ADAPTIVE POWER SAVING ON THE RECEIVER SIDE IN DIGITAL VIDEO BROADCASTING SYSTEMS BASED ON PROGRESSIVE VIDEO CODECS

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Agenda

- DVB-H and power saving

  DVB-H: Digital Broadcast Services to Handheld Devices

  G. FARIA, J. A. HENRIKSSON, E. STARE, AND P. TALMOLA, PROCEEDINGS OF THE IEEE, VOL. 94, NO. 1, JANUARY 2006

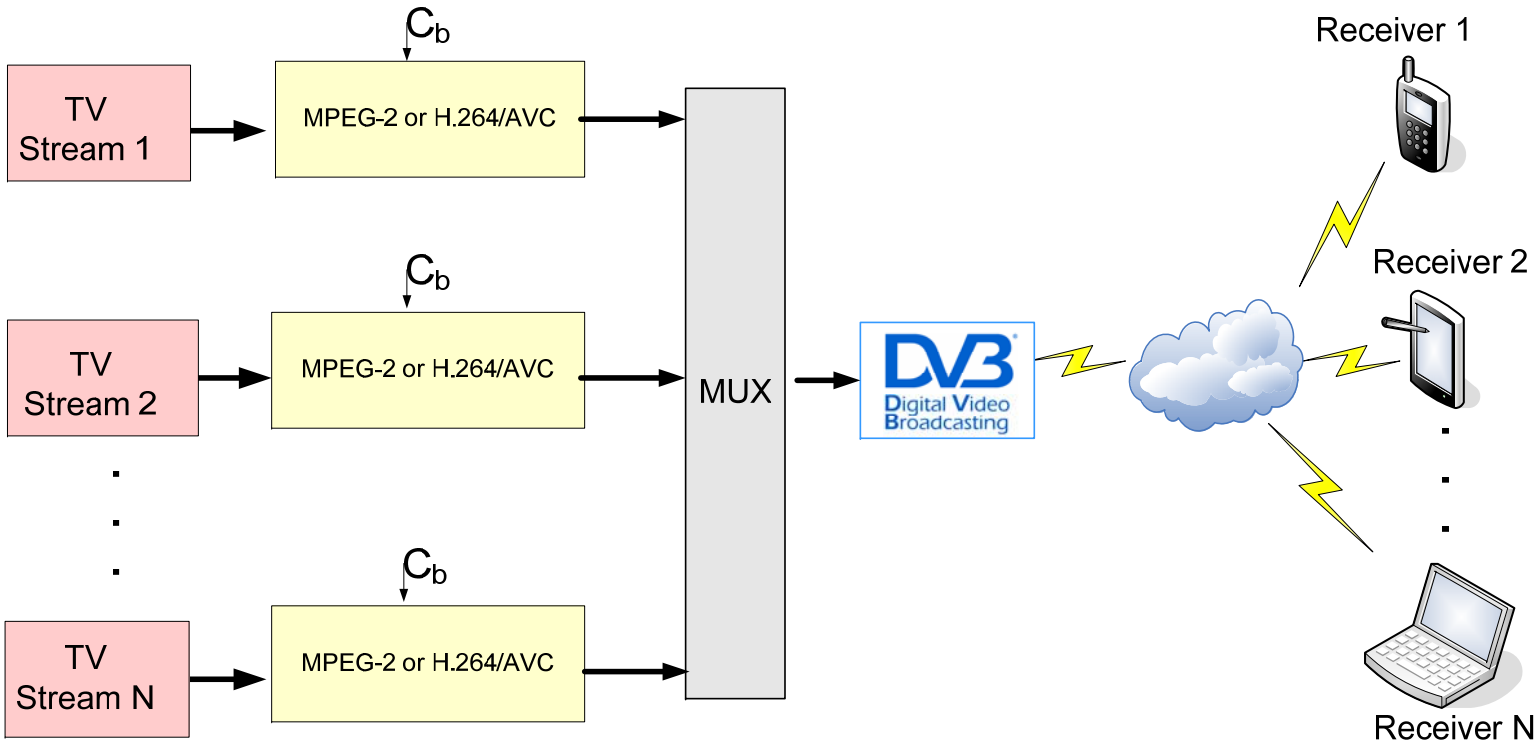
- JPEG2000 as progressive compression algorithm

