Reducing the feedback information in OFDM-based Adaptive Modulation Systems for 4G

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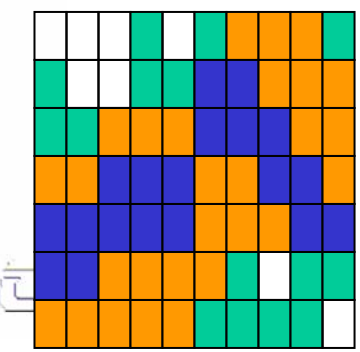
(Work performed in STSM in Chalmers)

Outline

- OFDMA for Downlink in 4G.
- Feedback information.
- Likely Feedback.
- System Description.
- Algorithms for compression:
  - Time correlation
  - Frequency correlation
  - Time-Frequency correlation
- Results.
- Conclusions.

OFDMA for downlink in 4G

- Several techniques for Downlink.
- OFDMA (Orthogonal Frequency Division Multiple Access) is a strong candidate.
- The BS (Base Station) allocates the different user's transmission across the orthogonal frequencies.



Feedback Information

- The Adaptive Modulation selects the adequate modulation squeme according to instantaneous channel conditions.
- Channel is usually known (estimated) at the receiver.
- The receiver should feedback this information.
- It may be highly rate-demanding.

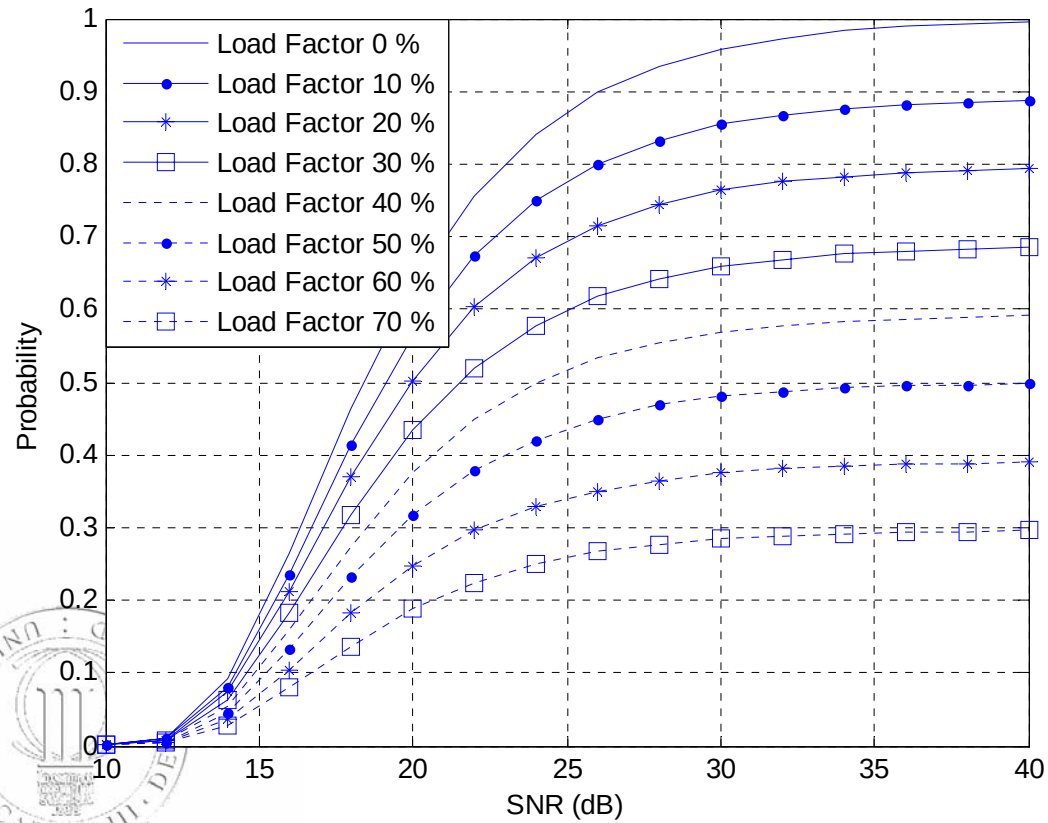
Compression

Likely Feedback

- The scheduler usually selects the best user(s) for transmitting. Maximum Throughput criterion.
- It is a waste of resources if a terminal with a bad channel feeds back its data (it will never be served except for fairness policies).
- The BS broadcasts a minimum quality for feeding back.

