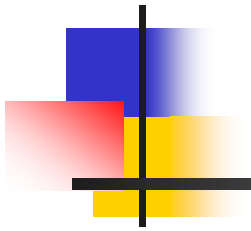
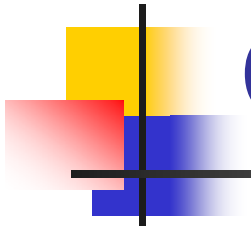


JPEG2000 adjustment for wireless video replication

Saint-Petersburg
State University of Aerospace Instrumentation

Ann Ukhanova
anja@vu.spb.ru

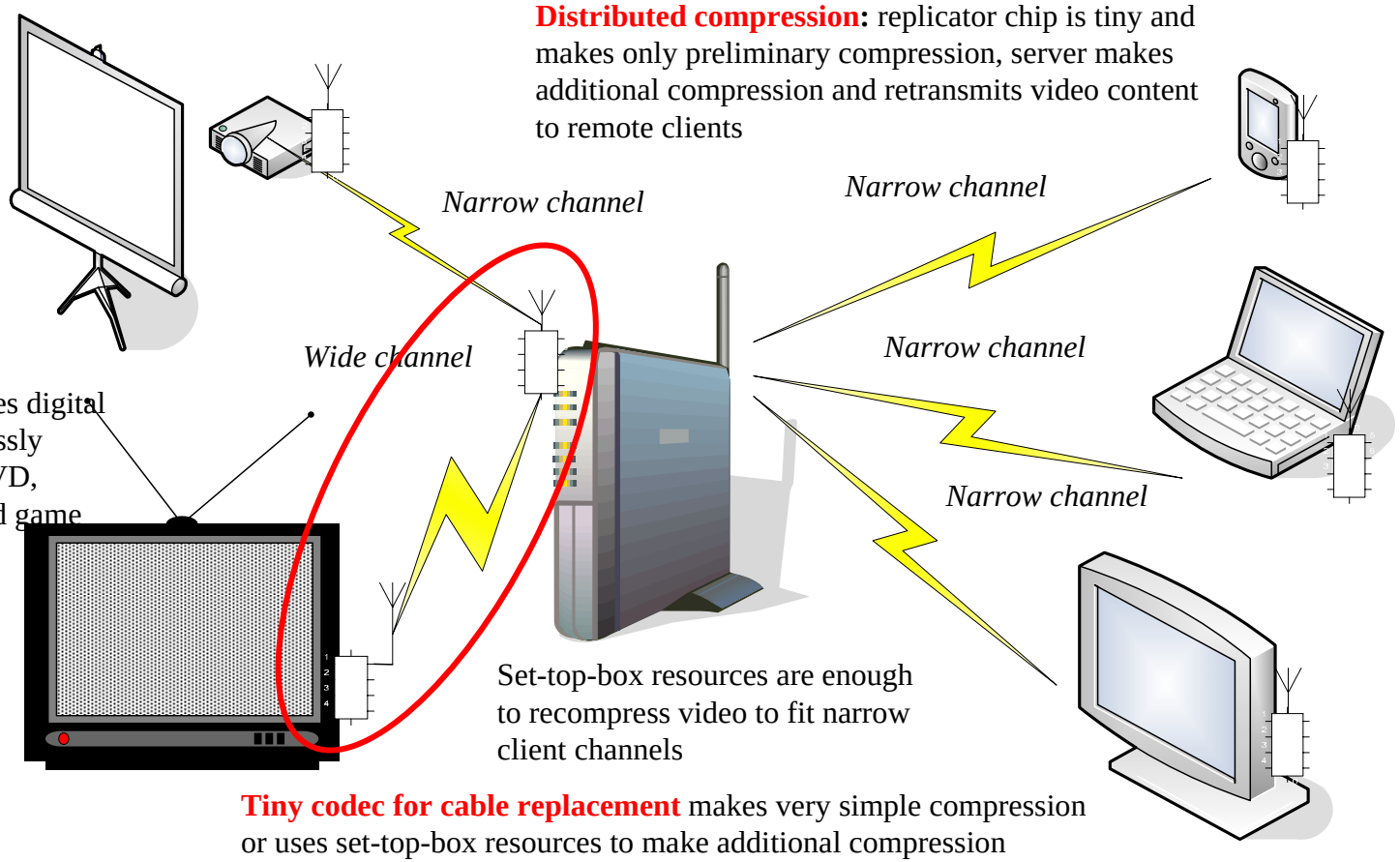


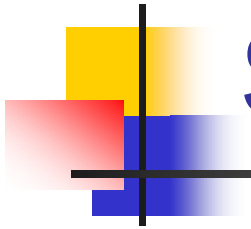
Outline

- System requirements
- Compression for wireless replication
- JPEG2000 scheme
- JPEG2000 complexity decreasing
- Rate & quality control algorithm
- Performance results