  JPEG 2000: Image Compression Fundamentals, Standards and Practice by David. S. Taubman and Michael W. Marcellin

- Multi-source quality-scalable rate-control algorithm with power saving based on JPEG2000

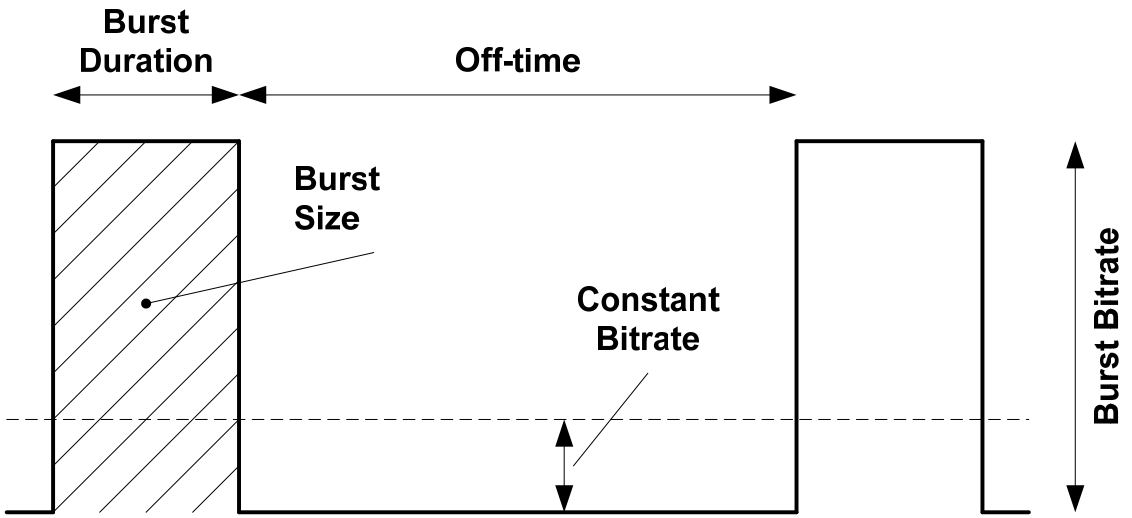
  E.Belyaev, A.Turlikov, A.Ukhanova “Rate-distortion control in wavelet-based video compression systems with memory restriction”, XI International Symposium on Problems of Redundancy in Information and Control Systems

DVB-H transmission



Power saving by time slicing

The main idea - receiver works for a short time interval, during it the part of the video data is received, then the receiver powers off completely

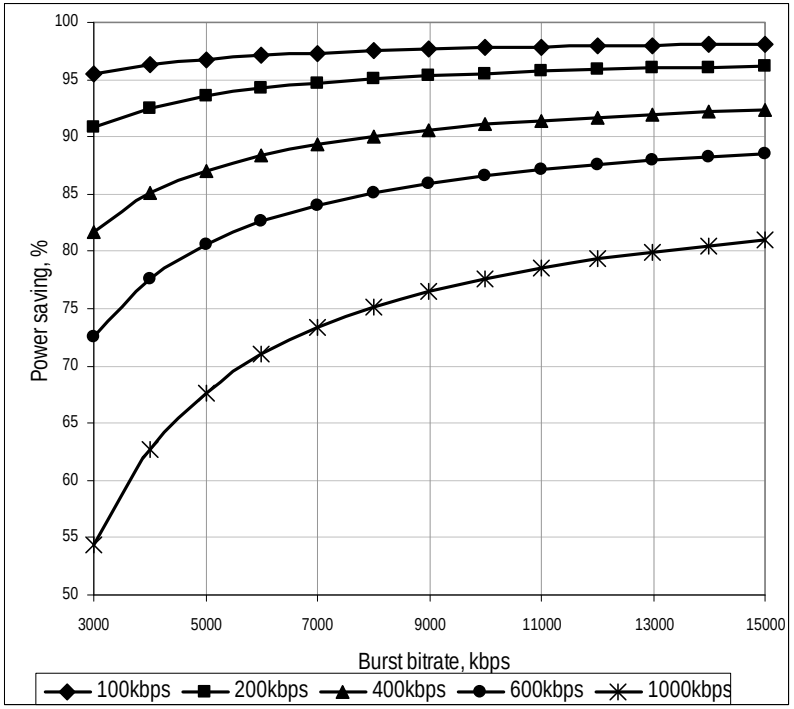


The current part of the video data also contains information about when to power on again to receive next part of the data