Likely Feedback (cont)

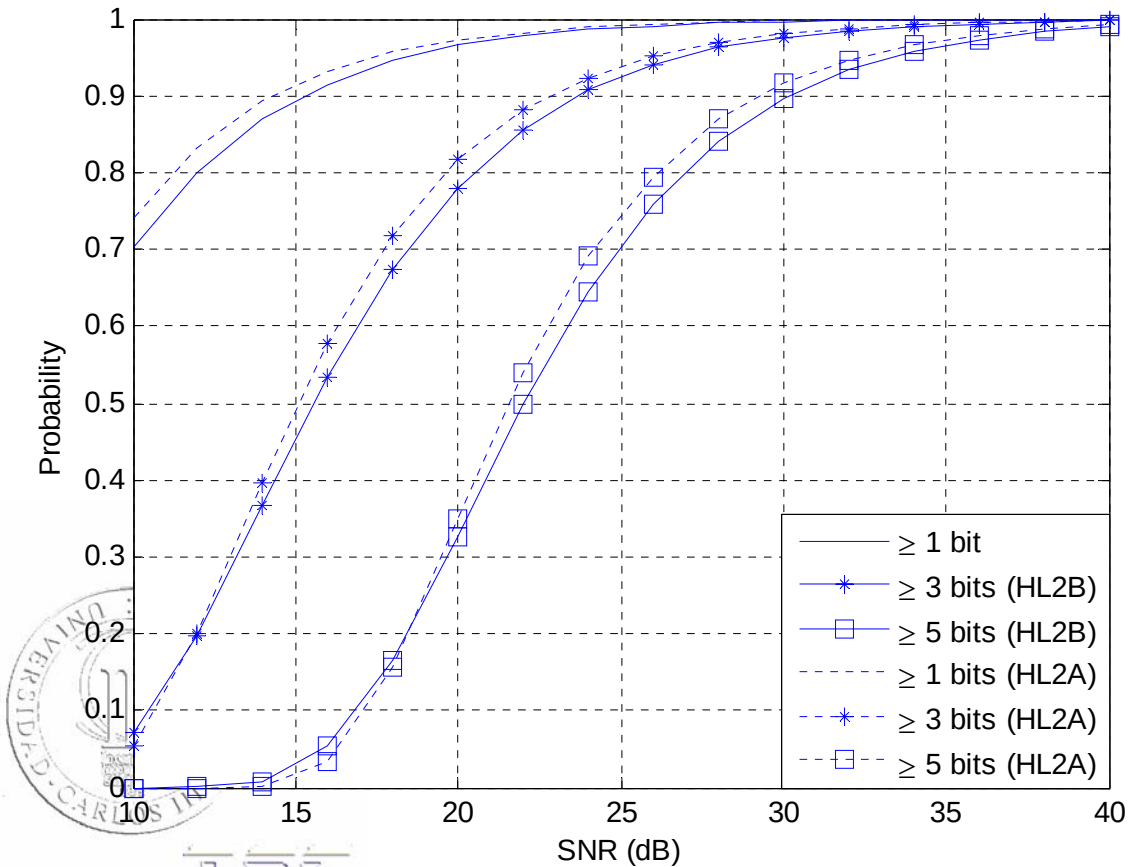
Prob of finding a subcarr able to tx >= 4 bits



HiperLAN 2 A Channel

(Load factor = % subcarr occupied when user arrives)

Likely Feedback (cont)