Cable Replacement

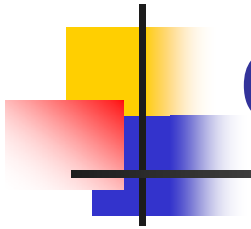
- Video compression for wireless replication
  - Tiny codec for cable replacement: 3-5m, p2p
  - Scalable & distributed compression: 3-20m, p2mp, range-based QoS





System requirements

- High performance video (HDTV, 1080i/60, 1920x1080, 24 bpp)
  - High quality
- Real time coding/decoding
  - Delay $\rightarrow$ min
- Cheap device
  - Complexity $\rightarrow$ min
- Wireless channel orientation
  - Rate Control
  - Compression Ratio ~ 10.0



Compression algorithm requirements

What are the primary parameters of the good algorithm for this system?

- Low complexity
- Low memory consumption
- High compression rate
- Rate control
- Scalability
- Progressiveness
- Packetization

Compression algorithms comparison

Why not all compression algorithms are suitable?

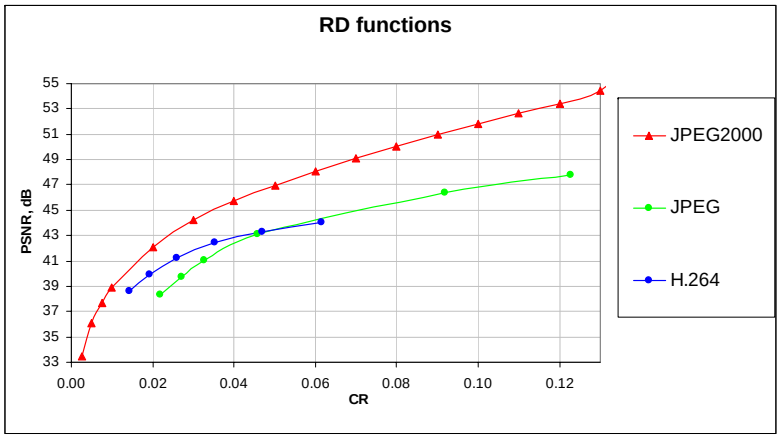
	Complexity	Memory (no tiling)	Memory (tiling)	PSNR	Rate Control	Progressiveness
JPEG-LS	Medium	Very good	Very good	Best	No	No
JPEG	Low	Very good	Very good	Good	No	No
PJPEG	Low	Good	Good	Good	No	Bad
JPEG 2000	**High**	Bad	**Good**	**Very good**	**Yes**	**Good**
H.264	High	Good	Very good	Good	No	No

Standard JPEG?

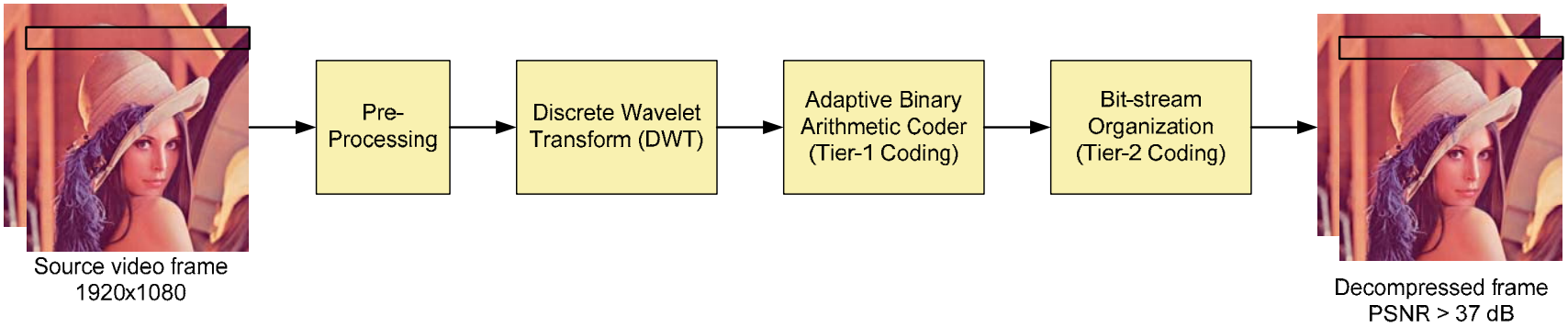
- Low complexity
- Low memory consumption
- Good rate-distortion characteristics

But! **No rate control**

No progressiveness



JPEG2000 scheme



Advantages:

- Lossless and lossy compression
- Tiling option
- Error resilience
- Blocking
- Multi-resolution representation
- Region Of Interest (ROI) coding
- Flexible file format etc.