Power saving calculation

Power saving is a function of constant and burst bitrates, burst size, synchronization time and delta-t jitter

$$P_s = \left(1 - \frac{C_b}{B_b} - 0.96 \cdot \frac{C_b}{B_s} \cdot \left(S_t + \frac{3}{4} D_j\right)\right) \cdot 100\%$$



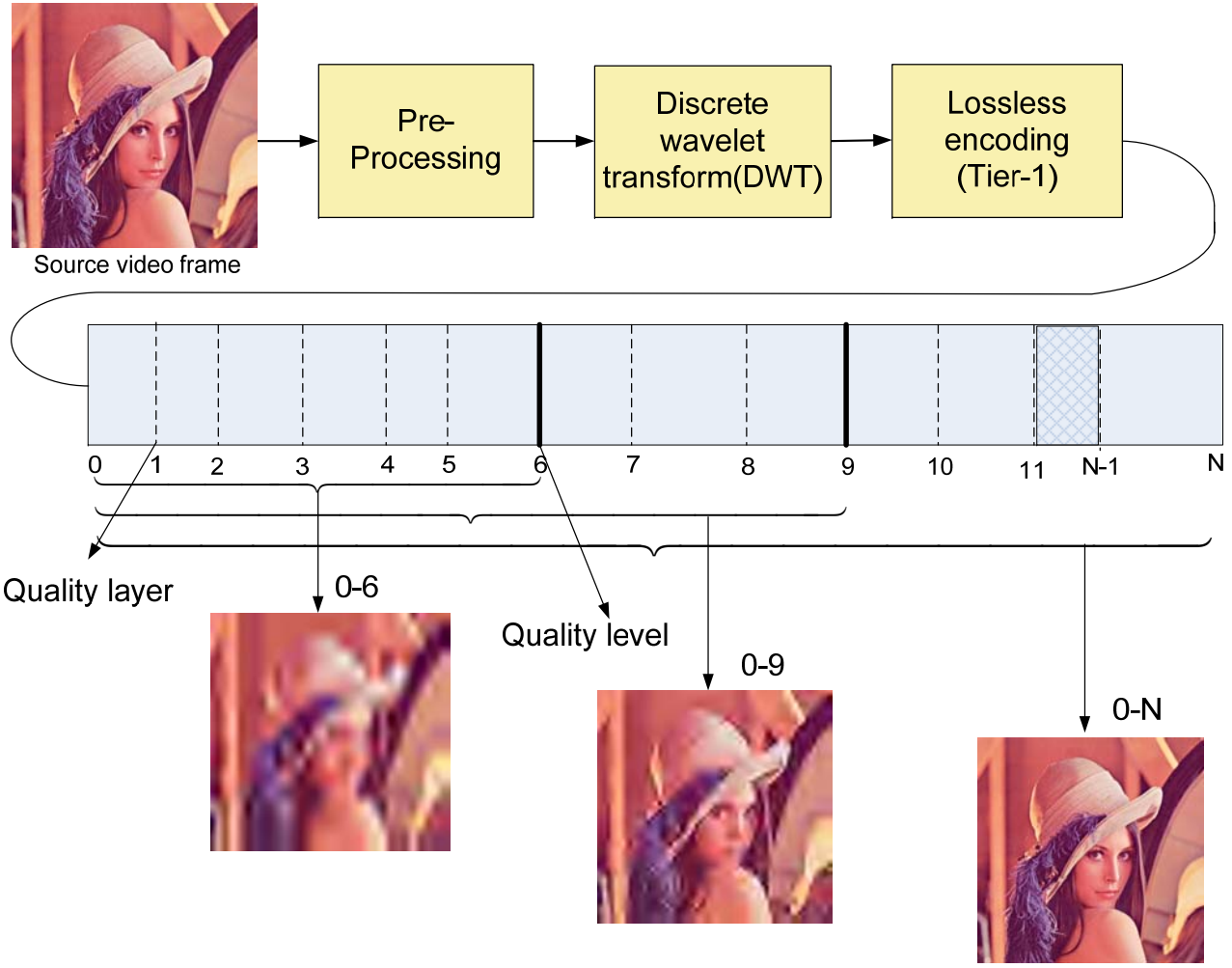
DVB-H power saving based on MPEG-2 or H.264/AVC