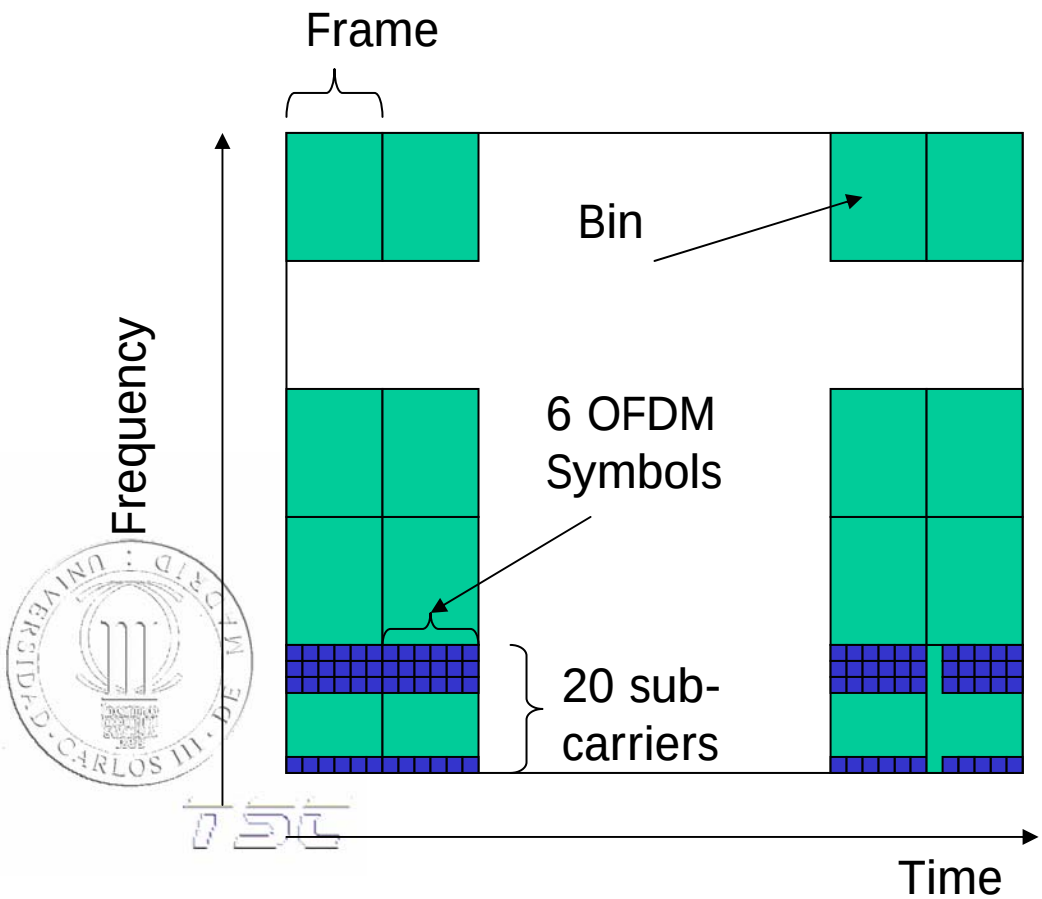


Load Factor = 0 %

System Description

- Downlink OFDMA.
- BW = 500 MHz.
- Sub-carriers divided into groups of 20 sub-carriers during 6 OFDM symbols = bin.
- 25 bins total.
- The same modulation scheme on the same bin but different (possibly) among them. Adaptive Modulation at bin level.
- UMTS channel models: vehicular A, pedestrian A.

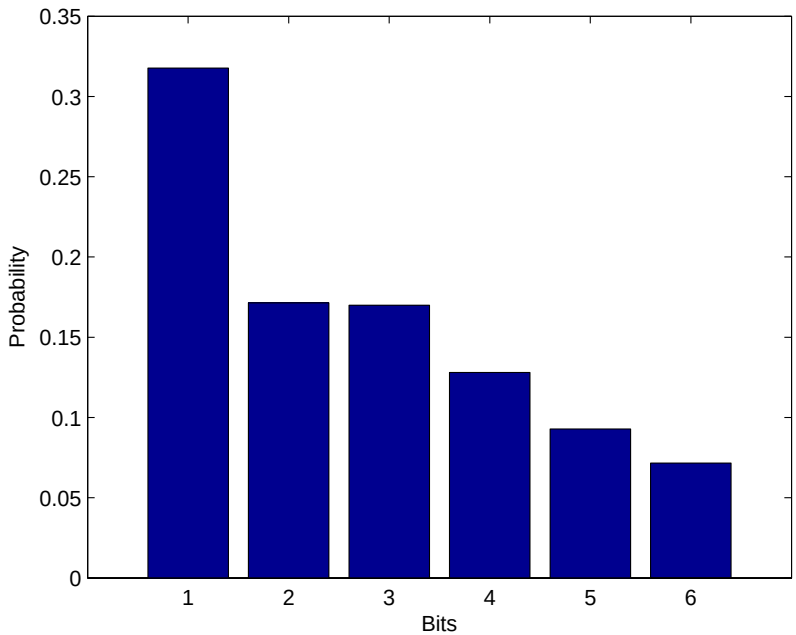
System Description (cont.)



