



# JPEG2000 adjustment for wireless video replication

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Saint-Petersburg  
State University of Aerospace Instrumentation

Ann Ukhanova  
anja@vu.spb.ru



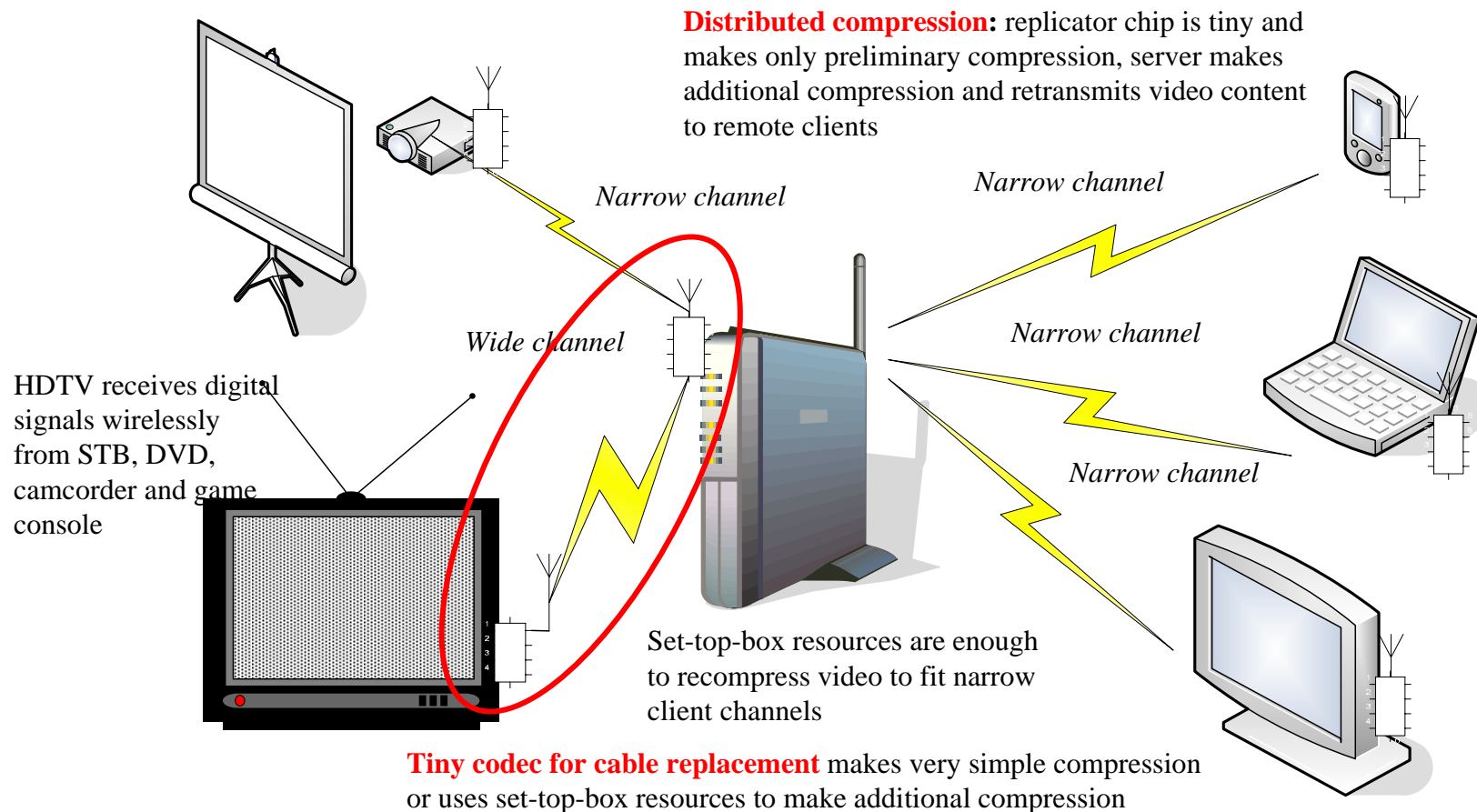
# Outline

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- 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

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



# Compression algorithm requirements

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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

