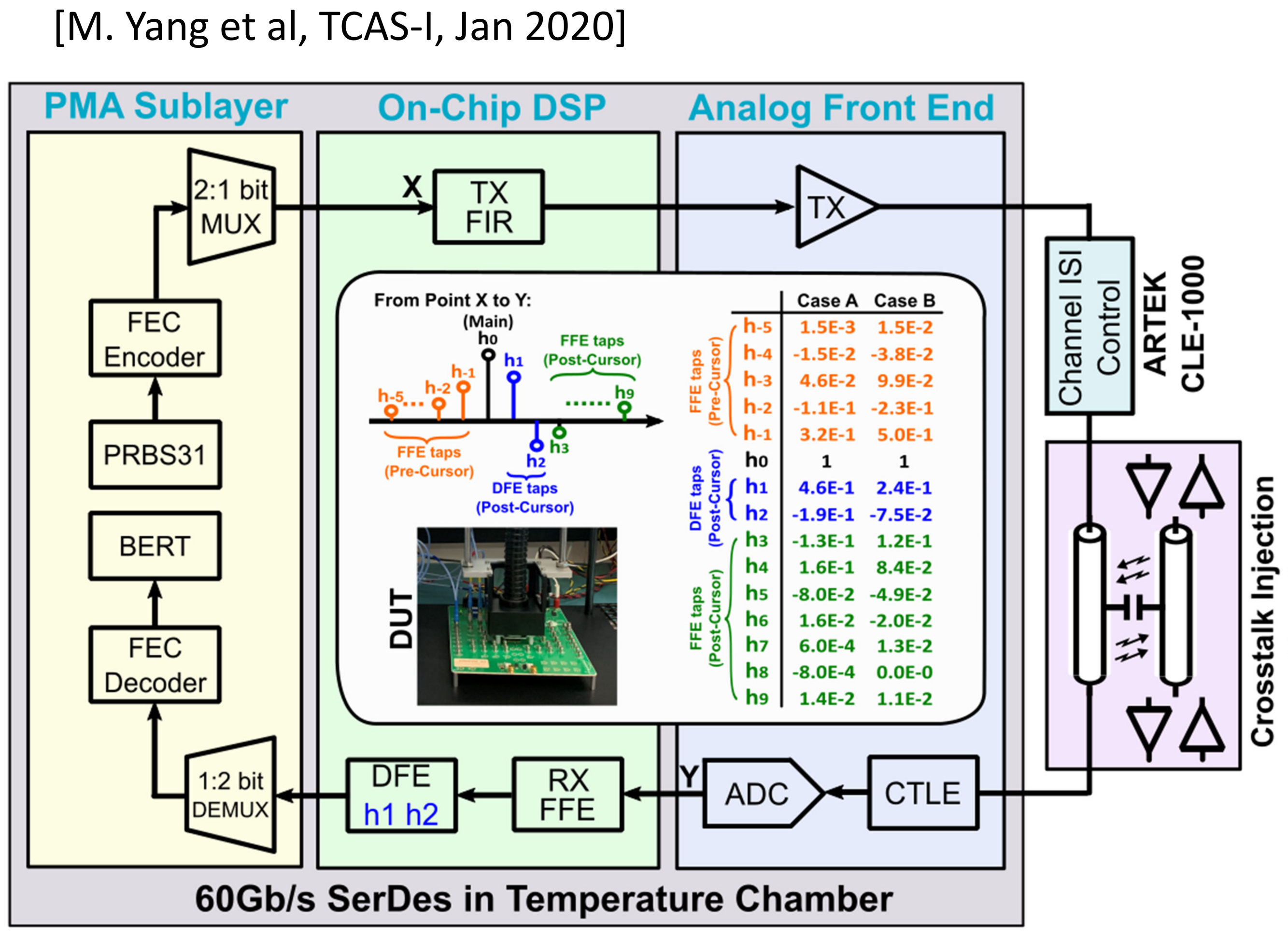
- Transceiver physical layers need to communicate to adaptively co-optimize their performance
- We introduce a low-speed "side-channel" to facilitate this
- The transmitter can be frequency modulated with side-channel data and recovered by the receiver CDR
- By selecting an appropriate frequency modulation depth, high-speed signal integrity is unaffected
- Demo side-channel at 50kbps with 200ppm frequency modulation

2 Accurate Post-FEC BER Estimation in the Presence of Burst Error Sources

[M. Yang et al, TCAS-I, Jan 2020]

- Post-FEC BERs below 10^{-15} are required, but can not be confirmed in simulation
- We developed a statistical (Markov-based) model of post-FEC BER including DFE burst errors and other important noise sources
- Validated with measurements of a 60Gbps 4-PAM LR transceiver in 7nm FInFET with KP4 and KR4 standard RS codes

