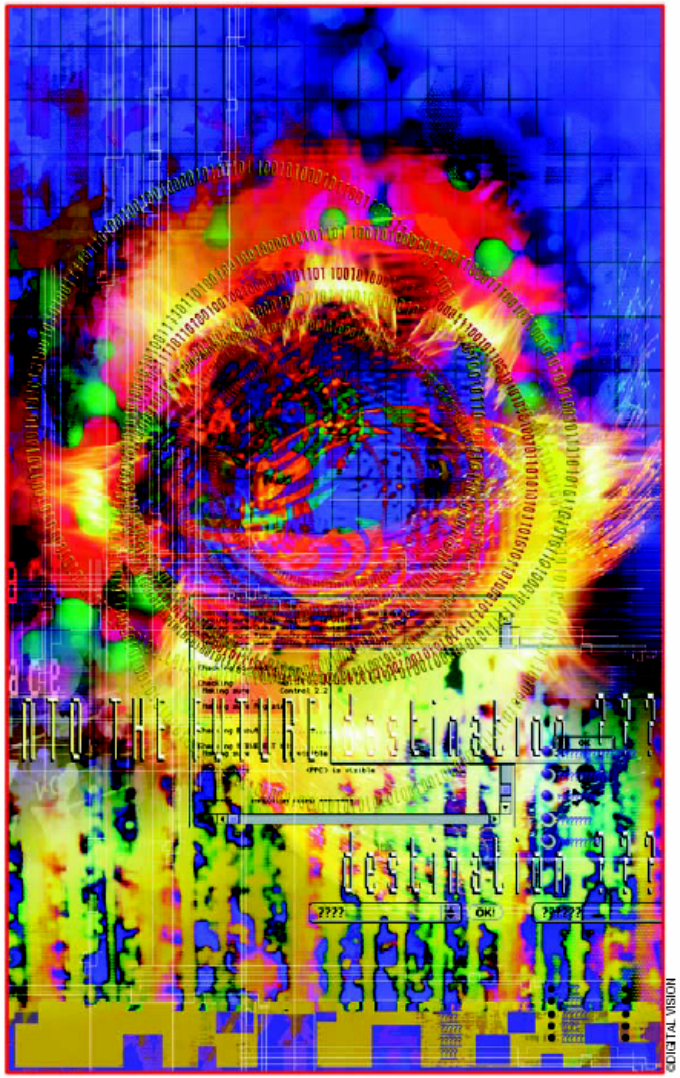
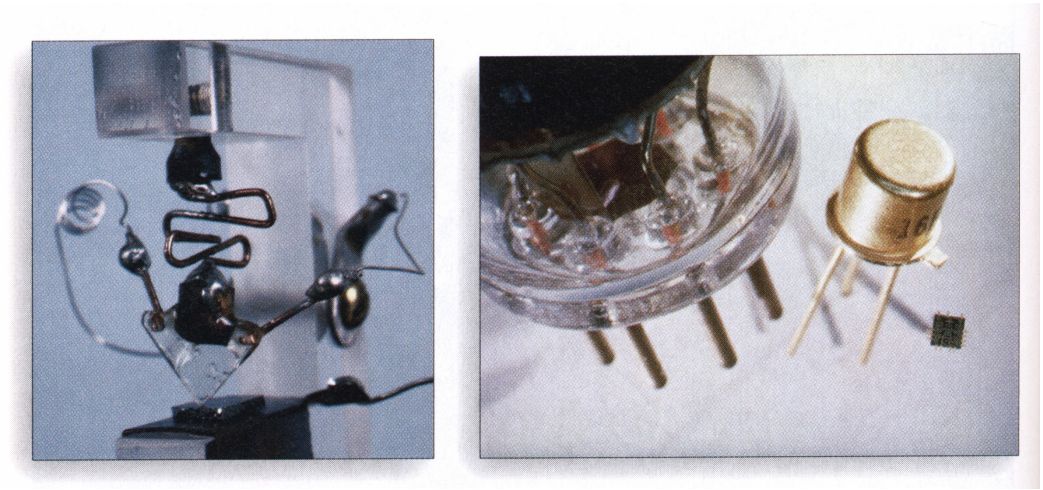
Hybrid Coding: Where Can Future Gains Come from?”

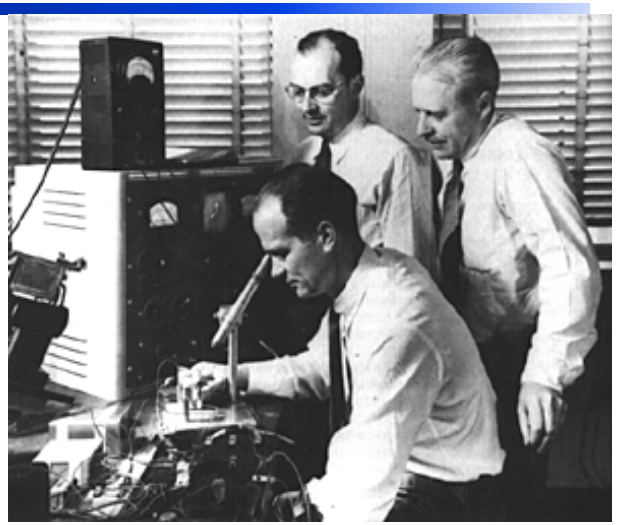


Jörn Ostermann

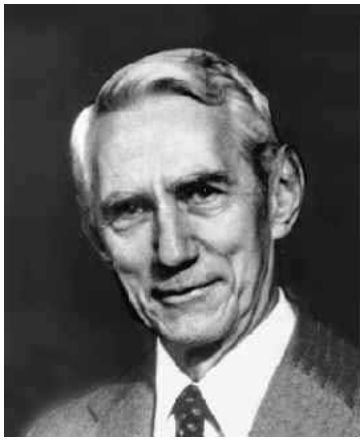
1947: Start of Modern Communikations

- J. Bardeen, W. Shockley, W. Brattain “Germanium Transistor”

