BIT-RATE BOUND DERIVATION FOR COMPRESSED TIME-DOMAIN FRONTHAUL

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MOTIVATION

- Fronthaul (FH) is one of the key enablers for C-RAN to further increase radio network capacity, and to reduce the radio cost and energy consumption
- Main challenge for FH: too high capacity for transporting IQ samples as specified in CPRI (time domain FH)
- FH compression and protocol stack split like PHY/MAC split are two main approaches to reduce FH bit rate
- We focus on time-domain FH compression, which has the advantage being standard transparent
- Main contribution of this work is the development of a lower bound for FH bit rate, showing the maximum achievable compression with the trade-off of performance (e.g. EVM)

REDUNDANCY ANALYSIS (EXAMPLE OF LTE)

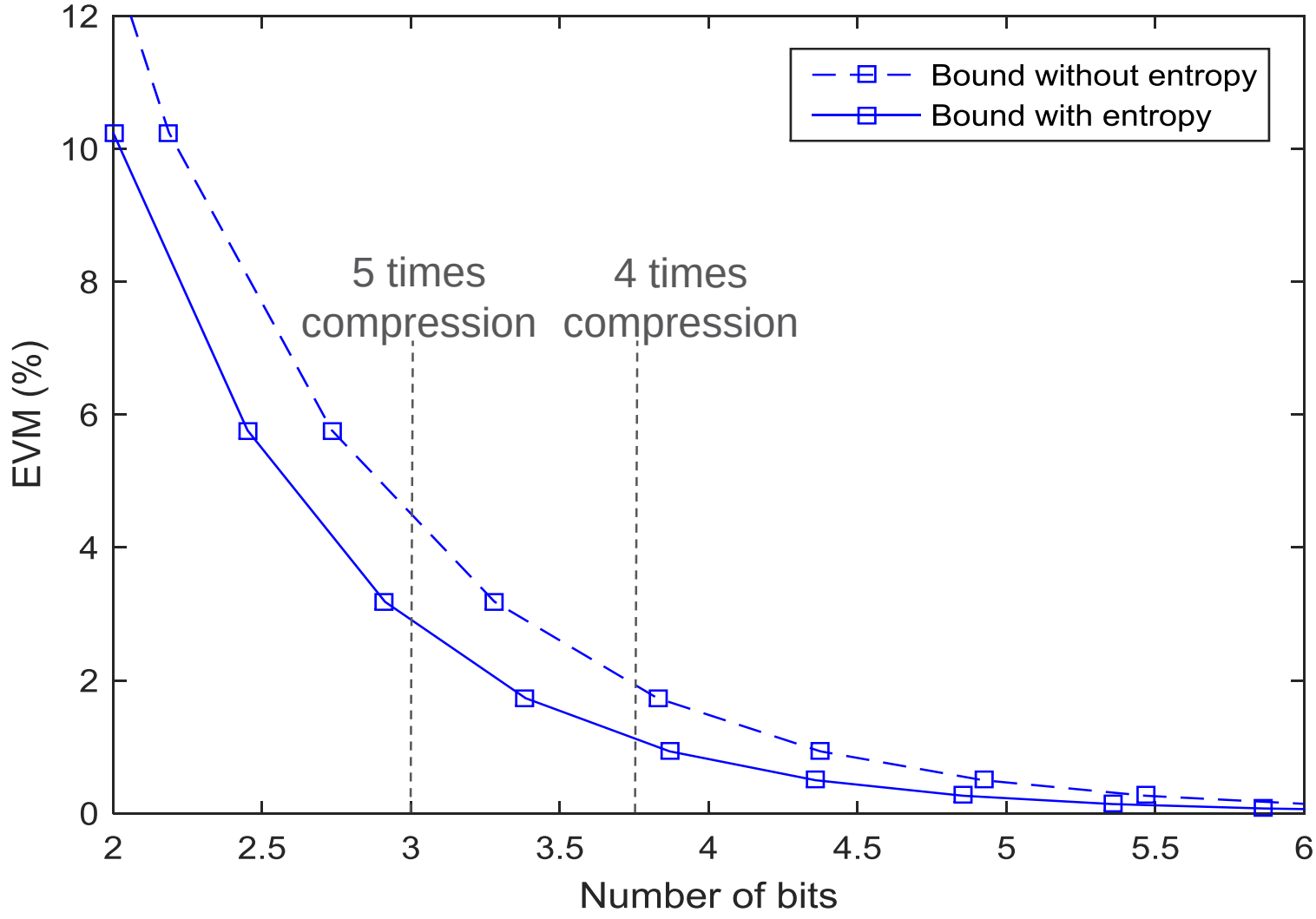
- *Cyclic prefix*
  - 6.67% CP overhead
- *Oversampling*
  - *Only1200 out of 2048 subcarriers are used*
  - 30.13% overhead comparing to Nyquist sampling
- *Over-quantization*
  - *15 bits per I/Q: > 80 dB SQNR*
  - *256-QAM requires ~30 dB SNR*
  - *If 7 bits is sufficient, there is 53% overhead*
- *Entropy coding*
  - Lossless compression, like Huffman, approaches the entropy