- MPEG-2 or H.264/AVC for fixed values in formula and the level of power saving does not vary, it depends only on C_b

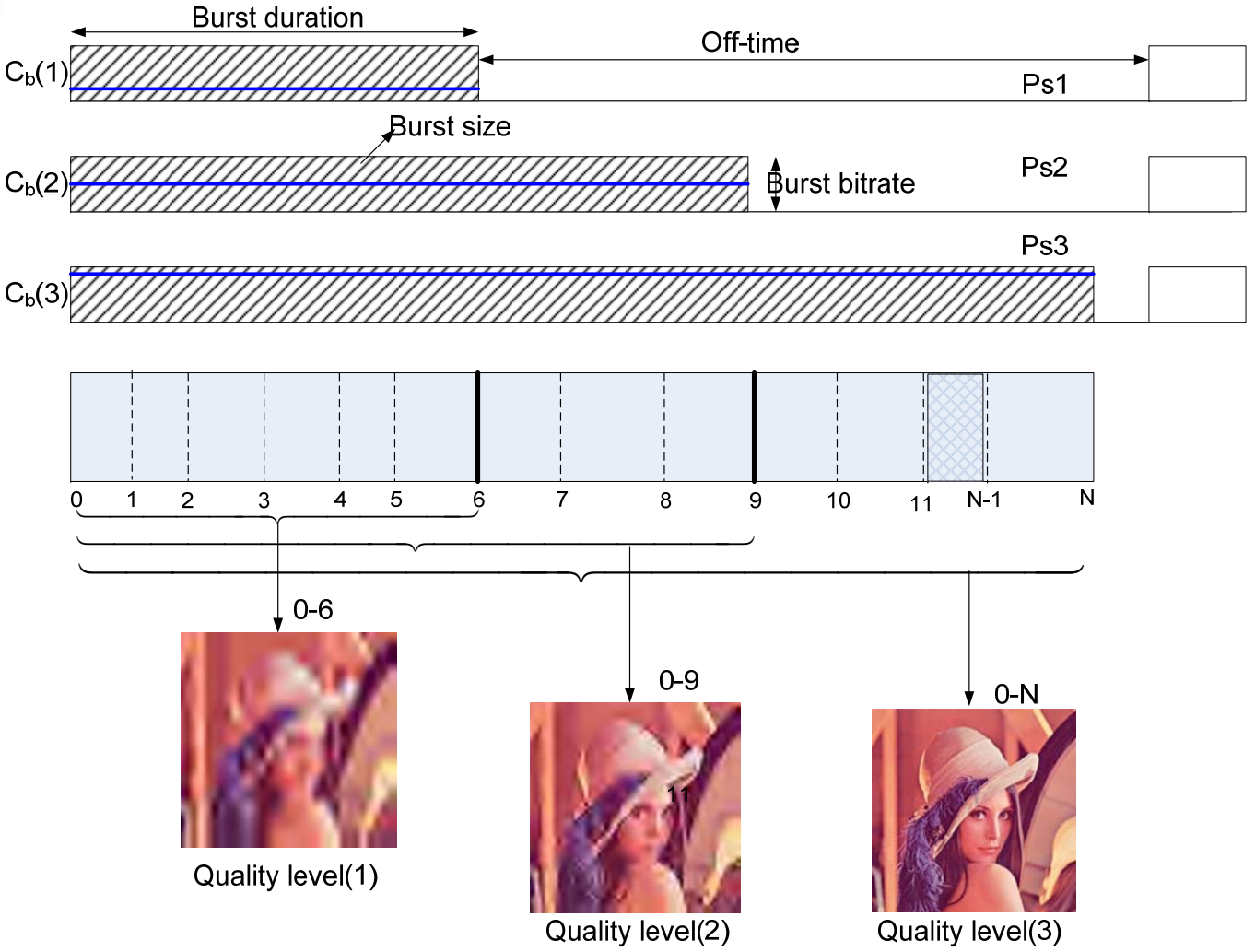
$$P_s = \left(1 - \frac{C_b}{B_b} - 0.96 \cdot \frac{C_b}{B_s} \cdot \left(S_t + \frac{3}{4} D_j\right)\right) \cdot 100\%$$