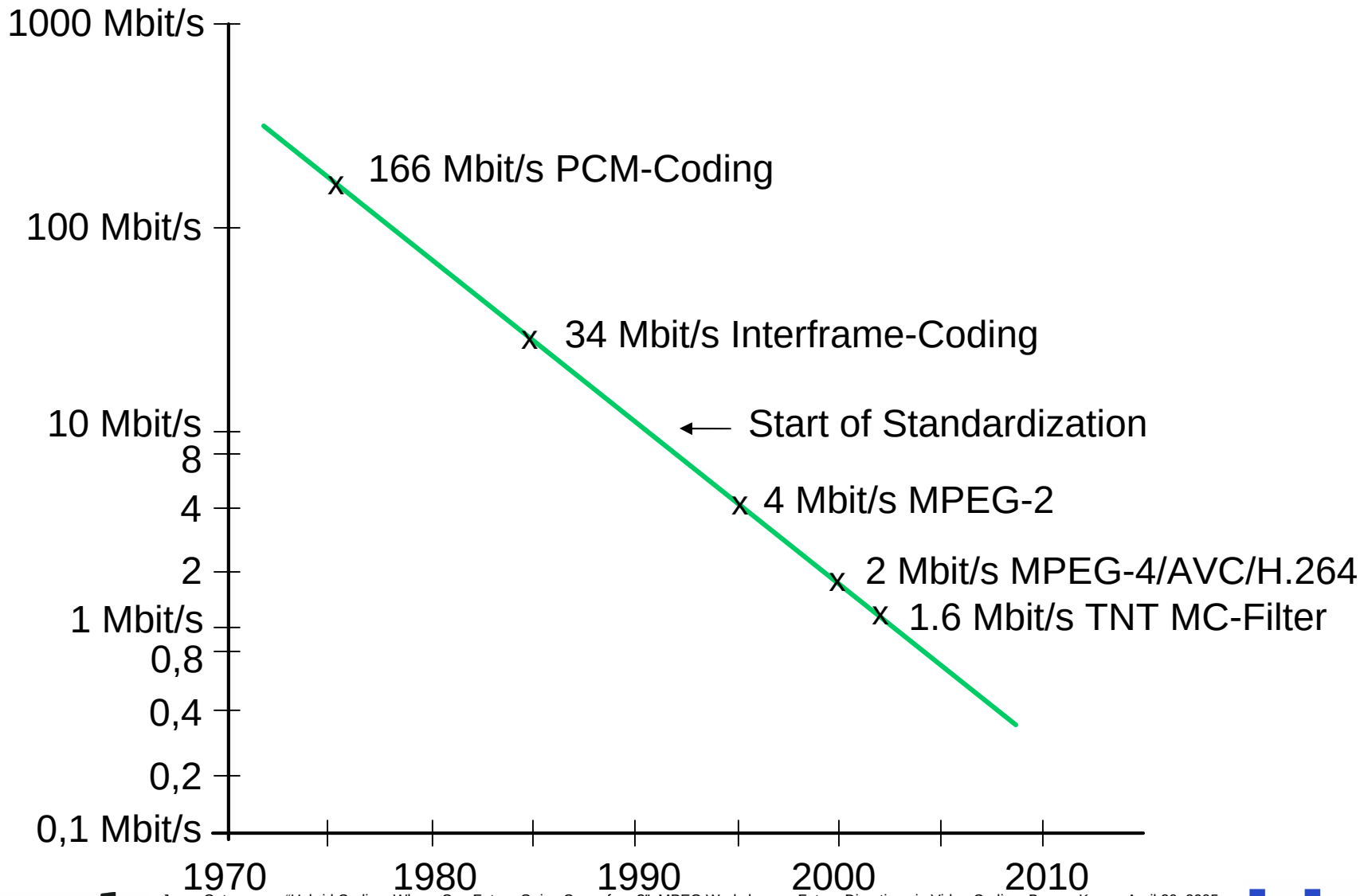




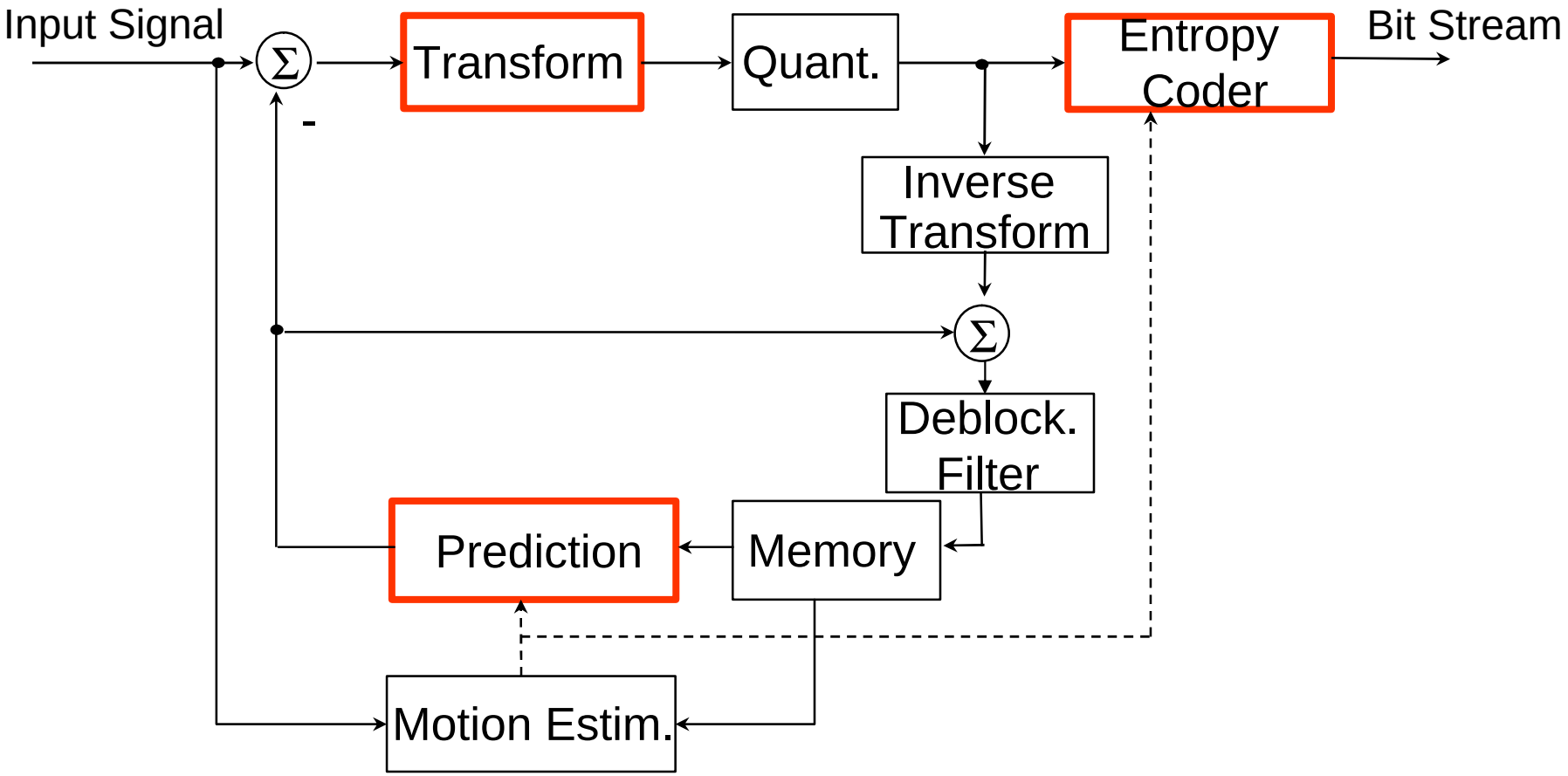
- C. E. Shannon "A Mathematical