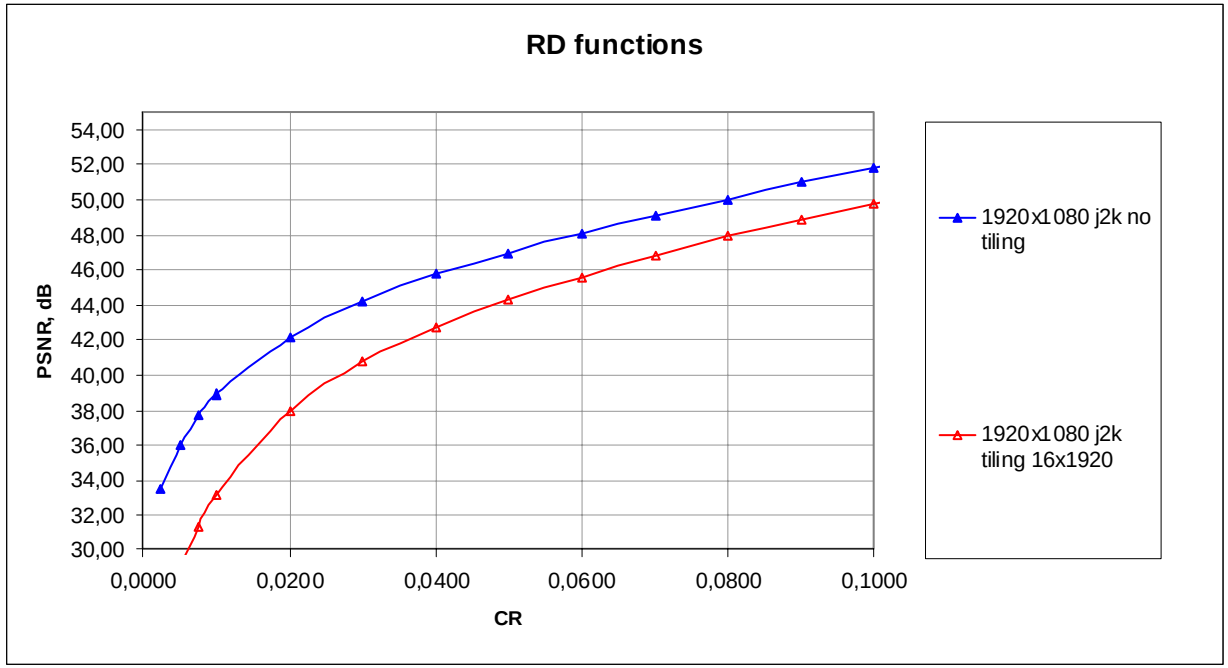
Disadvantages:

- Significantly slower than previous JPEG standard
- High complexity - extremely important for hardware implementation
- Shows moderate results for tiling mode

Complexity decreasing

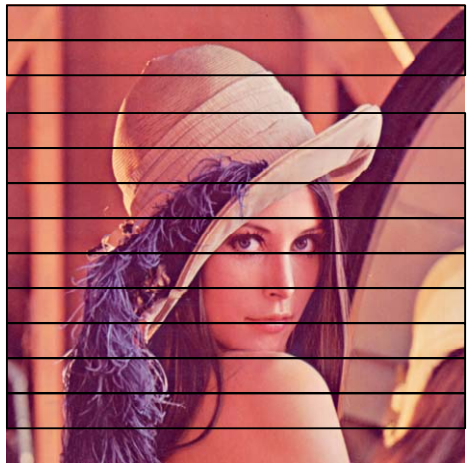
Tiling option

Goal: decrease memory consumptions at coder/decoder (only for one tile)