Algorithms for compression

- Huffman coding for compression. Needs well conditioned data.

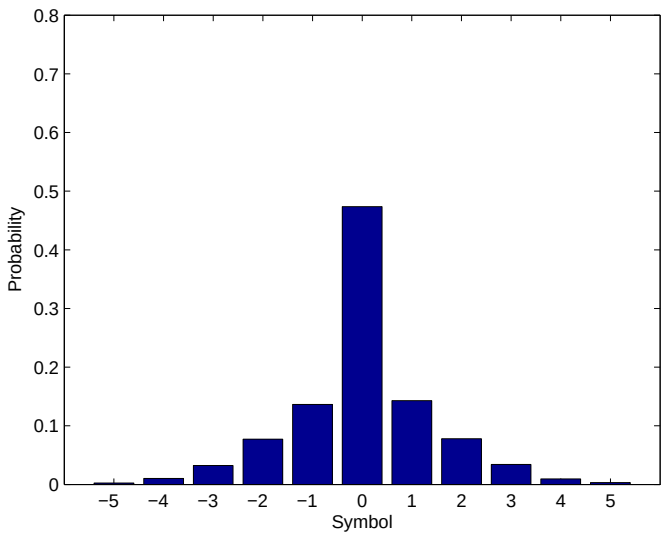
- Using Time correlation.
- Using Frequency correlation.
- Using Time-Frequency correlation.



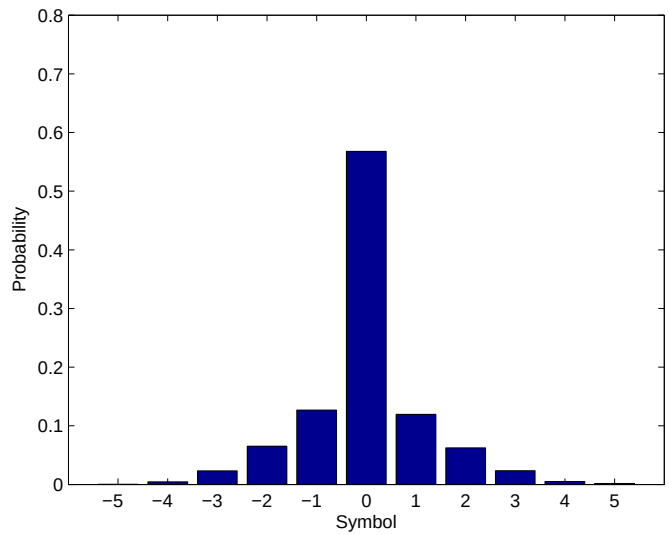
(BPSK, QPSK, … 64QAM)