Theory of Communication.“



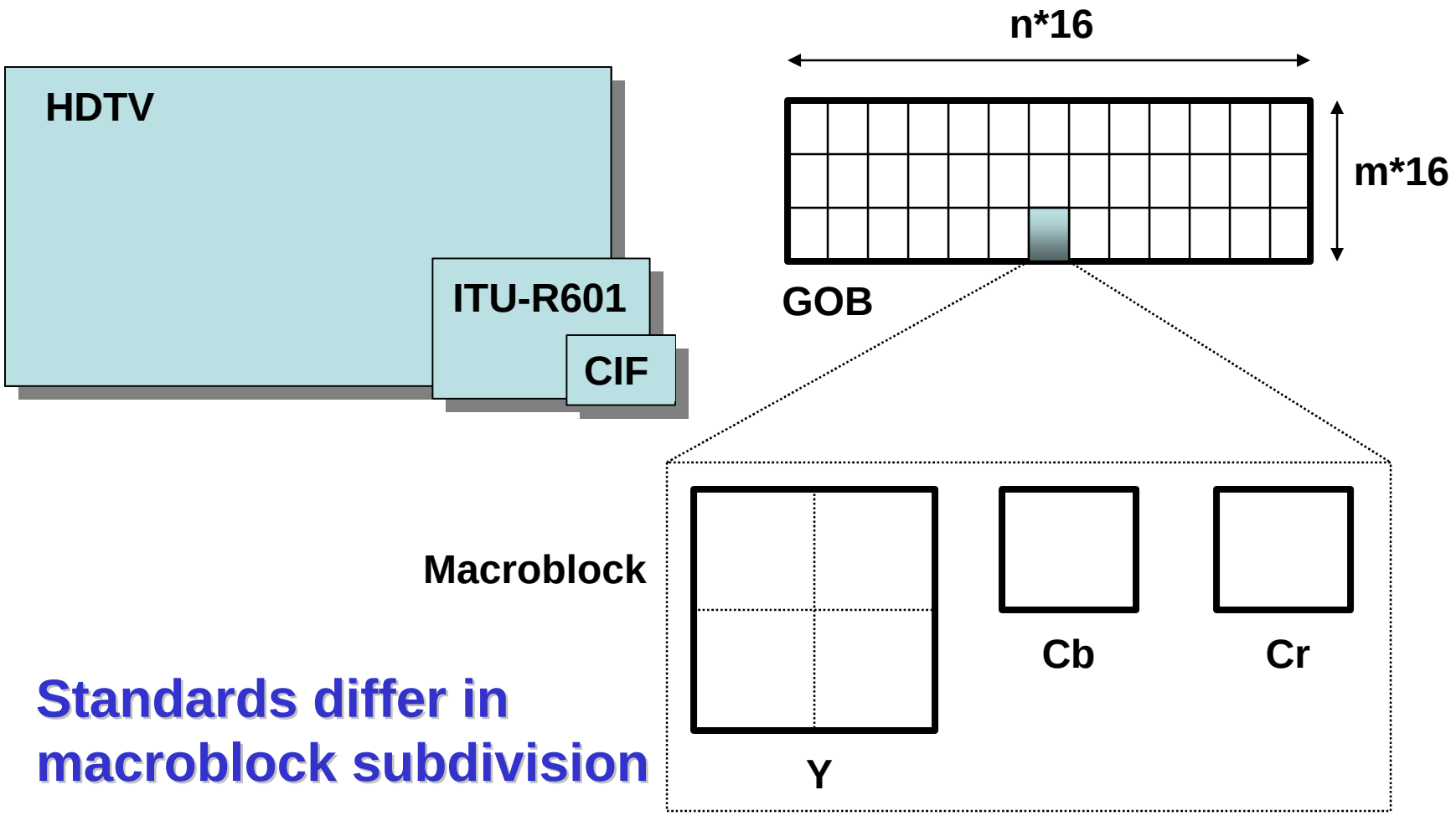
Moore's Law Data Rate for TV-Transmission