1920

16



tiling provides image partitioning into rectangular and non-overlapping tiles

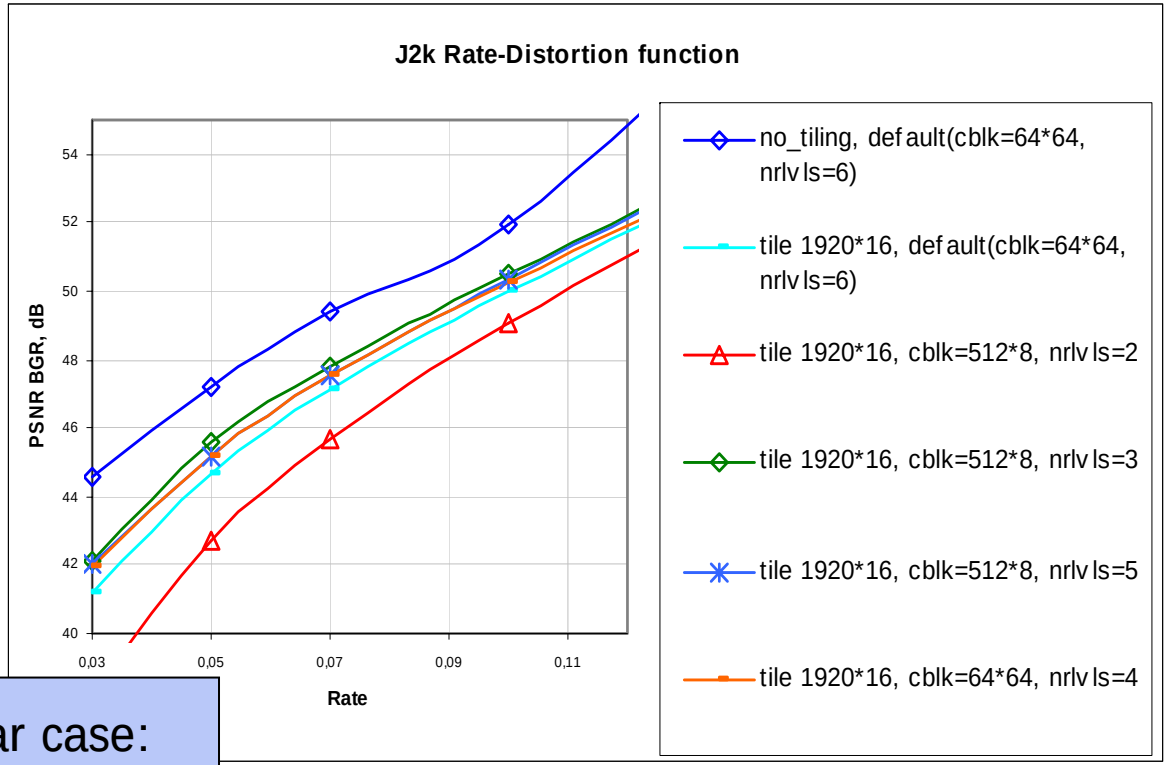
JPEG2000 algorithm without tiling shows much better results than version with tiling because the first one operates with the whole image

Parameters optimization

Goal: coordinate coding parameters with each other

Coding parameters:

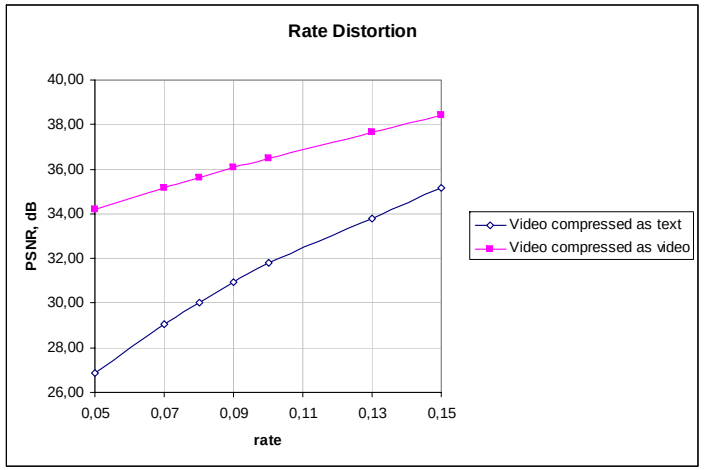
- tilewidth
- tileheight
- codeblock width
- codeblock height
- number of resolution levels etc.



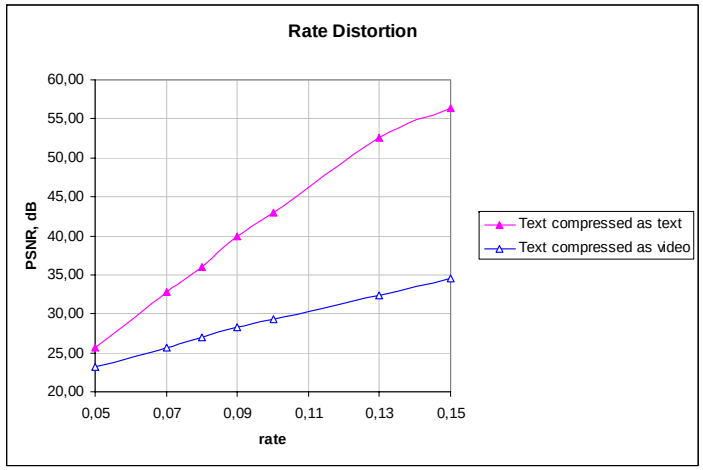
our particular case:
tiles of size 1920x16

Text & video compression

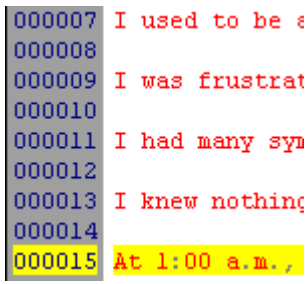
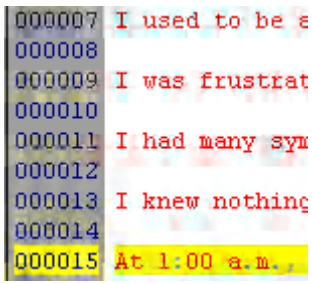
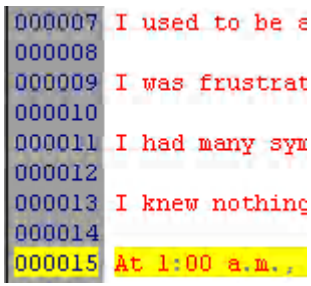
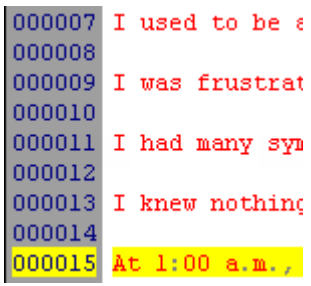
Video (Photo images) - 2 levels of DWT