- User can not choose the level of power consumption by himself

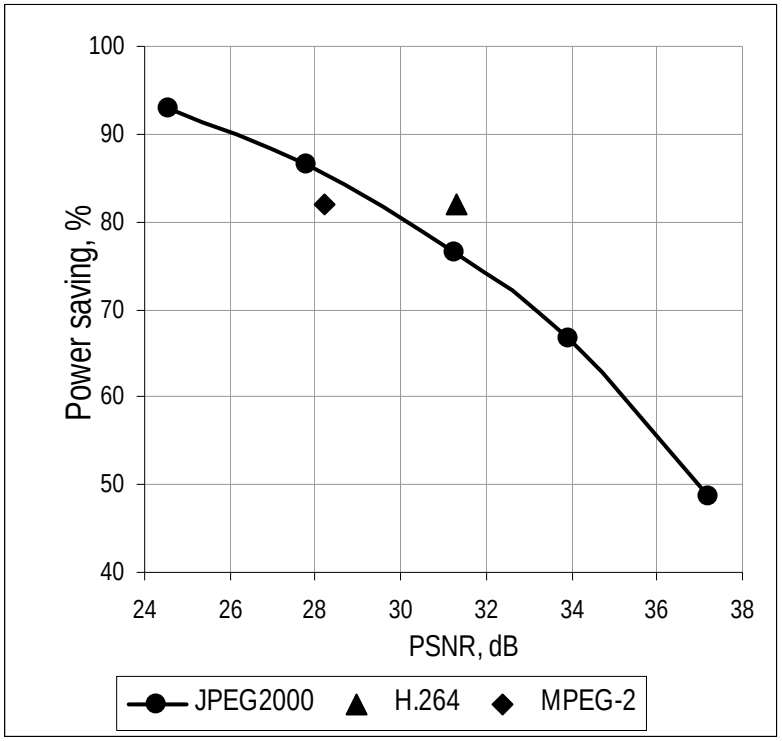
JPEG2000


Source video frame
Pre-Processing
Discrete wavelet transform(DWT)
Lossless encoding (Tier-1)
0
1
2
3
4
5
6
7
8
9
10
11
N-1
N
Quality layer
0-6
Quality level
0-9
0-N