Hybrid Coder with Motion Compensation



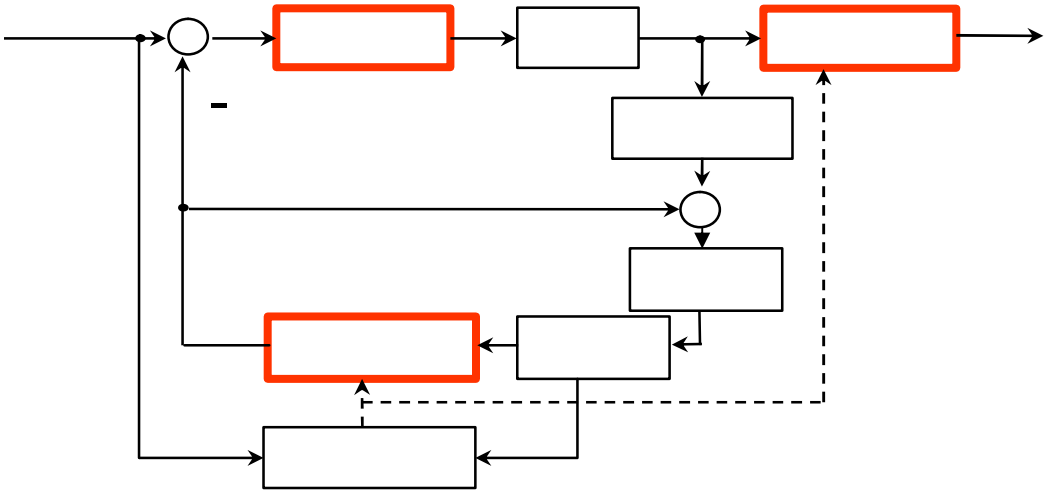
Video Coding: Formats



Standards differ in macroblock subdivision

Overview

1. Entropy Coding
2. Texture Coding
3. Prediction

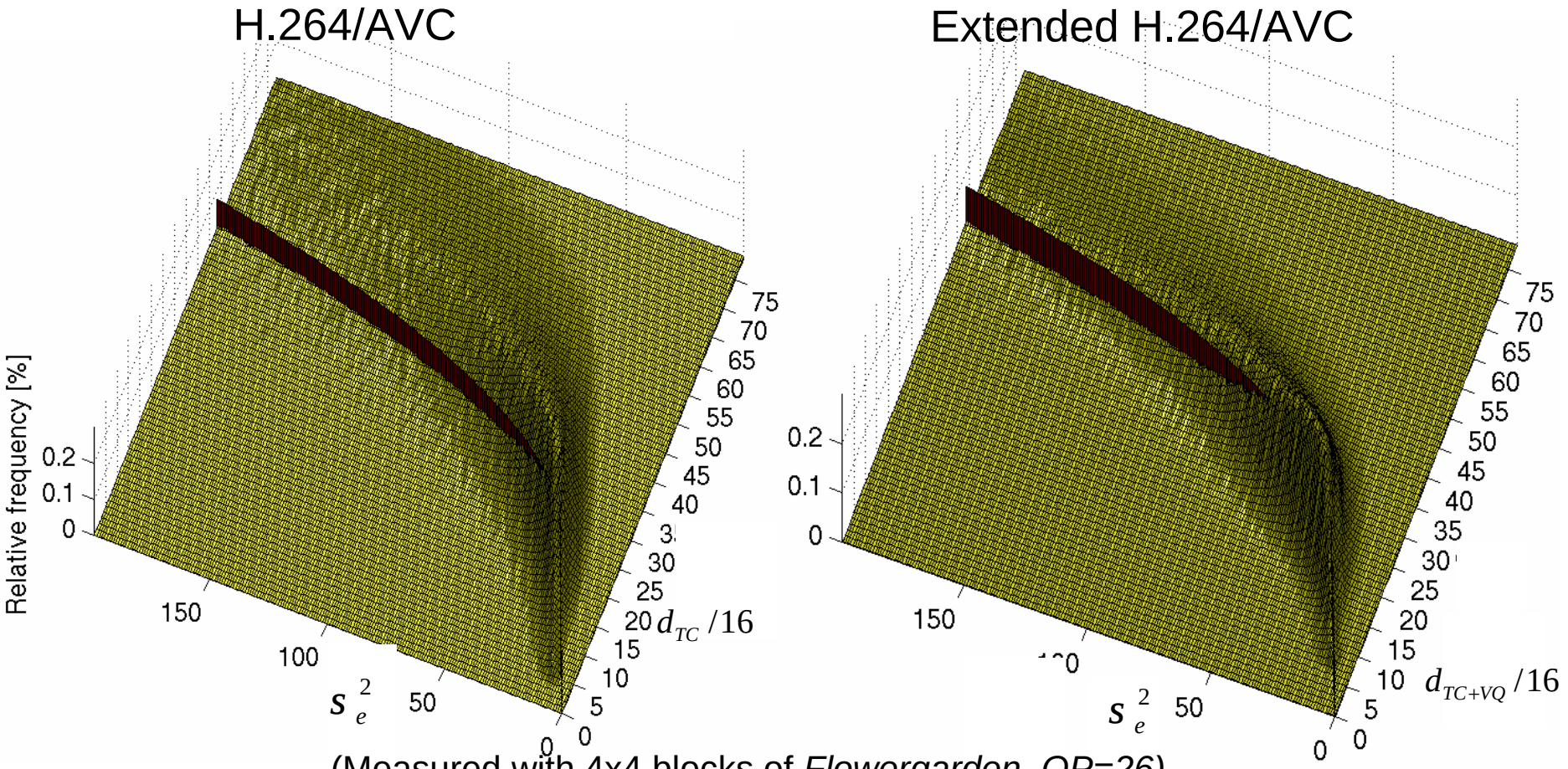


Entropy Coding