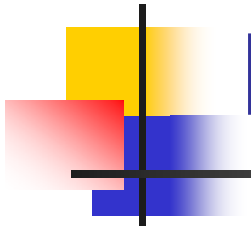


Text (Screenshots) – no DWT



Compression artifacts

			
Source image	5 DWT levels (default)	2 DWT levels (text compressed as video)	No DWT (text compressed as text)



Rate control mechanism

Rate control provides with the compression rate to fit channel throughput

Pre-compression rate control scheme: (H.264, JPEG)

Allows only to define the most appropriate Quantizing Parameter (QP) before encoding.

Actually, it doesn't mean that the highest PSNR can be achieved for this rate even if QP is calculated considering previously encoded tiles.

Post-compression rate control scheme: (JPEG2000)

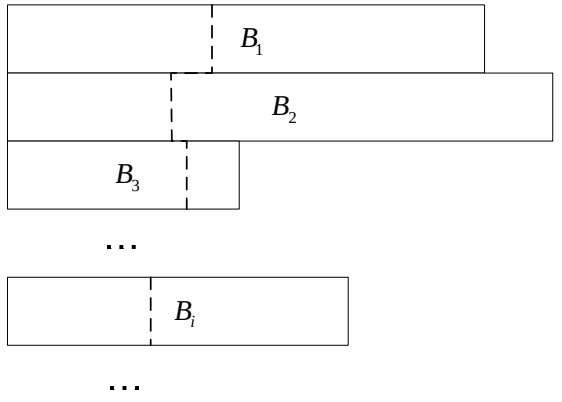
After lossless encoding only some parts of the compressed data are included into the final bit stream. This let us win the maximum PSNR for the target rate, and the result rate gives the best fit from below