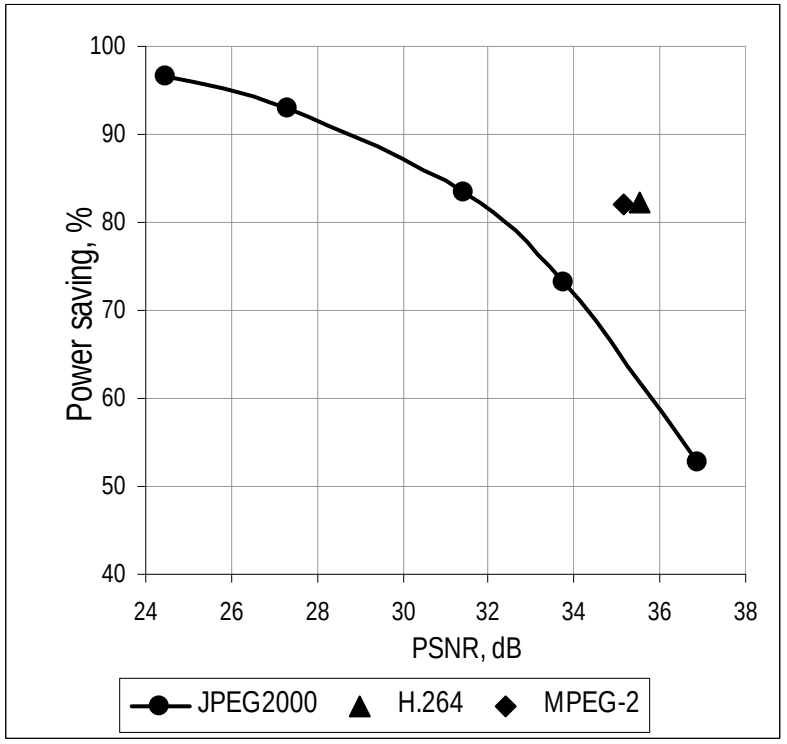
Power saving with JPEG2000



Results

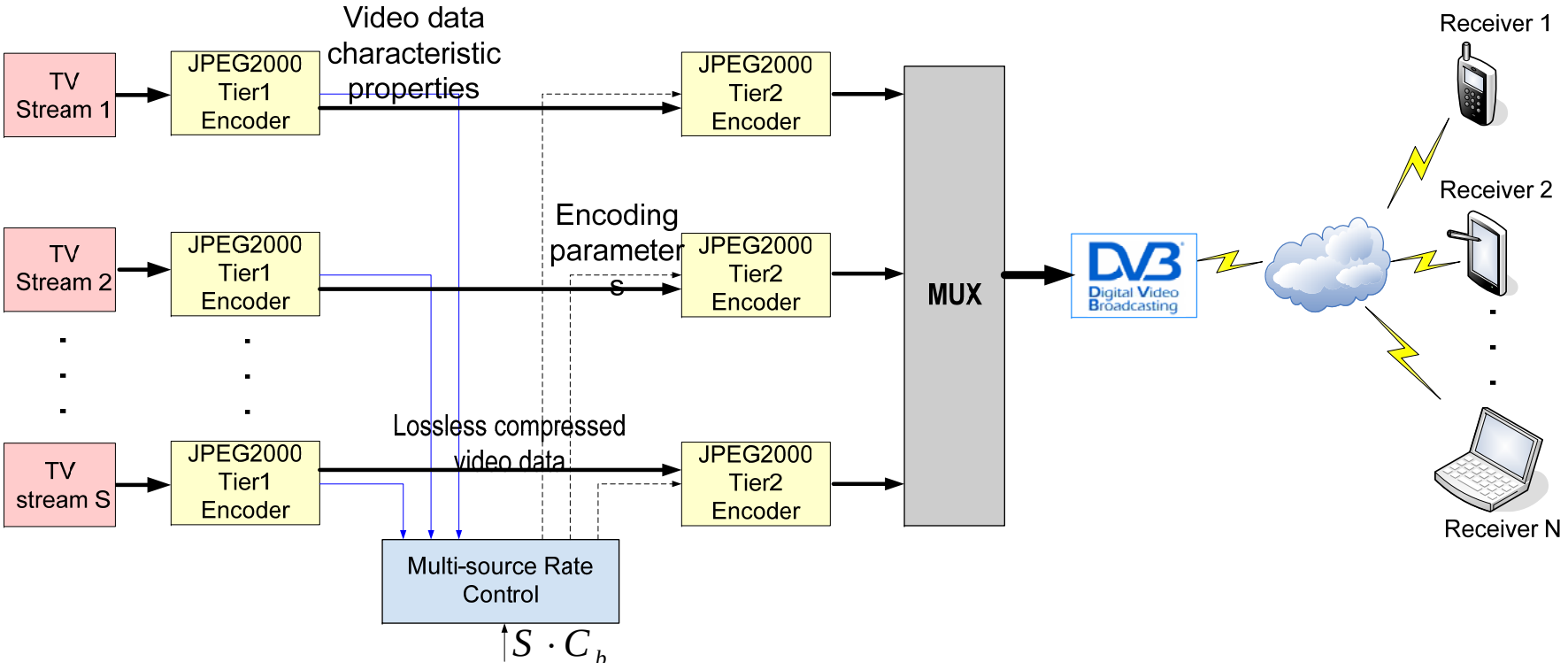


Video sequence “matrix”