- Huffman Coding
  - H.261 … AVC/H.264
- Arithmetic Coding
  - MPEG-4 Part 2
- CABAC
  - H.264
- Rumors
  - Better context modelling
  - More efficient, less complex

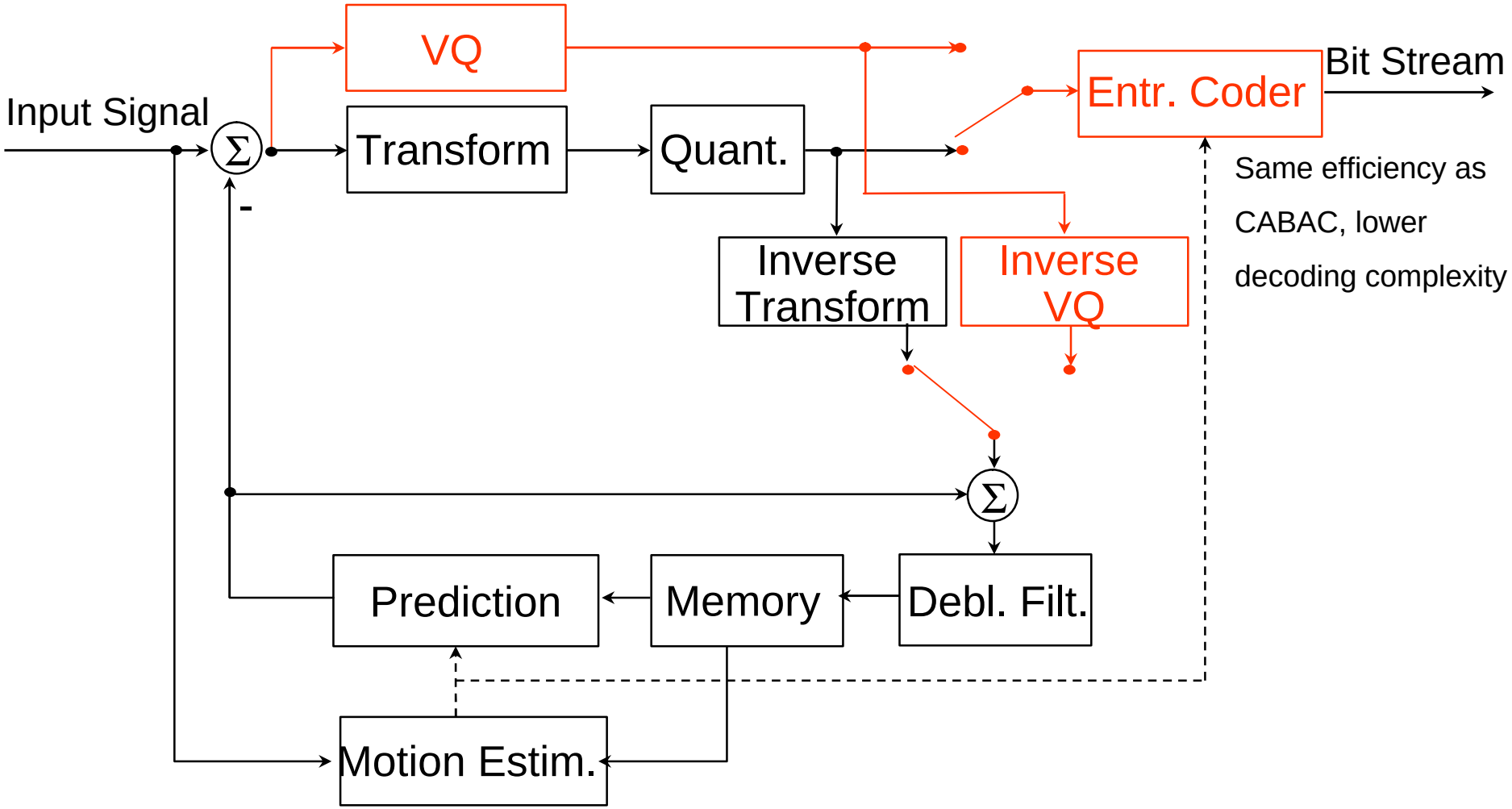
Texture Coding: Extension H.264/AVC by a Vector Quantizer