Time and Frequency Correlation

Feed-back difference between actual and former bin

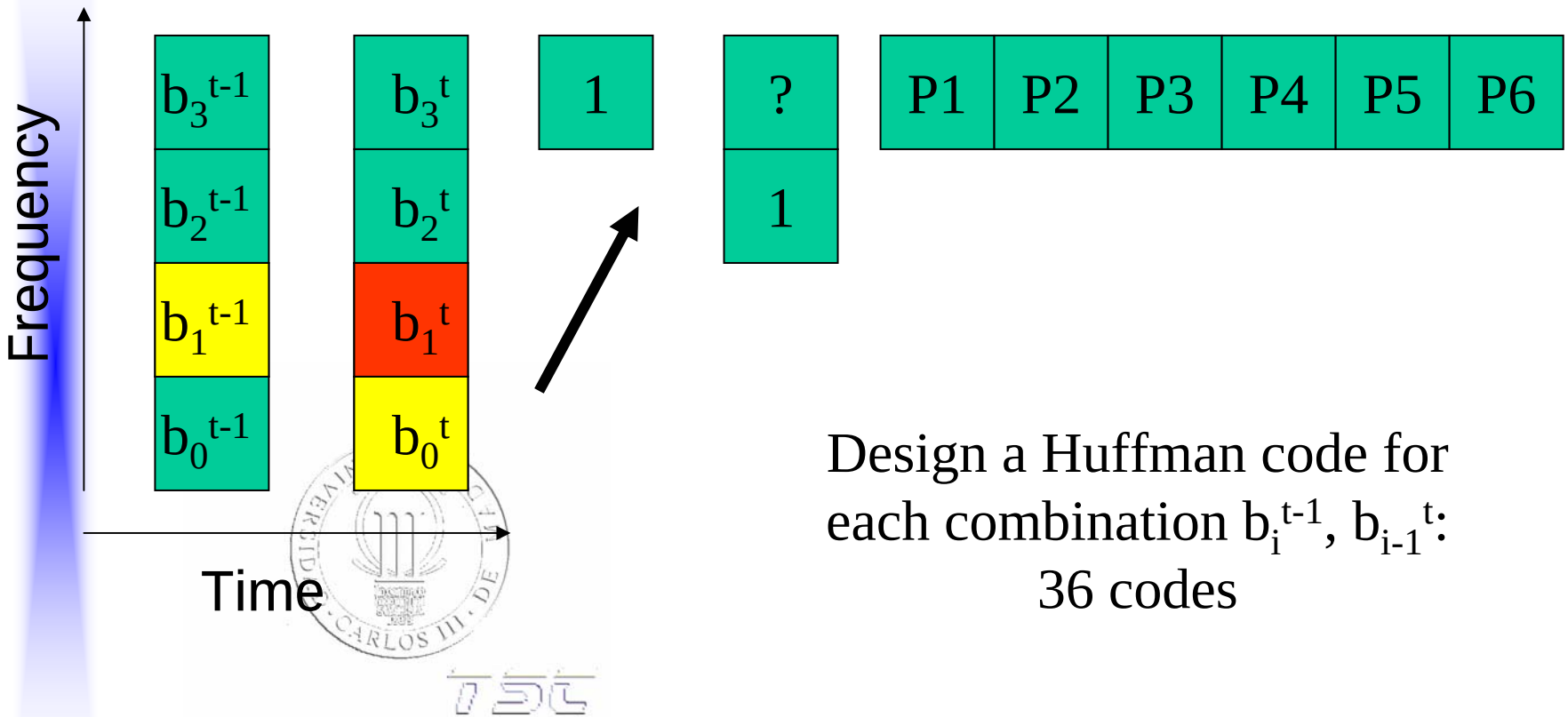


Time



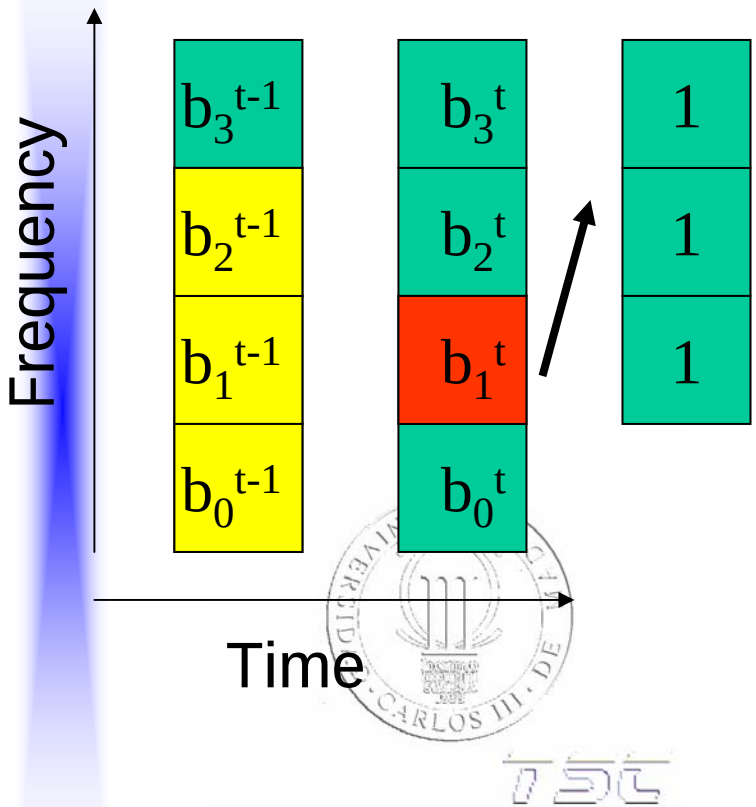
Frequency

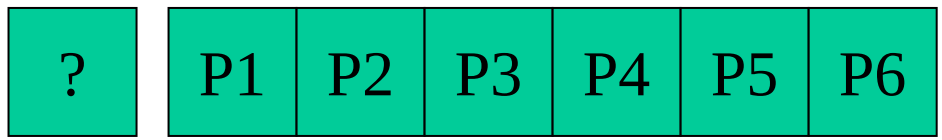
Iterative Time-Frequency



