Laboratoire d'Informatique de Robotique et de Microélectronique de Montpellier

LIRMM

SIMPA SIGNAL IMAGE PAROLE

UNIVERSITÉ MONTPELLIER 2 SCIENCES ET TECHNIQUES

UNÎMES UNIVERSITÉ

A Joint JPEG2000 Compression and Watermarking System using a TCQ-based Quantization Scheme

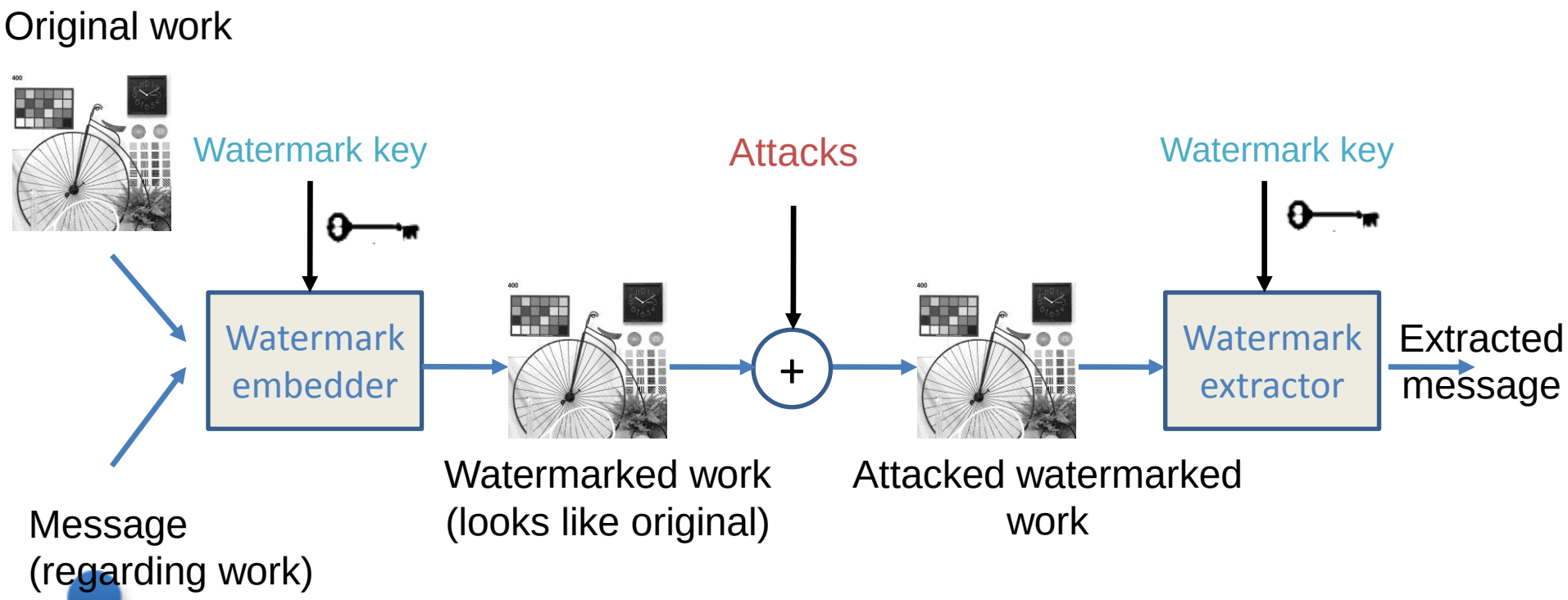
Authors: D. Goudia (LIRMM-SIMPA)
M. Chaumont (LIRMM)
W. Puech (LIRMM)
N. Hadj Said (SIMPA)