DERIVATION OF LOWER BOUND

- Lower bound can be found by taking out all redundancies identified with the consideration of radio performance (e.g. SNR)
- Three steps:
  - Calculate SQNR for a given quantizer. We use the optimal uniform quantizer [1] for getting the highest SQNR given a number of bits
  - Assume normal distribution of the IQ samples, calculate the entropy values for different numbers of bits
  - Finally remove other redundancies, i.e. CP and over-sampling.

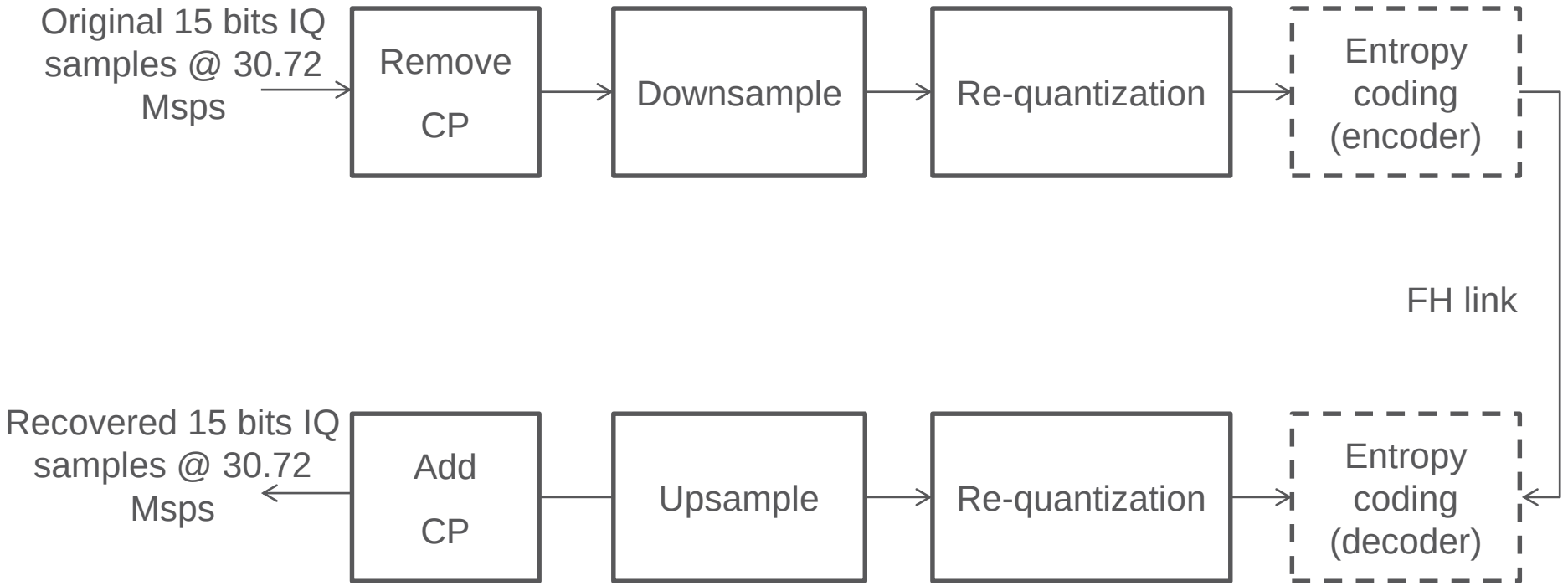
[1] Michael Bernhard, David R¨orich, Thomas Handte, and Joachim Speidel, “Analytical and numerical studies of quantization effects in coherent optical OFDM transmission with 100 Gbit/s and beyond,” ITG-Fachtagung Photonische Netze, Leipzig, Germany, 7-8 May 2012, pp. 34-40.