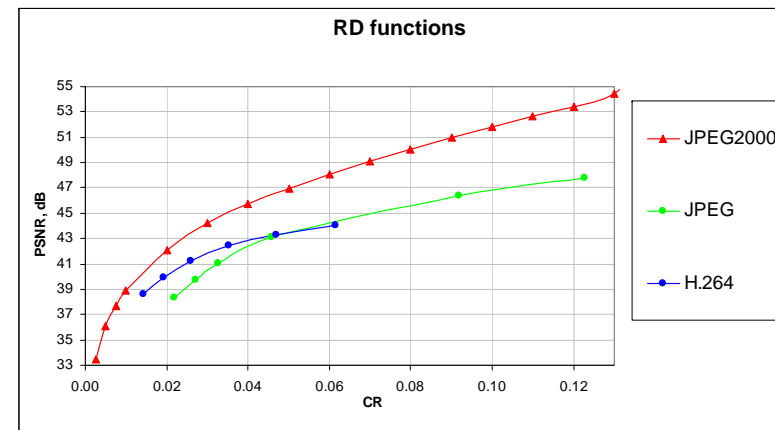
Why not all compression algorithms are suitable?

	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
<b>JPEG 2000</b>	<b>High</b>	Bad	<b>Good</b>	<b>Very good</b>	<b>Yes</b>	<b>Good</b>
H.264	High	Good	Very good	Good	No	No

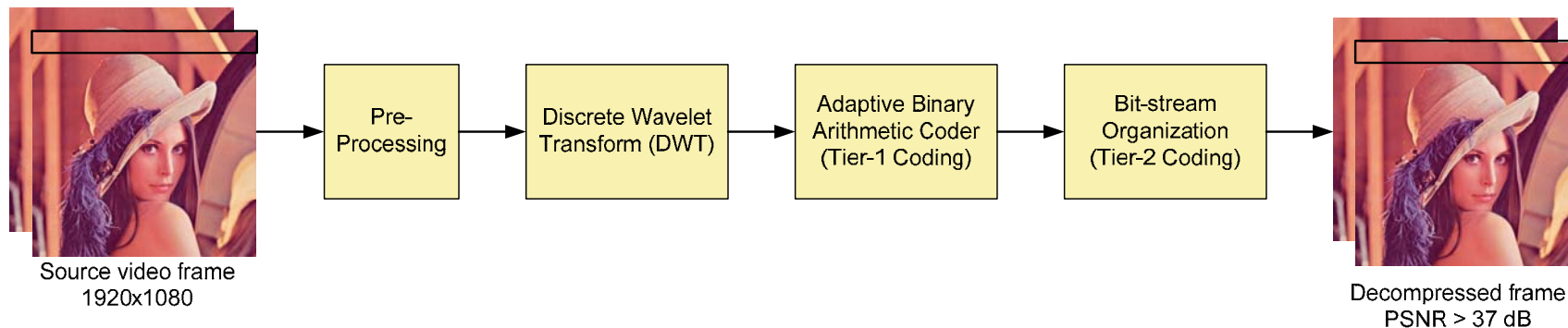
## Standard JPEG?