Rate control algorithm in JPEG2000

Rate: $R = \sum_i r_i^{n_i}$

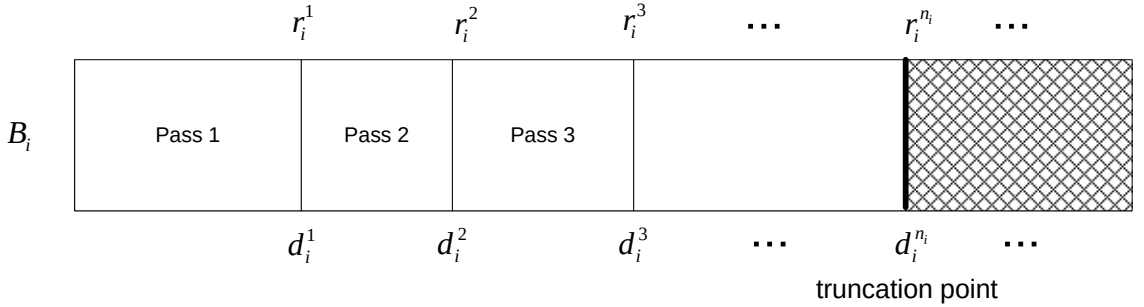
Distortion: $D = \sum_i d_i^{n_i}$

Optimally truncated code blocks

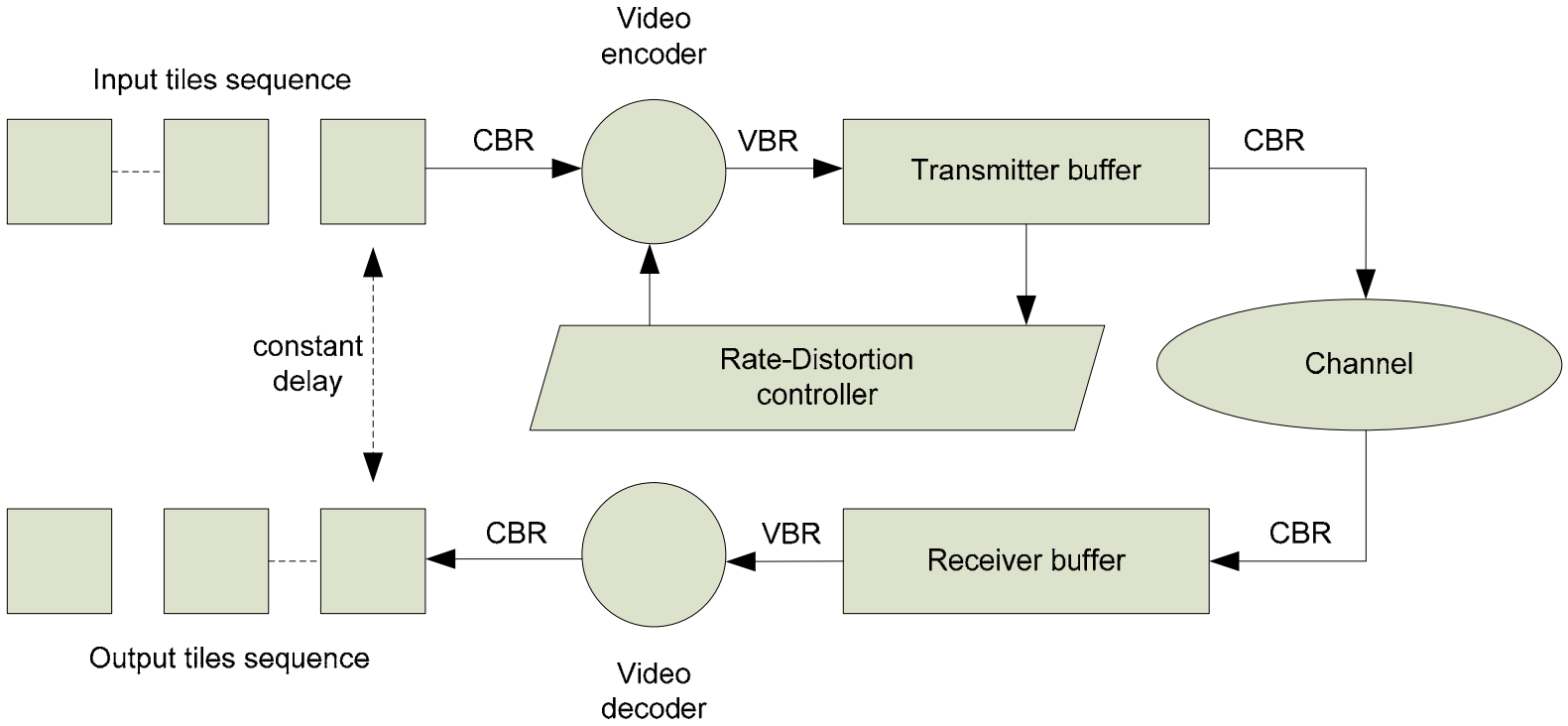


Optimization task:

$$\begin{cases} \text{minimize } D \\ R < R_{channel} \end{cases}$$

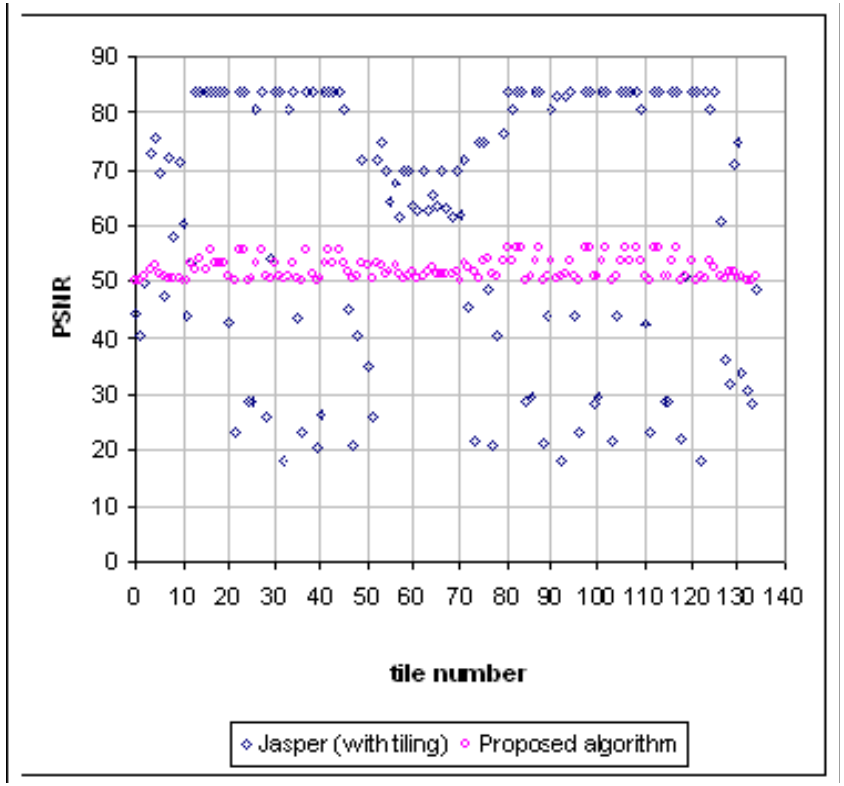


Rate & Quality control: scheme



Comparison with original JPEG2000

Why is the original JPEG2000 rate control scheme not suitable?