Design a Huffman code for each combination b_i^{t-1}, b_{i-1}^{t}: 36 codes

Block Time-Frequency

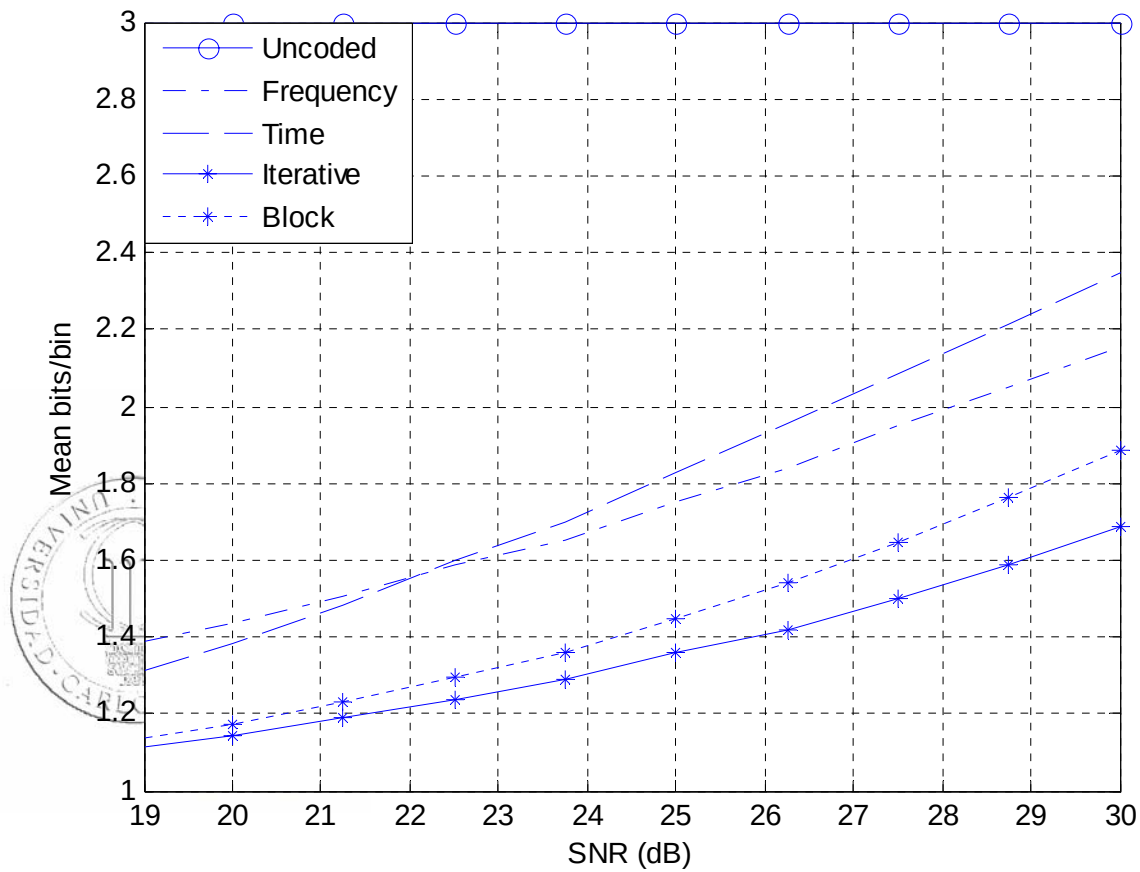




Design a Huffman code for each combination b_{i-1}^{t-1}, b_i^{t-1} , b_{i+1}^{t-1} : 216 codes