Reference: M. Narroschke: „Extending the prediction error coder by a vector quantizer“, VCIP 2005, Beijing, 2005



(Measured with 4x4 blocks of *Flowergarden, QP=26)*

Texture Coding: Extension H.264/AVC by a Vector Quantizer



Reference: M. Narroschke: „Extending the prediction error coder by a vector quantizer“, VCIP 2005, Beijing, 2005

Texture Coding: Texture Replacement at the Encoder

Requirements for texture synthesis:

1. Easy to compress

Compressed frames with synthesized texture

Compressed original frames

$BR_2 < BR_1$

2. Similar to original texture

Same semantic, visually similar

Reference: Adriana Dumitras and Barry G. Haskell, A Texture Replacement Method at the Encoder for Bit Rate Reduction of Compressed Video, *IEEE Transactions on Circuits and Systems for Video Technology*, Vol. 13, No. 2, February 2003, pp. 163-175

Texture Coding: Texture Replacement at the Encoder

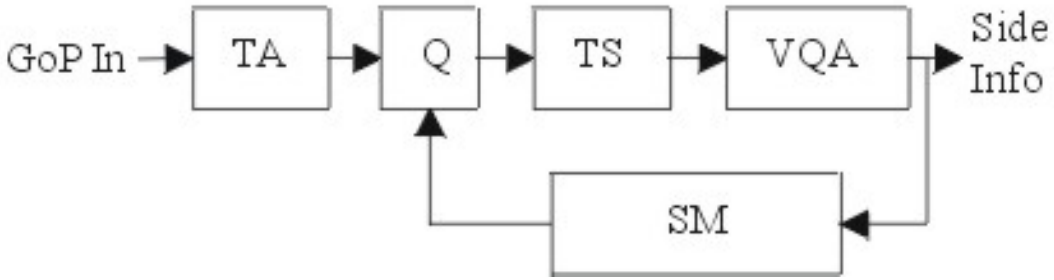
Decoded sequence “6 Days and 7 Nights” with mapped synthesized texture

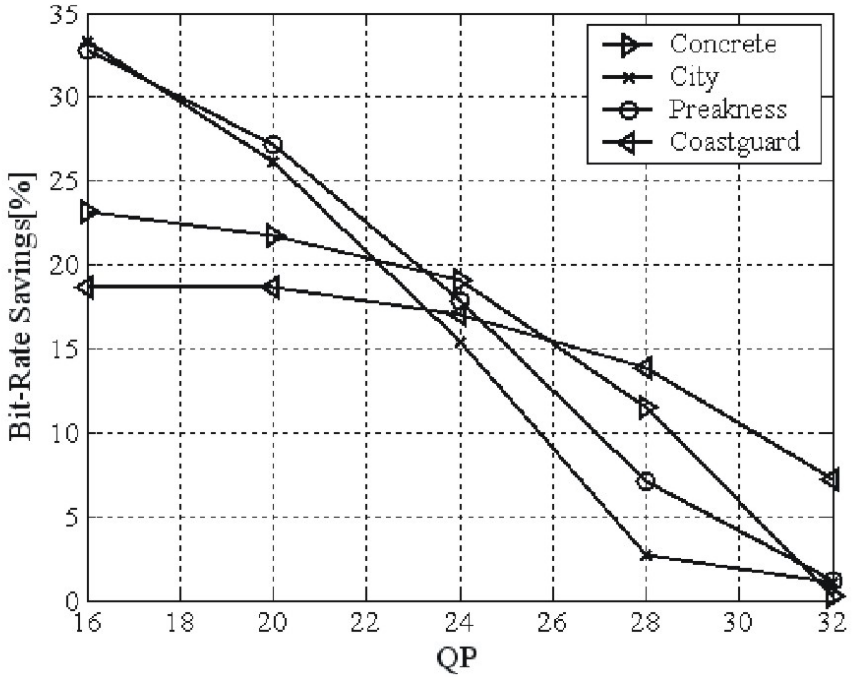
Coding gain of about 20 %

Reference: Adriana Dumitras and Barry G. Haskell, A Texture Replacement Method at the Encoder for Bit Rate Reduction of Compressed Video, *IEEE Transactions on Circuits and Systems for Video Technology*, Vol. 13, No. 2, February 2003, pp. 163-175

Texture Coding: Texture Synthesis at the Decoder (B-Frames)