DERIVED LOWER BOUND

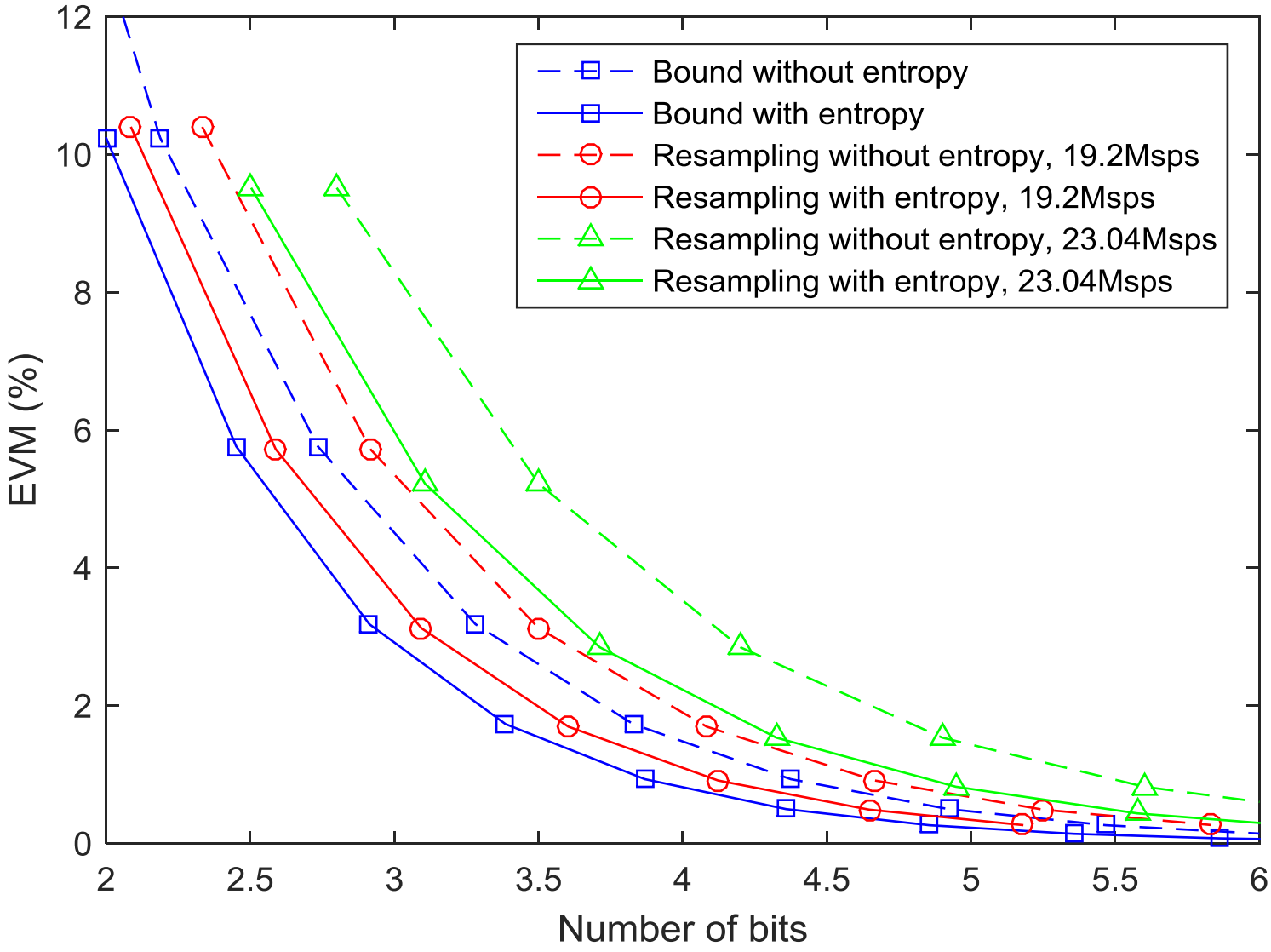


Note: 20 MHz LTE: 5 times -> 184 Mbps, 4 times -> 230 Mbps

SIMULATION DIAGRAM



SIMULATION RESULTS



CONCLUSIONS

- Large redundancy identified in time-domain FH, mainly in over-sampling and over-quantization
- Entropy coding can further reduce the rate
- 4-5 times compression is achievable without compromising the radio performance

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