Outline

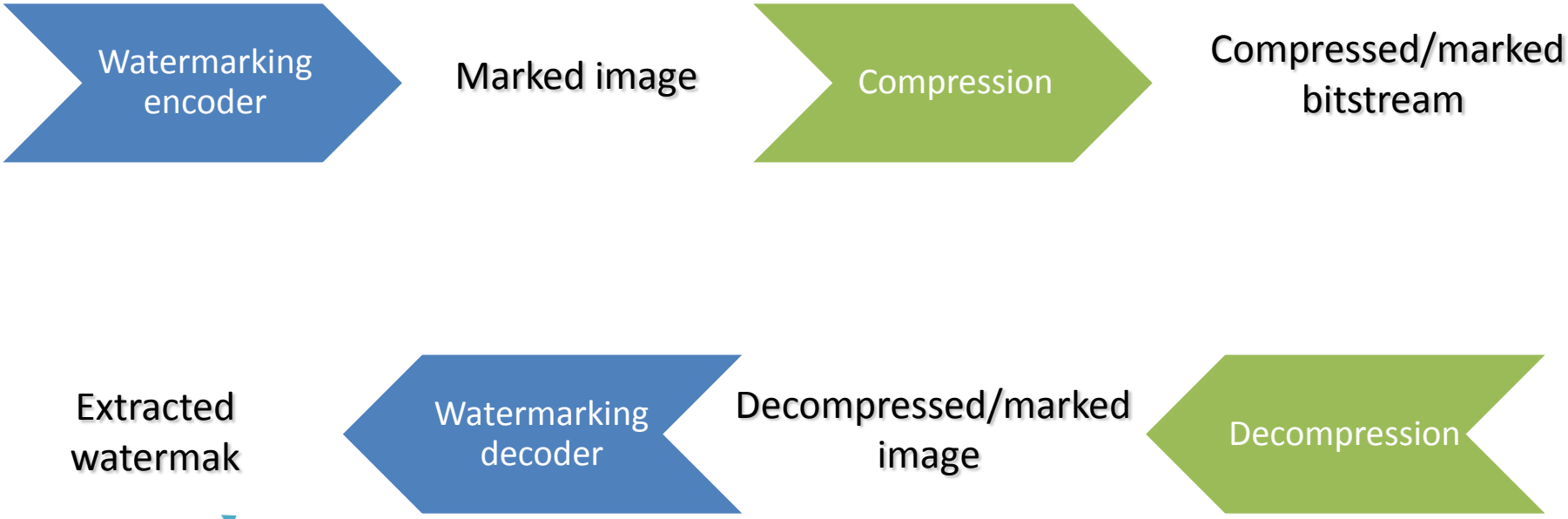
- Few words about watermarking & compression
- The proposed joint JPEG2000 compression & watermarking scheme
- Experimental evaluations
- Conclusions

Compression & Watermarking

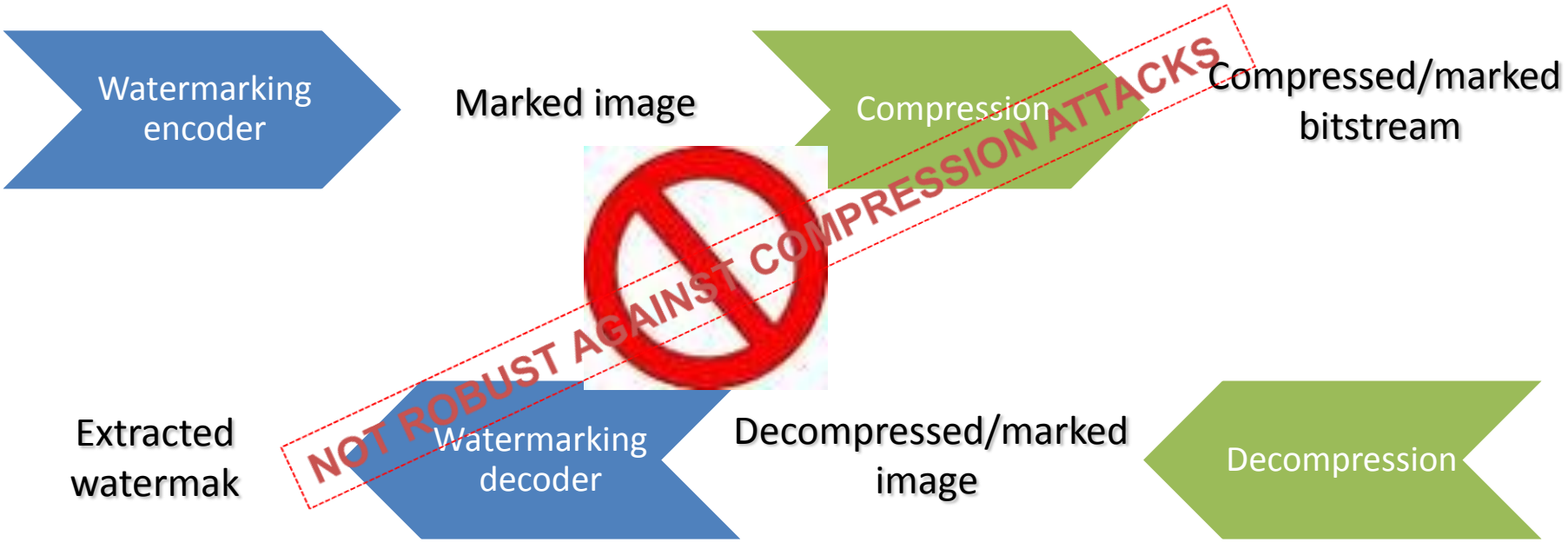
Definitions of watermarking basic design of a system



