Dynamic Distortion Control for 3-D Embedded Wavelet Video over Multiuser OFDM Networks

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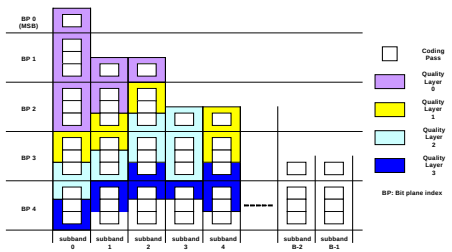
Streaming Video

- Transmitting video over band-limited fading wireless channel has been a booming service.
- Orthogonal Frequency Division Modulation (OFDM) is a promising modulation scheme for broadband communication.
- Different video scenes have different content complexities. If the users pay the same price, the received qualities of all users should be similar.
- We formulate this system as a minimax problem to minimize the maximal distortion for all users.

3-D Embedded Wavelet Video

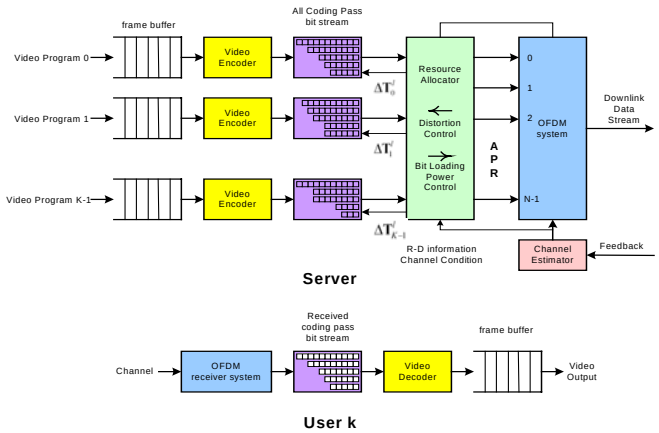
- EWV consists of 4 parts: 3-D wavelet transform, quantization, bit plane arithmetic coding, and rate-distortion optimization.
- Coding Pass and Quality Layer:



Modulation and Channel Coding

- The user k's SNR at the subcarrier n is $\phi_{kn} \blacksquare P_{kn} G_{kn} / \bullet^2$
- With appropriate modulation scheme and channel coding, the distortion introduced by channel to the received video can be negligible when BER is kept low.
- By given the transmitted power level (SNR) to meet a desired BER, adaptive modulation and adaptive channel coding provide each user with the ability to adjust each subcarrier's data transmission rate.
- We use MQAM and convolutional codes as they provide high spectrum efficiency and strong forward error protection, respectively.

System Description



Problem Formulation

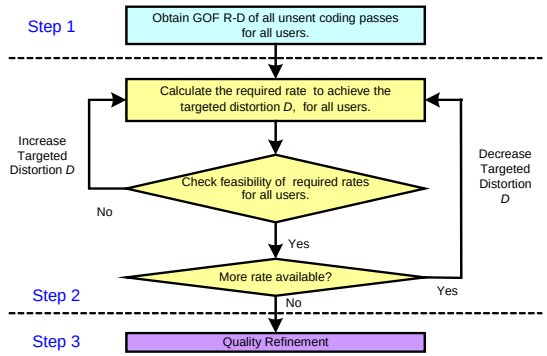
- There are *K* users and *N* subcarriers in this system. We need to determine:
  a) which subcarrier is assigned to which user,
  b) the modulation scheme, channel coding rate, and power of each subcarrier,
  c) the required rate to achieve targeted perceptual quality,
  d) which coding passes in which subband need to be included in the current quality layer.
- We formulate the problem as a minimax problem:

$$\min_{\mathbf{A},\mathbf{R},\mathrm{DT}^l} \max_k w_k f(D_k^l)$$

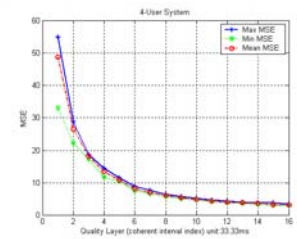
$$\text{s.t.} \begin{cases} \sum_{k=0}^{K-1} a_{kn} \le 1, a_{kn} \in \{0,1\}, \forall n; & \Leftarrow \text{Subcarrier assignment constraint} \\ 0 \le \mathrm{DR}_k^l \le \sum_{n=0}^{N-1} a_{kn} r_{kn}, \forall k; & \Leftarrow \text{Rate constraint} \\ \sum_{k=0}^{K-1} \sum_{n=0}^{N-1} a_{kn} P_{kn} \le P_{\max} & \Leftarrow \text{Power constraint} \end{cases}$$

where w_k is the quality weight, $f(.)$ the perceptual quality function, a_{kn} the indicator that represents whether subcarrier n is assigned to user k, r_{kn} and P_{kn} the corresponding rate and power if a_{kn}=1, P_{max} the maximal power provided in the system, and R^l_k the required rate for user k to achieve the targeted distortion

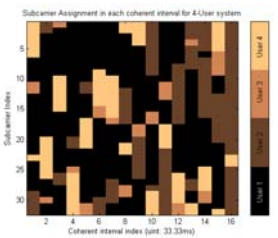
Proposed Algorithm



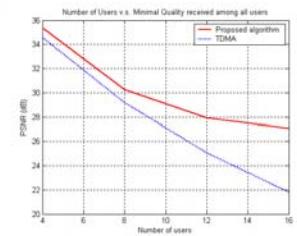
Experimental Results



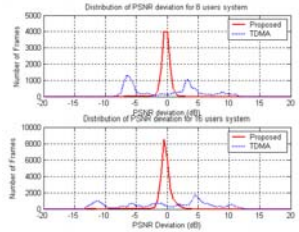
Distortion improvement in each transmission interval



Subcarrier assignment in each transmission interval



The worst quality received among all users v.s. the number of users in system



Histogram of PSNR deviation