- 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

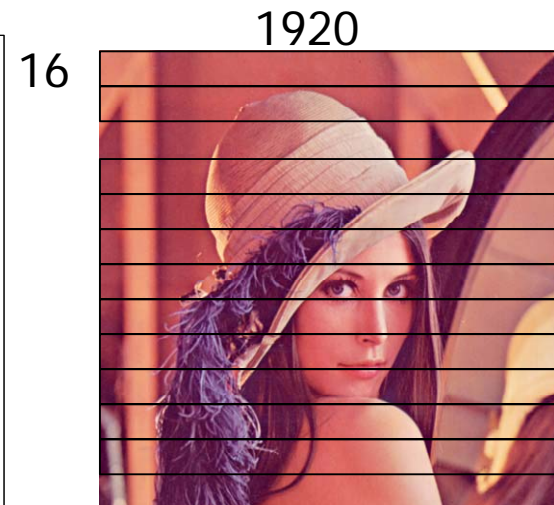
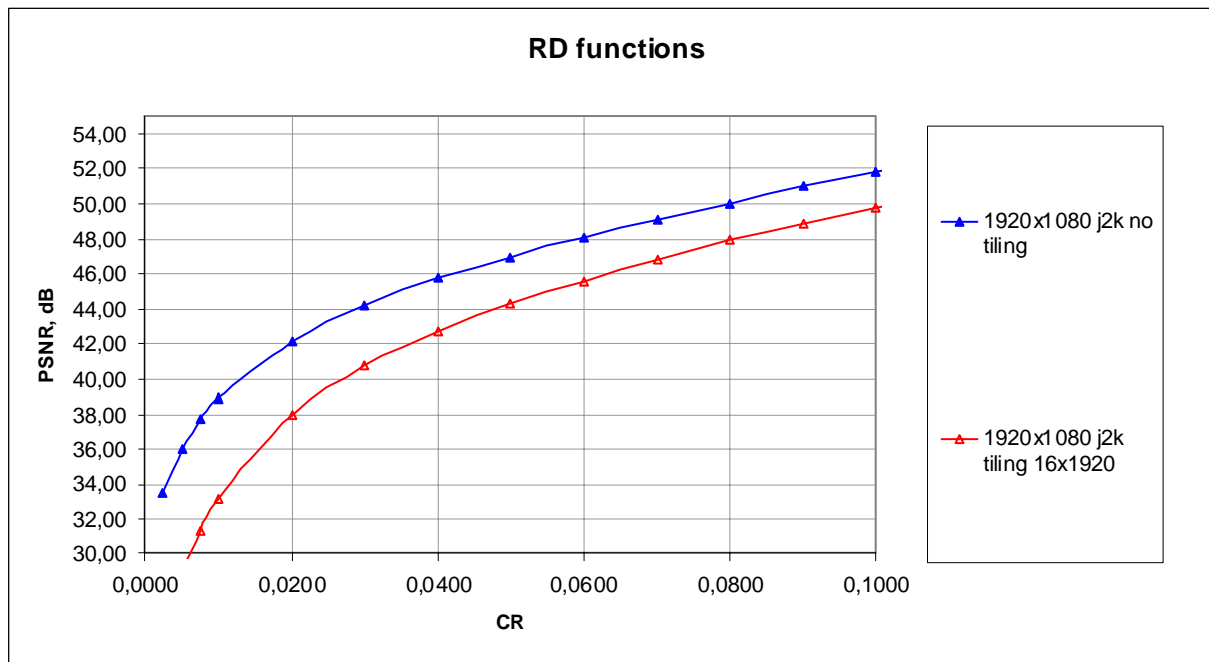


Complexity decreasing



# Tiling option

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



tiling provides image partitioning into rectangular and non-overlapping tiles

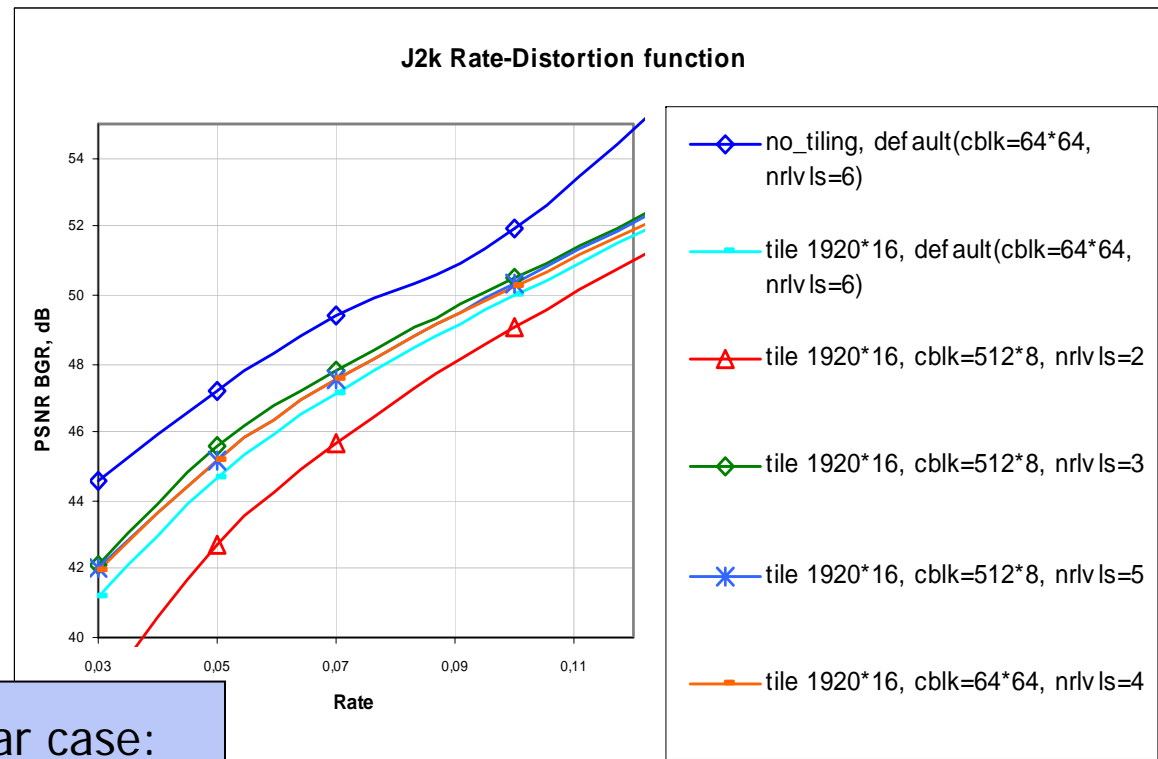
JPEG2000 algorithm without tiling shows much better results than version with tiling because the first one operates with the whole image