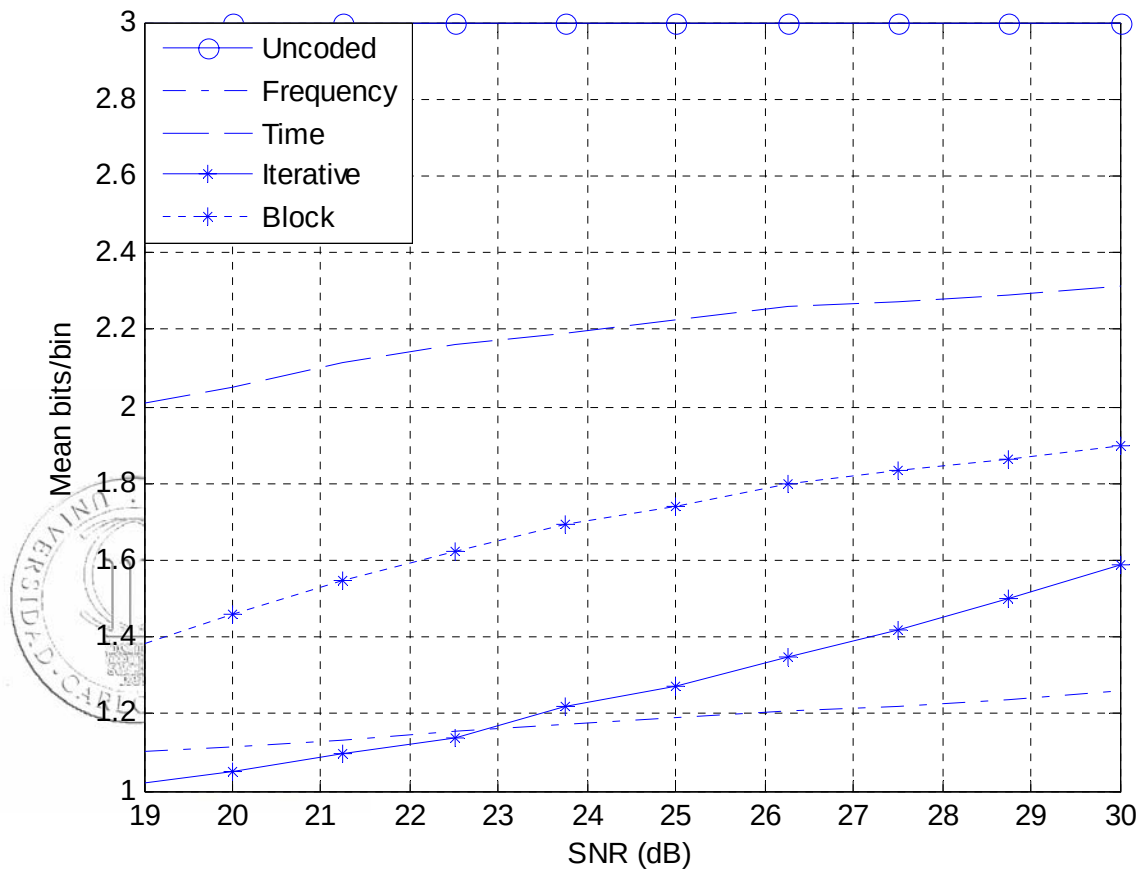
Results (UMTS Vehicular A)

Comparison for 120 km/h



Results (UMTS Pedestrian A)

Comparison for 10 km/h



Conclusions

- Likely feedback allows 50 % of reduction in feedback data.
- The compression of feedback data by using time, frequency or both correlation is feasible and offers compression in the range of 50 %.
- Time-Frequency techniques exhibit better performance than the others (in general).
- Compression algorithms jointly with Likely feedback allow reductions of more than four times.
- Once the codes are designed and stored, complexity is negligible.
- Adaptivity in Future OFDMA systems is closer to be implemented.

Thank you very much

Any Questions or Comments

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