Original JPEG2000 and JPEG2000 with buffering comparison

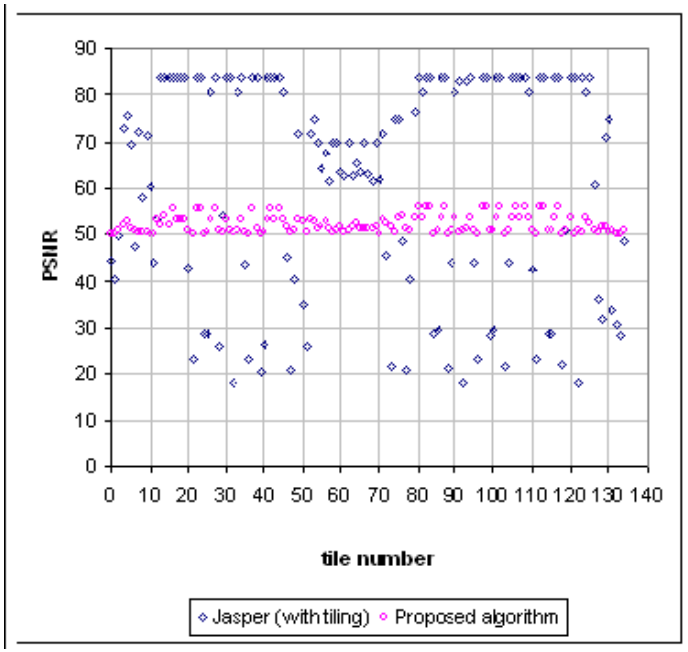
Rate & Quality control: algorithm

For each tile

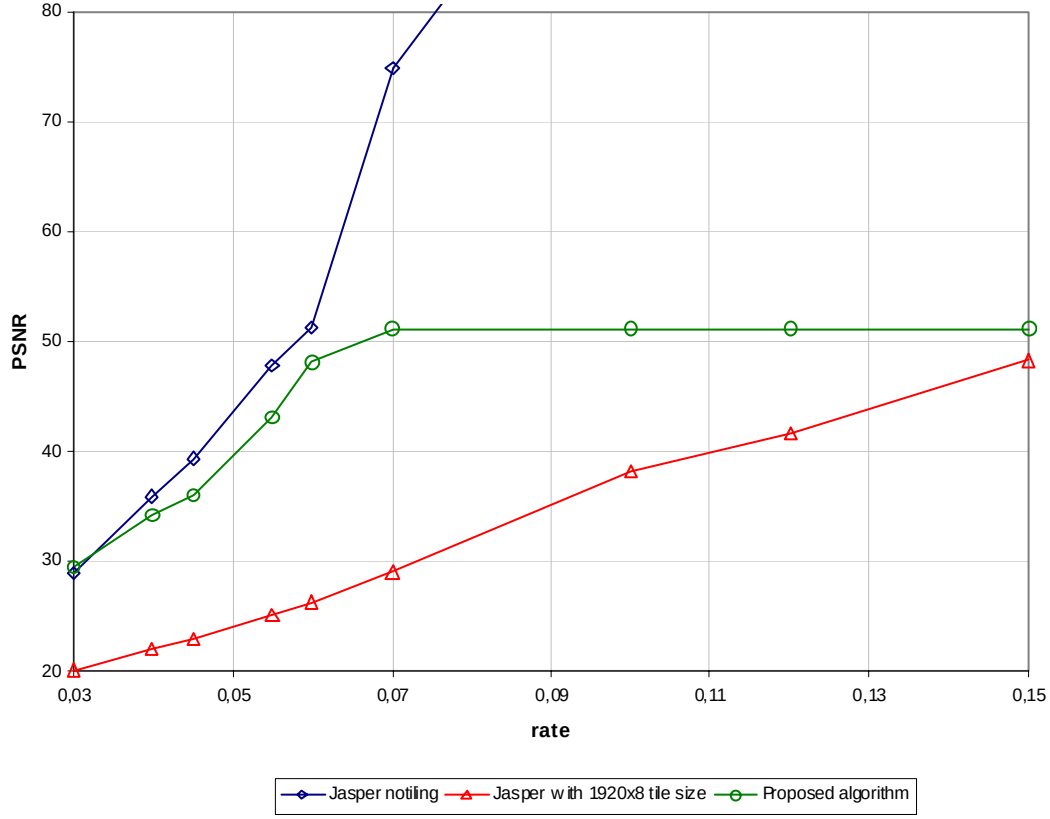
$$\begin{cases} \text{minimize } R_t \\ D_t \le D_{\max} \end{cases}$$