# Parameters optimization

**Goal:** coordinate coding parameters with each other

## Coding parameters:

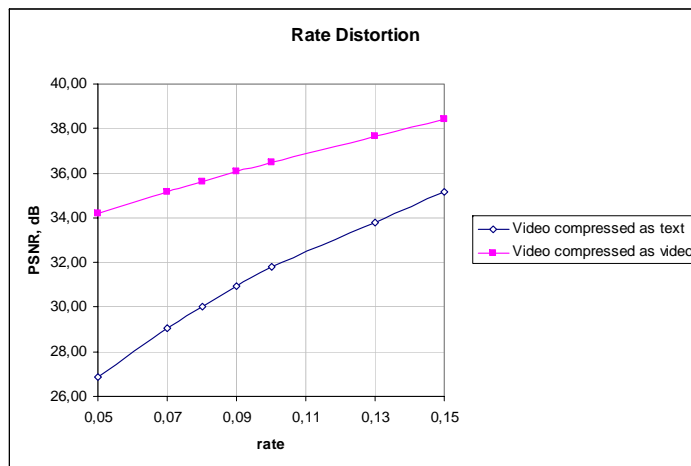
- tilewidth
- tileheight
- codeblock width
- codeblock height
- number of resolution levels etc.



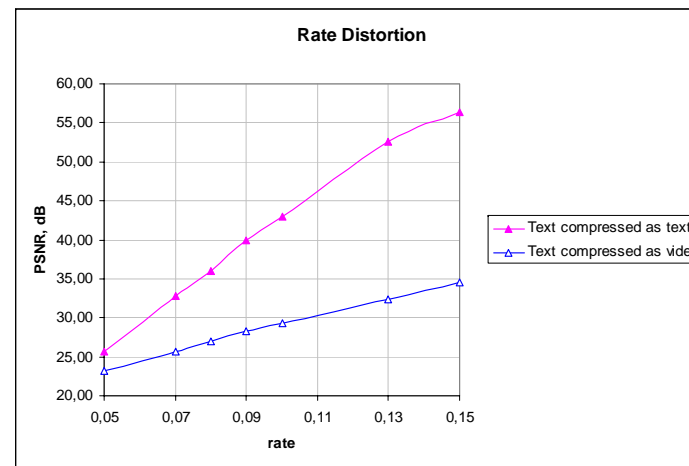
our particular case:  
tiles of size 1920x16

# Text & video compression

Video (Photo images) - 2 levels of DWT



Text (Screenshots) – no DWT



## Compression artifacts

<pre>000007 I used to be e 000008 000009 I was frustrat 000010 000011 I had many sym 000012 000013 I knew nothing 000014 000015 At 1:00 a.m.,</pre>	<pre>000007 I used to be e 000008 000009 I was frustrat 000010 000011 I had many sym 000012 000013 I knew nothing 000014 000015 At 1:00 a.m.,</pre>	<pre>000007 I used to be e 000008 000009 I was frustrat 000010 000011 I had many sym 000012 000013 I knew nothing 000014 000015 At 1:00 a.m.,</pre>	<pre>000007 I used to be e 000008 000009 I was frustrat 000010 000011 I had many sym 000012 000013 I knew nothing 000014 000015 At 1:00 a.m.,</pre>
Source image	5 DWT levels (default)	2 DWT levels (text compressed as video)	No DWT (text compressed as text)



# Rate control mechanism

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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