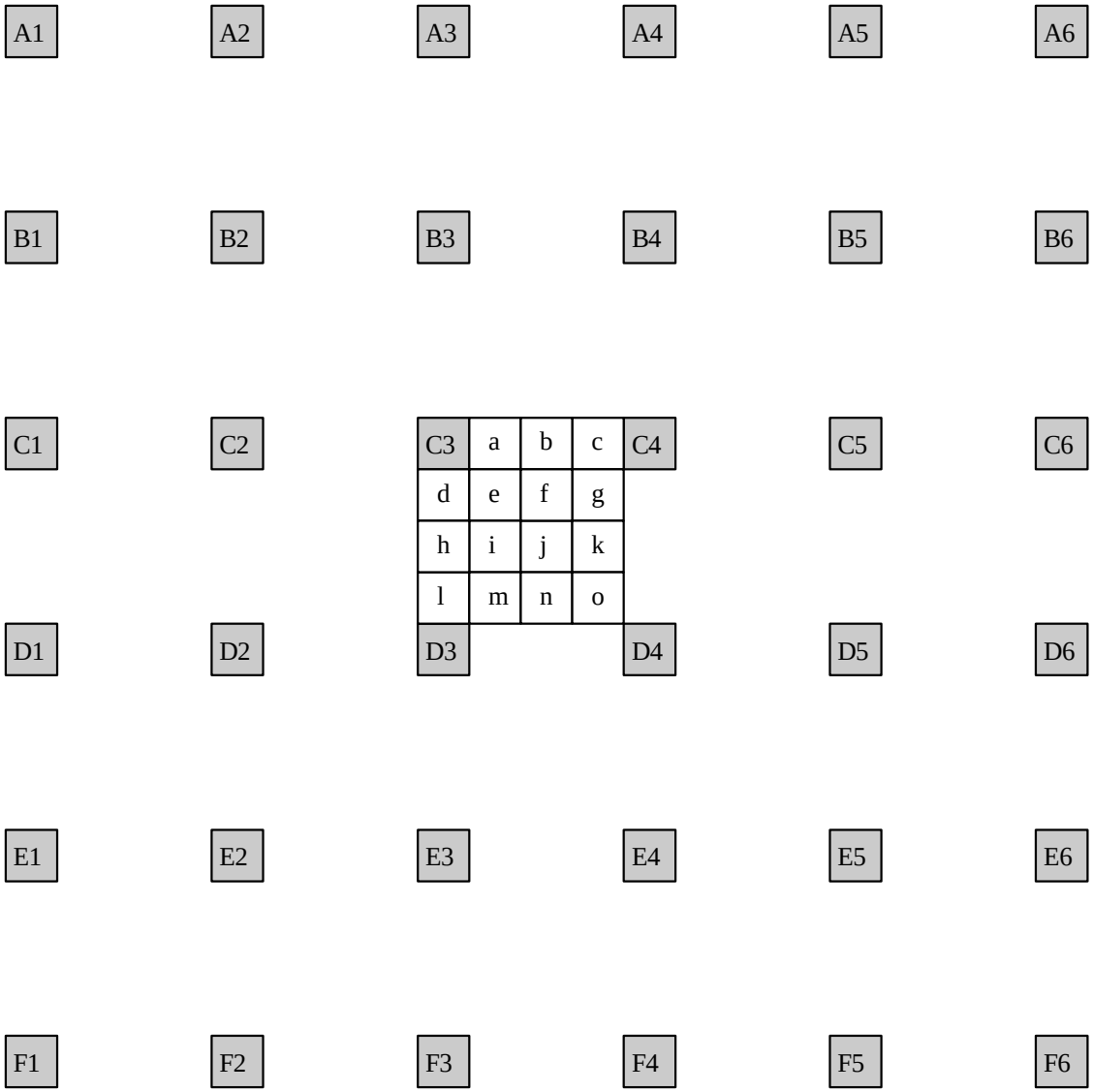
- Encoder
  - Texture Analysis
  - Quantization
  - Texture Synthesis
  - Quality Assessment
  - Improvements
- Decoder
  - Texture Synthesis
- Gain
  - Up to 20% for good quality (QP < 20)





P. Ndjiki-Nya et al., "Improved H.264/AVC Coding Using Texture Analysis and Synthesis," *ICIP 2003*.

Prediction: Motion Compensation



Prediction: 2D non-separable Adaptive Interpolation Filter

- Value $p^{SP}(\,SP \in [a,\ldots,o]\,)$ to be interpolated:

$$p^{SP} = \sum_{i=1}^{6}\sum_{j=1}^{6} P_{i,j}\, h^{SP}_{i-1,j-1}$$

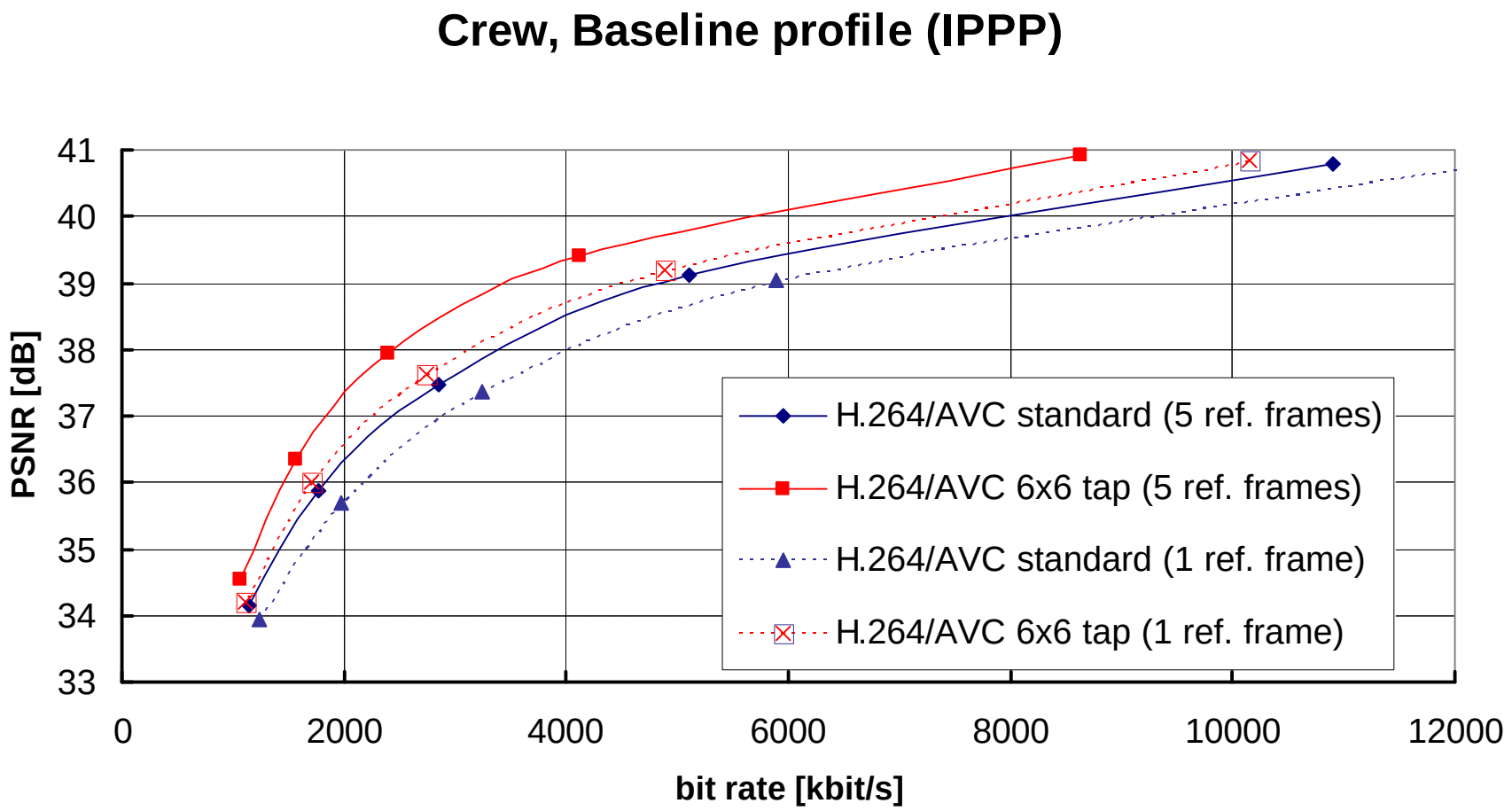
where $P_{i,j}$ is an integer sample value ($A1 \ldots F6$) and $h^{SP}_{i,j}$ are filter coefficients for sub-pel position *SP*.

$$0 = \sum_{x}\sum_{y}\left(S_{x,y} - \sum_{i=1}^{6}\sum_{j=1}^{6} h^{SP}_{i,j}\, P_{\tilde{x}+i,\tilde{y}+j} \right) P_{\tilde{x}+k,\tilde{y}+l}$$

$$\forall k,l \in [0;5]$$

Reference: Y. Vatis et. al: „ Coding of Coefficients of two-dimensional non-separable Adaptive Wiener Interpolation Filter “, VCIP 2005, Beijing, 2005

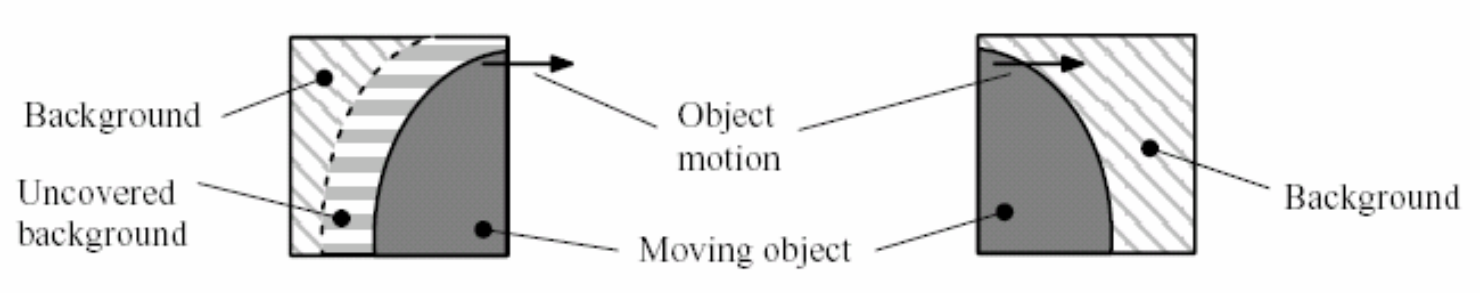
Prediction: 2D non-separable Adaptive Interpolation Filter



- Increase of PSNR for all bit rates of up to 1,2 dB for HDTV sequences and of up to 0,5 dB for CIF sequences.

Prediction: Object Boundaries

- Motion compensation: 1/8 pel block motion, parametric motion models
- Prediction error becomes noise except:



- Shape coding (on a block basis) for improving prediction at object boundaries, alias compensation
- Scene dependent

Conclusions

- Entropy coding
  - Little gain in efficiency, improvements in complexity
- Texture coding:
  - VQ little gain in efficiency
  - Texture replacement 20%
- Prediction
  - Improved motion compensation filter: Up to 1,2 dB gain for HDTV
  - Texture analysis and synthesis: 20% for some sequences
  - 1/8 pel for HDTV
  - Tools from the past: Shape coding
- Strategy for standards development
  1. High quality
  2. High coding efficiency
  3. Complexity reduction