Video sequence “robin”

Scheme with Multi-source Rate-Control



Optimization task

$$\begin{cases} \textbf{minimize} \max\limits_{s,i\in GOP_k} d(v_i^s), \\ \sum\limits_{s=1}^{S} \sum\limits_{i\in GOP_k} r(v_i^s) \le \dfrac{l}{L} \cdot S \cdot C_b \end{cases}$$

where

v_i^s – encoder parameter for frame i of tv-source s,

$\mathrm{d}(v_i^s)$ – frame distortion

$r(v_j^s)$ – frame bit size

$\mathrm{GOP_k}$ – frames with numbers $k \cdot N, ..., (k+1) \cdot N - 1$

N – number of frames in GOP,

l – current quality level, $l = 1, 2, ..., L$

Multi-source Rate Control: advantages

Fr.#	PSNR	bits		
		1	2	3
92	26.5	3523	456	243
93	26.5	3527	415	245
94	26.5	698	431	218
95	26.5	670	438	245
96	26.5	665	425	198
97	26.5	701	441	169
98	26.5	838	438	148
99	26.5	690	436	131
100	26.5	630	1412	82
101	26.5	625	1632	95

Summary

The proposed scheme allows:

- User can choose the level of power saving (Scalability)
- When changing channels – quality is equal and acceptable (Multi-source Rate Control)

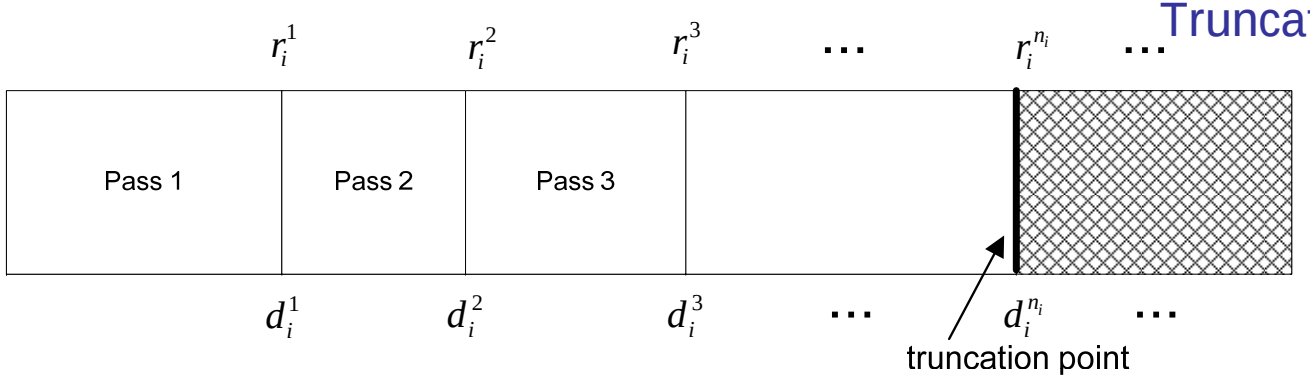
Future collaboration

- Use scalable extension of H.264/AVC Standard as codec with the scalability of the compressed stream

The end

Thank You for Your attention!!!

Rate Control in JPEG2000



Truncation vector: $\mathbf{n} = \{n_i\}$

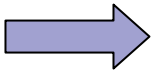
Rate: $r(\mathbf{n}) = \sum_i r_i^{n_i}$

Distortion: $d(\mathbf{n}) = \sum_i d_i^{n_i}$

Optimization task:

Find $\mathbf{n}_{opt}$, so that:

$$\begin{cases} d(\mathbf{n}_{opt}) = \min\limits_{\{\mathbf{n}\}} d(\mathbf{n}) \\ r(\mathbf{n}_{opt}) \le r \end{cases}$$



Optimally truncated code blocks