ICWMC/MAAZE: Wireless Communications: The March Towards Absolute Zero

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An Open Question

- What is the operating SNR per bit of the present day mobile phones?
  - No answer in the open literature

- Surprisingly, the SNR per bit has not been used as a performance measure in the context of wireless communications.
A coherent receiver requires the minimum signal-to-noise ratio (SNR) per bit to achieve a given bit-error-rate (BER)

- This translates to a longer battery life in the mobile
- Sync and channel estimation required – training (preamble) needs to be transmitted along with the data

- Data is organized into frames, QPSK modulation
- A rate-1/2, 4-state turbo code is used to improve the BER
- A frequency selective Rayleigh fading channel having a uniform power delay profile is assumed
- Channel is static over one frame, varies independently from frame-to-frame
The other impairments considered are the carrier frequency offset (CFO) and additive white Gaussian noise (AWGN).

Orthogonal frequency division multiplexing (OFDM) converts a frequency selective (multipath) channel into a frequency flat channel, thereby eliminating intersymbol interference (ISI).

Two transmit and two receive antennas are considered (2 × 2 MIMO OFDM system).

Channel is independent across different transmit and receive antennas.
Contributions

- Discrete-time algorithms have been developed for carrier and timing synchronization and channel estimation.
- The minimum SNR per bit for error-free transmission over fading channels has been derived and shown to be identical to that of the AWGN channel, that is, $-1.6 \, \text{dB}$.
- Simulations results for a $2 \times 2$ turbo coded MIMO OFDM system indicate that a BER of $10^{-5}$, is obtained at an SNR per bit of just $5.5 \, \text{dB}$, which is a $2.5 \, \text{dB}$ improvement over the earlier work.
  
  The best so far in the open literature.

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The concepts can be extended to massive MIMO systems.

- The peak-to-average power ratio (PAPR) of the transmitted signal needs to be addressed.