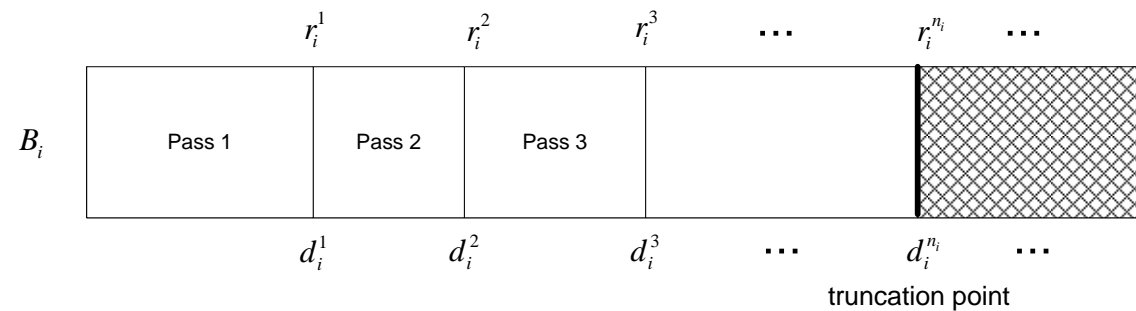
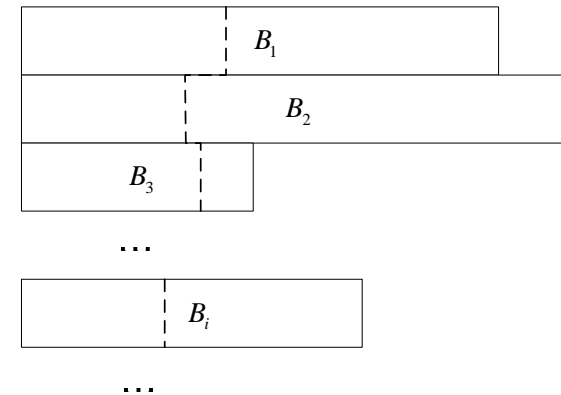
Rate:  $R = \sum r_i^{n_i}$

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

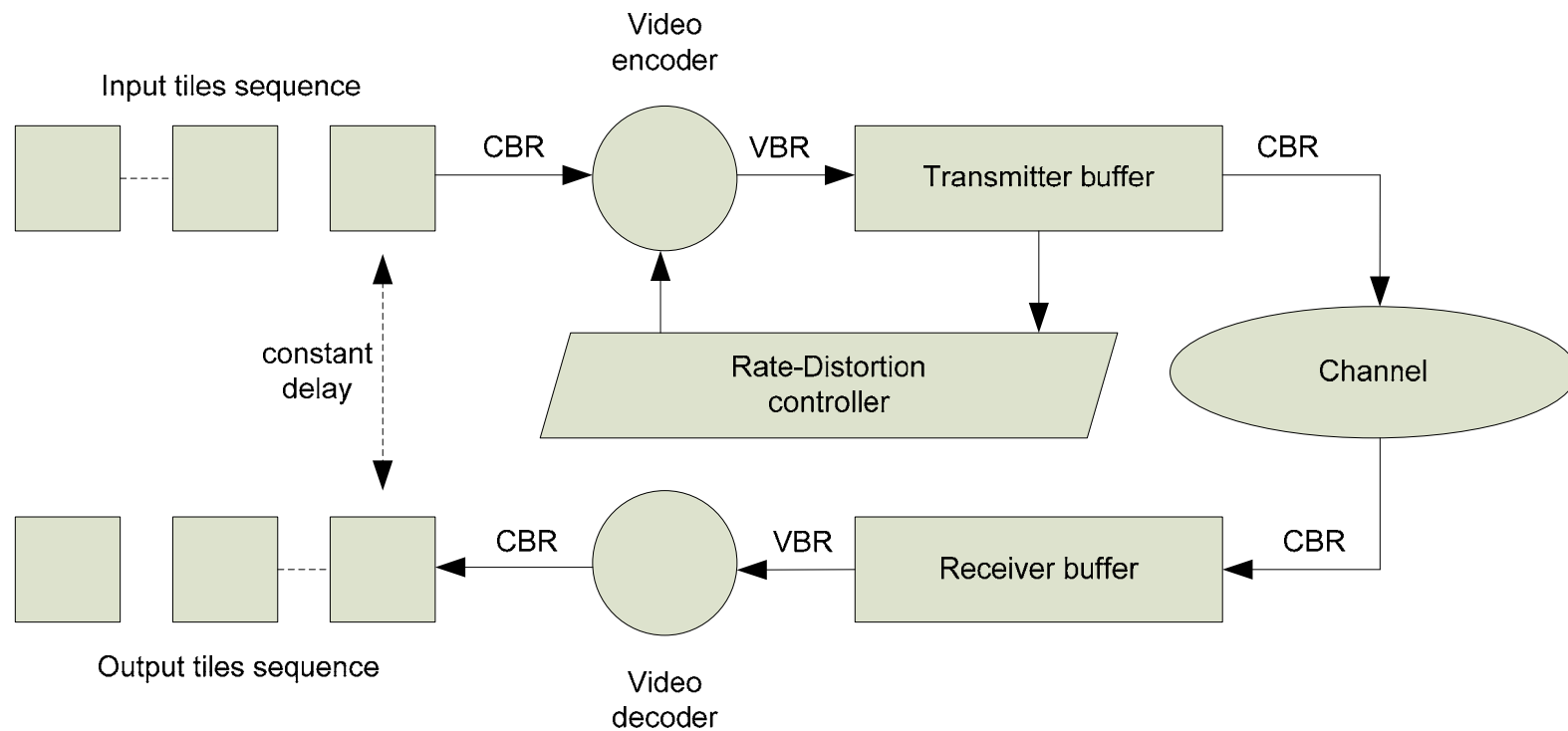
Optimization task:

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

Optimally truncated code blocks

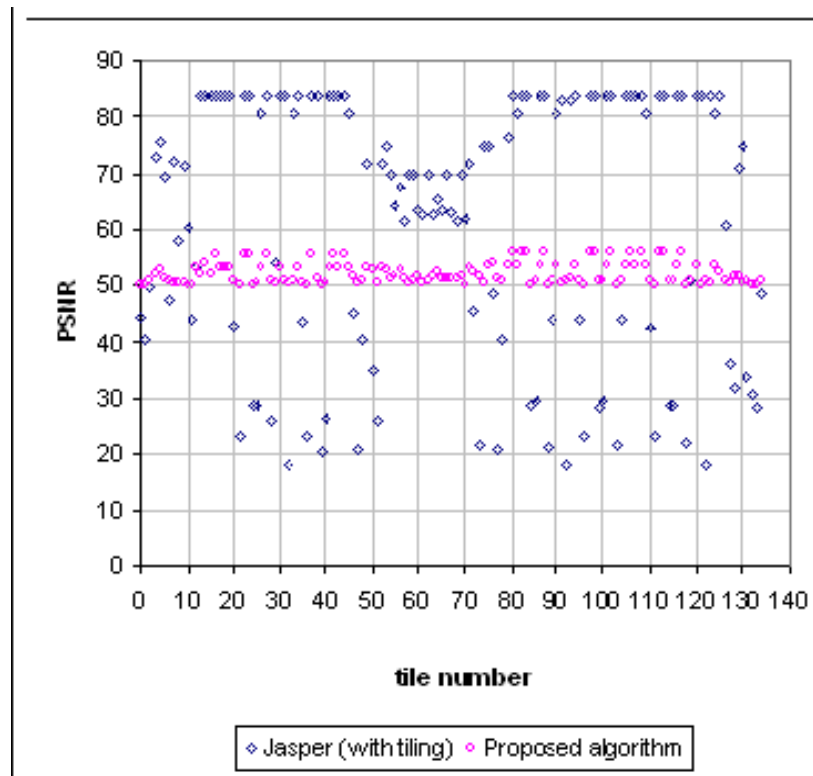


# Rate & Quality control: scheme



# Comparison with original JPEG2000

Why is the original JPEG2000 rate control scheme not suitable?