Optimization task (for all tiles):

$$\begin{cases} \text{minimize } \max_t D_t \\ b_t \le B_0 \end{cases}$$

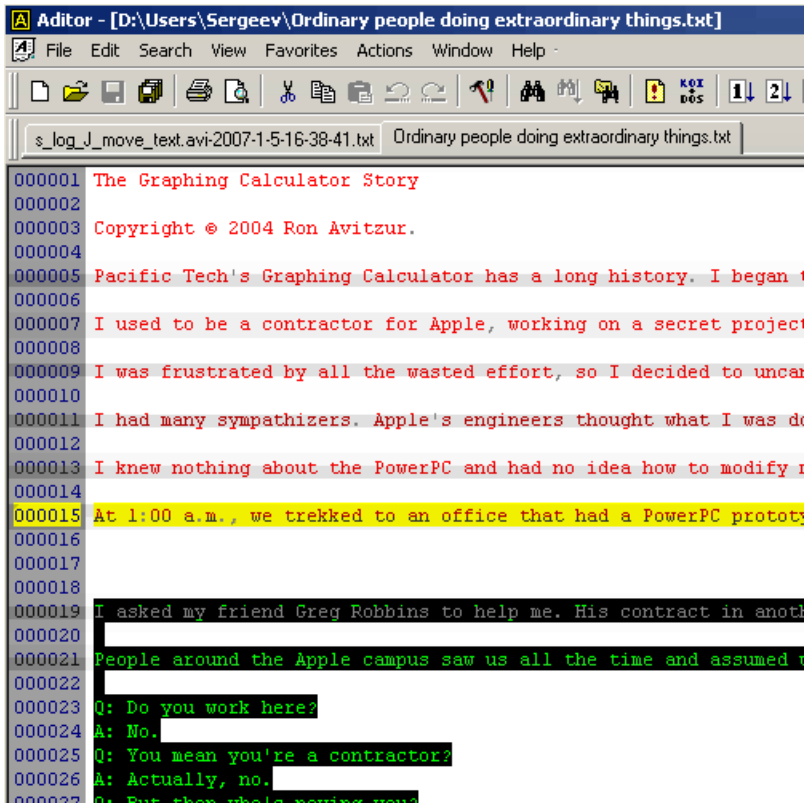


Rate & Quality control: results (graphs)



Original JPEG2000 and JPEG2000 with buffering comparison

Rate & Quality control: results (images)



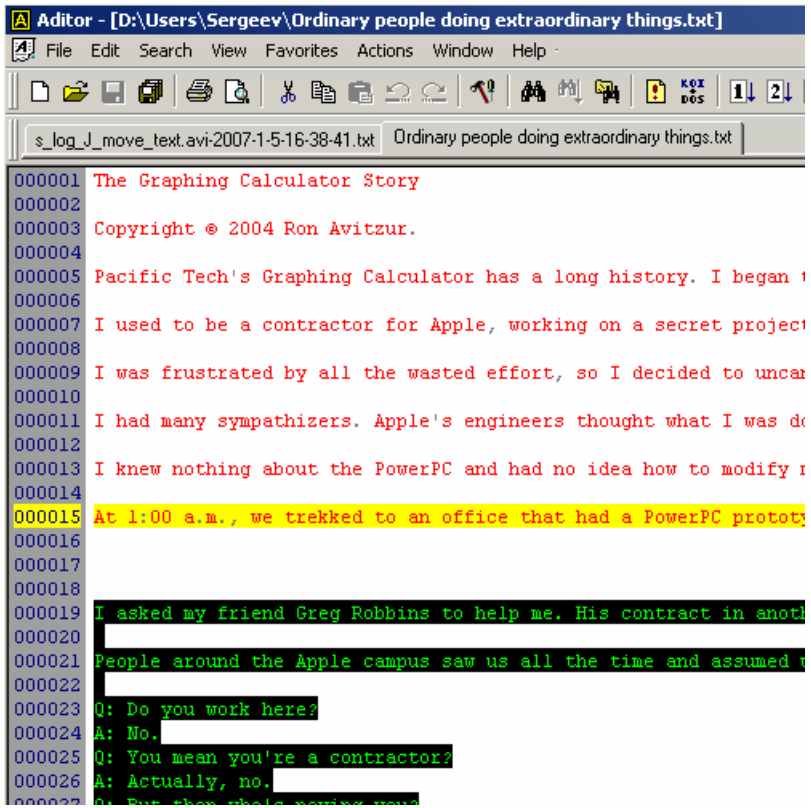
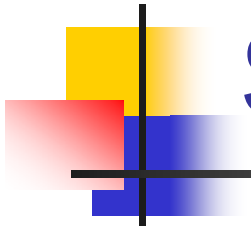


Image compressed with original JPEG2000

Image compressed with JPEG2000 with buffering



Summary

- Algorithms comparison (from the view of memory constrained wireless video replication)
- JPEG2000 parameters optimization
- Rate & Quality control algorithm