Distortion Management of Real-time MPEG-4 FGS Video over Downlink Multicode CDMA Networks

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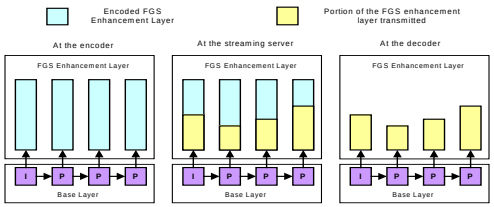
Streaming Video

- Transmitting real-time compressed video over multicode CDMA network is an emerging service.
- To provide subscribers with satisfactory received qualities, we face a critical issues: the system's resources are limited.
- We formulate this system as an optimization problem to achieve minimal overall distortion received by all users subject to the available number of codes and maximal power for transmission. We propose a fast algorithm to solve this problem.

MPEG-4 FGS Video

- MPEG-4 FGS codec consists of base and FGS layer.
- FGS coding enables a video sequence to be encoded once, and transmitted/decoded at different rates according to the available bandwidth



Channel Coding and Power Control

- The received SINR for assigning code *i* to user *j* :

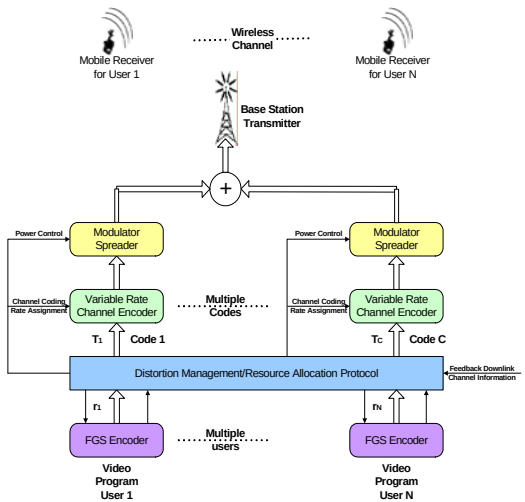
$$\gamma_i = (W/R)\left(P_i G_j / (G_j \sum_{k \neq i}^{C} P_k + \sigma^2)\right)$$

- Targeted SINR can be approximated as a function of channel coding rate $\gamma_i \approx 2^{AT_i} - B$.
- To maintain BER below 10^{-6} such that the video quality is controllable through noisy channel, the received SINR should be no less than the targeted SINR. This can be achieved using adaptive channel coding and power control.
- The overall required power can be approximated as

$$P_{sum} = \sum_{i=1}^{C} \frac{\sigma^2 \gamma_i}{G_i} = \sum_{i=1}^{C} \sum_{k \neq i}^{C} \frac{\sigma^2 \gamma_i \gamma_k}{G_k}$$

$$\text{where } \gamma_i = \begin{cases} 0, & \text{if code is not assigned} \\ \left(2^{AT_i} - B\right) \frac{W}{R}, & \text{for user j} \end{cases}$$

System Description



Problem Formulation

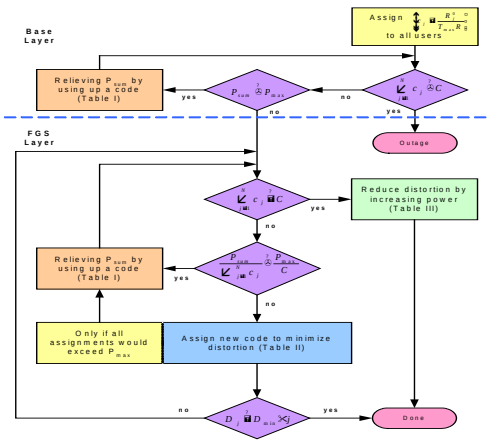
- There are *N* users and C codes in this system. We need to determine:
  a) how many codes are assigned to each user,
  b) the channel coding rates, transmitted power for each code
- We formulate the problem as follows:

$$\min_{T_i, a_{ij}} \sum_{j=1}^{N} D_j$$

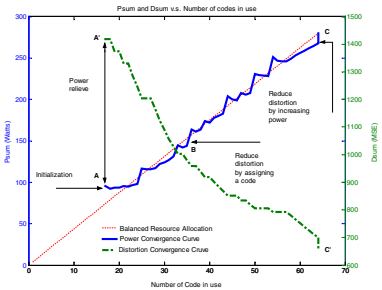
$$\text{s.t.} \begin{cases} \sum_{j=1}^{N} a_{ij} \le 1, \quad a_{ij} \in \{0,1\}, \forall i, & \Leftarrow \text{code constraint} \\ P_{sum} = \sum_{i=1}^{C} P_i \le P_{\max}, & \Leftarrow \text{Power constraint} \\ R_j^0 \le r_j = R \sum_{i=1}^{C} a_{ij} T_i \le R_j^P, \forall j & \Leftarrow \text{Rate constraint} \end{cases}$$

where a_{ij} the indicator that represents whether code *i* is assigned to user *j*, T_i and P_i the corresponding channel coding rate and power of for code *i*, P_{max} is the maximal power provided in the system, R^p_j and R^0_j are the maximal and minimal FGS rate for each video frame.

Proposed Algorithm

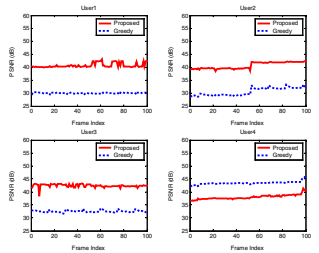


Experimental Results

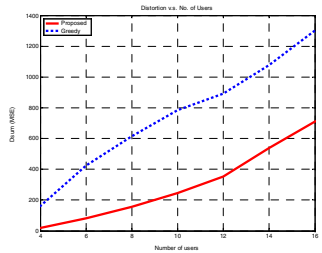


- Point A: base layer of each user is allocated. System is power unbalanced, assign code to reduce power.
- Point B: System is not power unbalanced, assign codes to reduce distortion
- Point C: All codes are assigned but $P_{sum} < P_{max}$. Use remaining power to reduce distortion.

Power and Distortion vs the number of assigned codes



PSNR results for user 1 to user 4



Performance comparison