Original JPEG2000 and JPEG2000 with buffering comparison

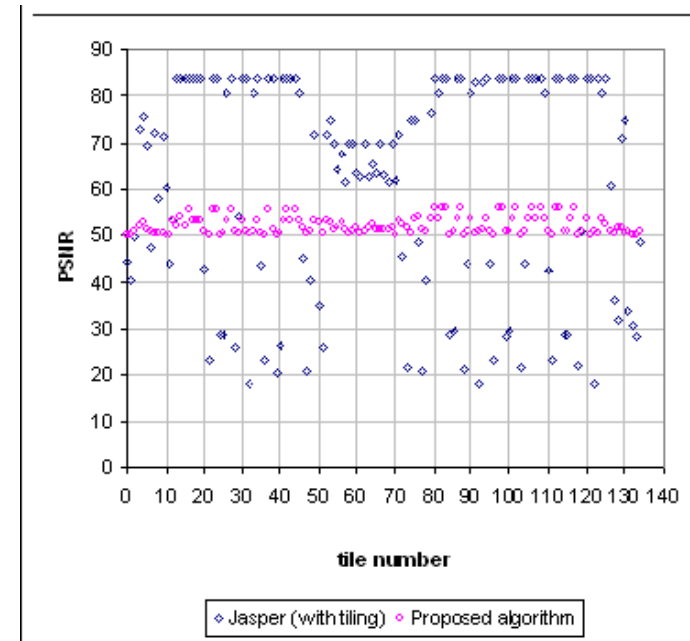
# Rate & Quality control: algorithm

For each tile

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

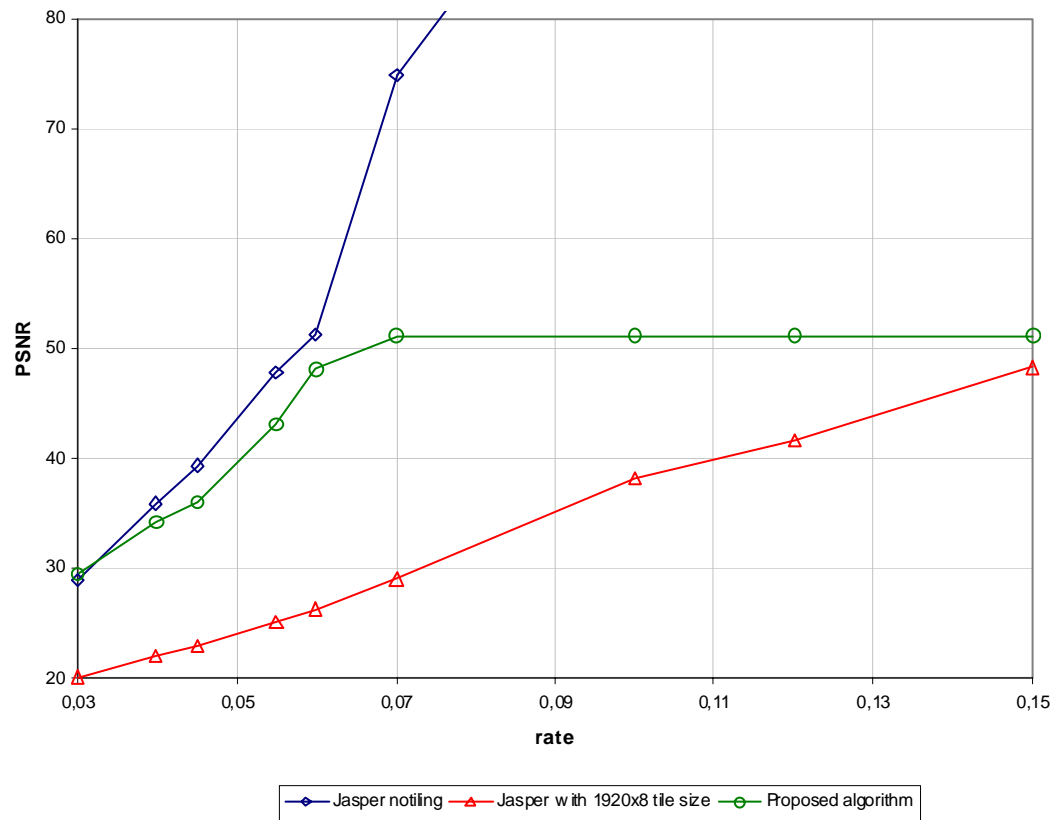
Optimization task (for all tiles):