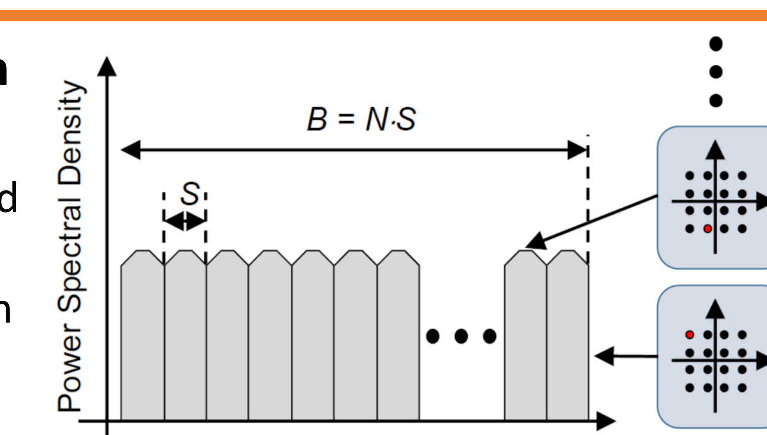


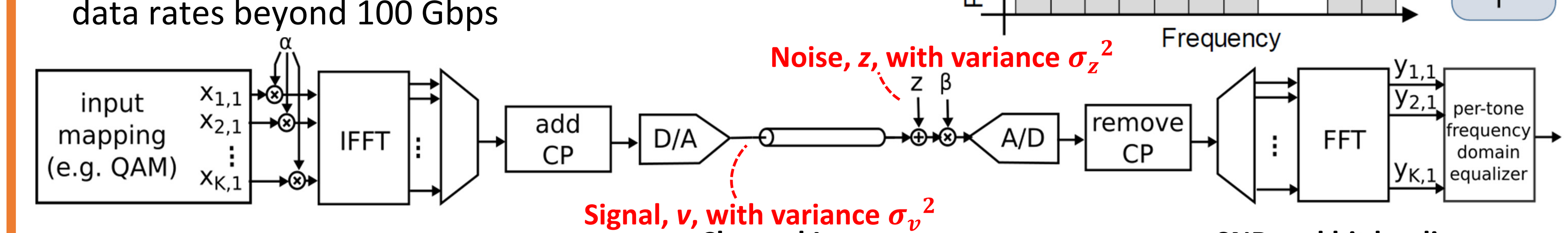


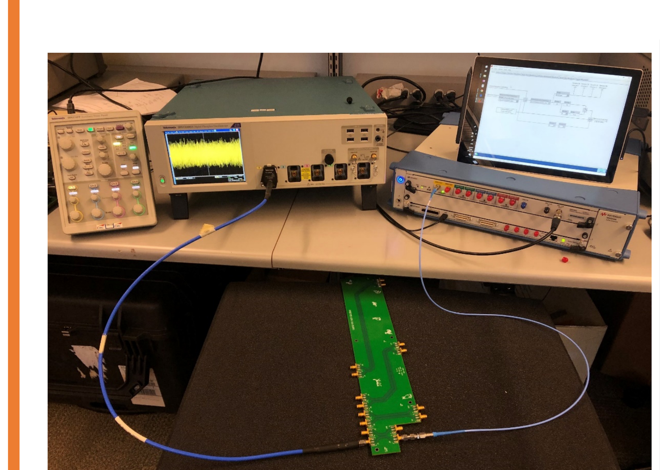
4 Discrete Multitone Wireline Communication

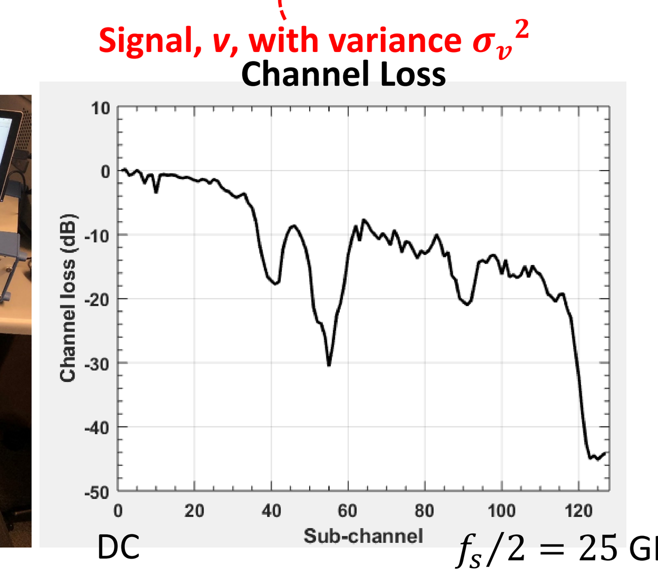
[B. Vatankhahghadim et al, ISCAS 2020]

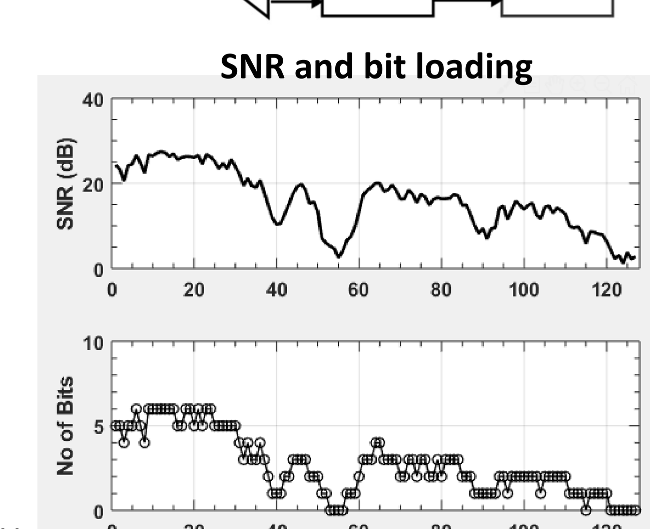
- DMT is a flexible modulation format that can be adapted to a wide variety of rates and channel conditions
- Spectral efficiency can exceed that of 4-PAM modulation
- Shown below is a lab platform for evaluation of DMT at data rates beyond 100 Gbps











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