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



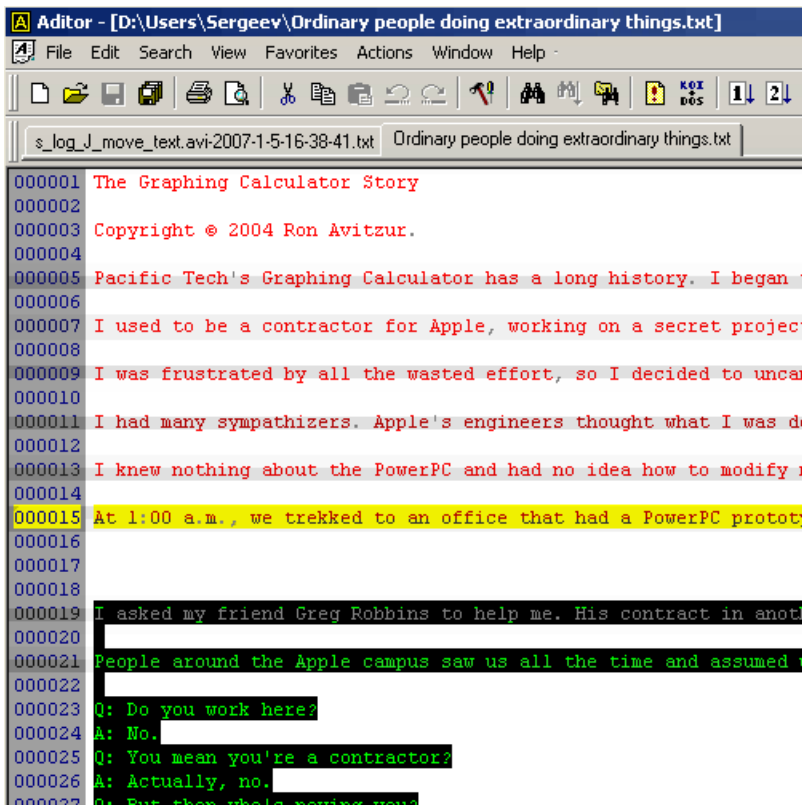


# Rate & Quality control: results (graphs)



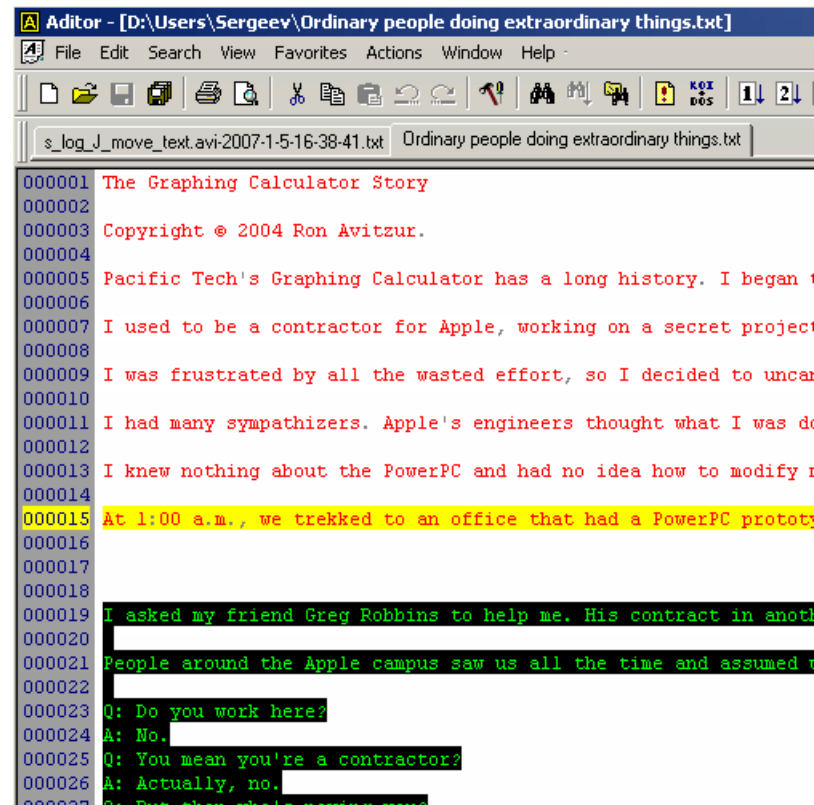
Original JPEG2000 and JPEG2000 with buffering comparison

# Rate & Quality control: results (images)



```
Aditor - [D:\Users\Sergeev\Ordinary people doing extraordinary things.txt]
File Edit Search View Favorites Actions Window Help
s_log_J_move_text.avi-2007-1-5-16-38-41.txt Ordinary people doing extraordinary things.txt
000001 The Graphing Calculator Story
000002
000003 Copyright © 2004 Ron Avitzur.
000004
000005 Pacific Tech's Graphing Calculator has a long history. I began t
000006
000007 I used to be a contractor for Apple, working on a secret project
000008
000009 I was frustrated by all the wasted effort, so I decided to uncar
000010
000011 I had many sympathizers. Apple's engineers thought what I was d
000012
000013 I knew nothing about the PowerPC and had no idea how to modify r
000014
000015 At 1:00 a.m., we trekked to an office that had a PowerPC prototy
000016
000017
000018
000019 I asked my friend Greg Robbins to help me. His contract in anot
000020
000021 People around the Apple campus saw us all the time and assumed t
000022
000023 Q: Do you work here?
000024 A: No.
000025 Q: You mean you're a contractor?
000026 A: Actually, no.
000027
```

Image compressed with original JPEG2000



```
Aditor - [D:\Users\Sergeev\Ordinary people doing extraordinary things.txt]
File Edit Search View Favorites Actions Window Help
s_log_J_move_text.avi-2007-1-5-16-38-41.txt Ordinary people doing extraordinary things.txt
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```

Image compressed with JPEG2000 with buffering



# Summary

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