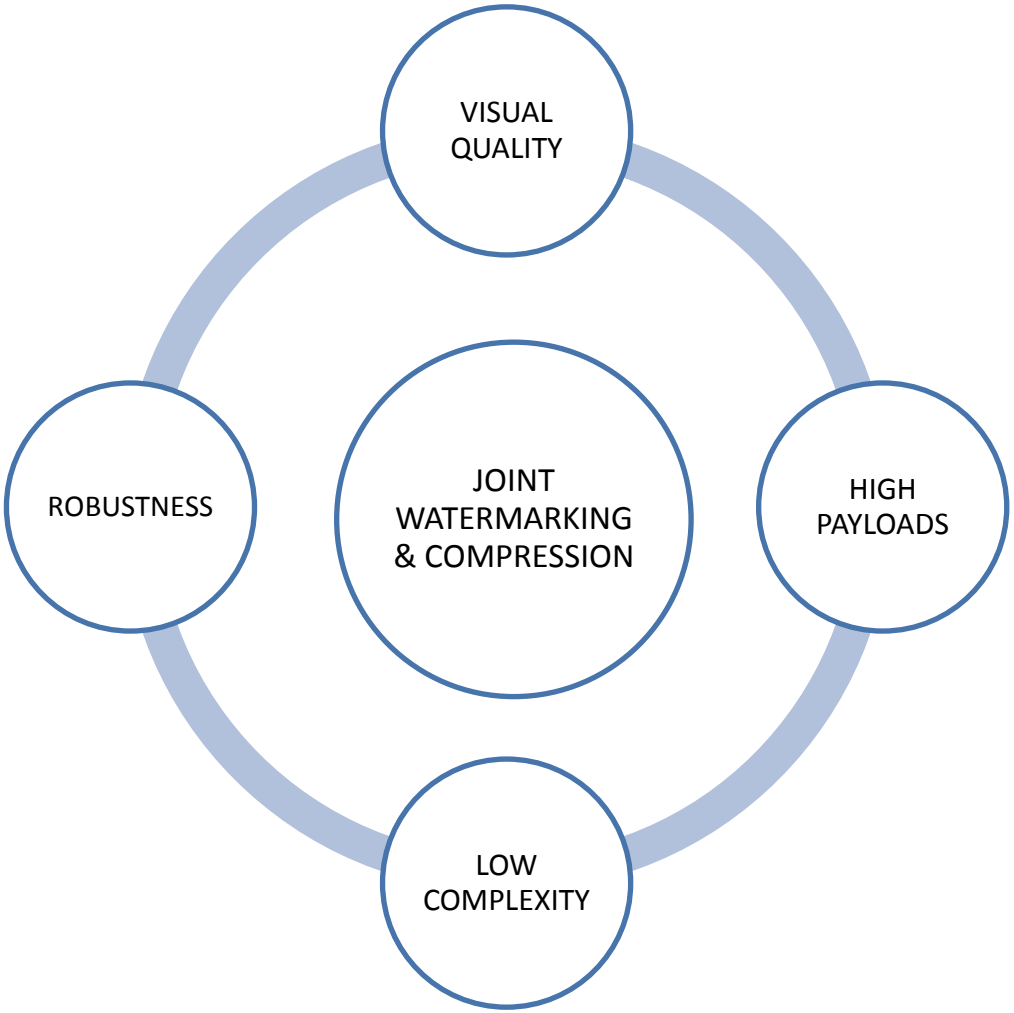
Watermarking & Compression



Watermarking & Compression



Watermarking & Compression



The proposed joint JPEG2000 compression and watermarking scheme

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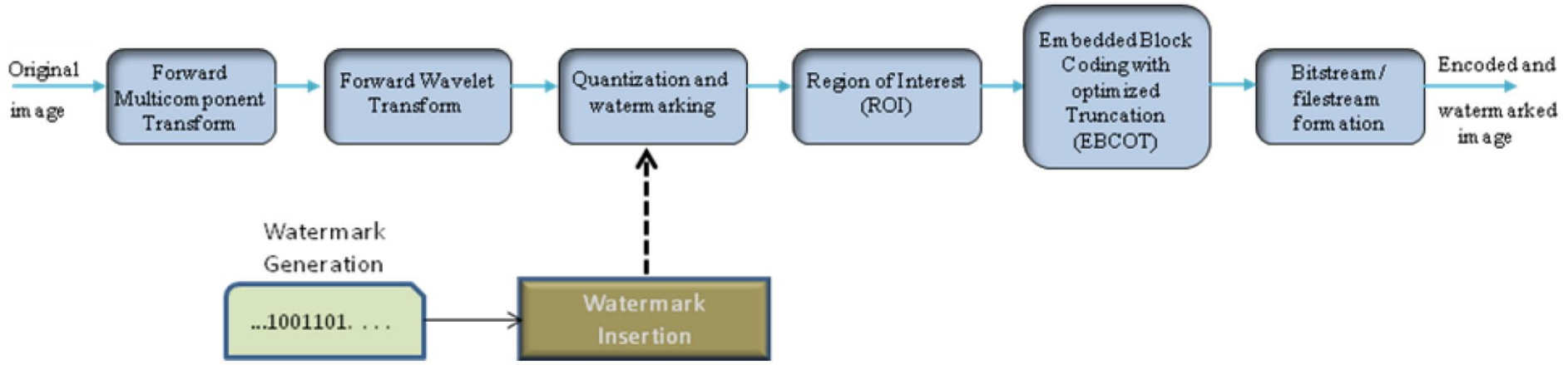
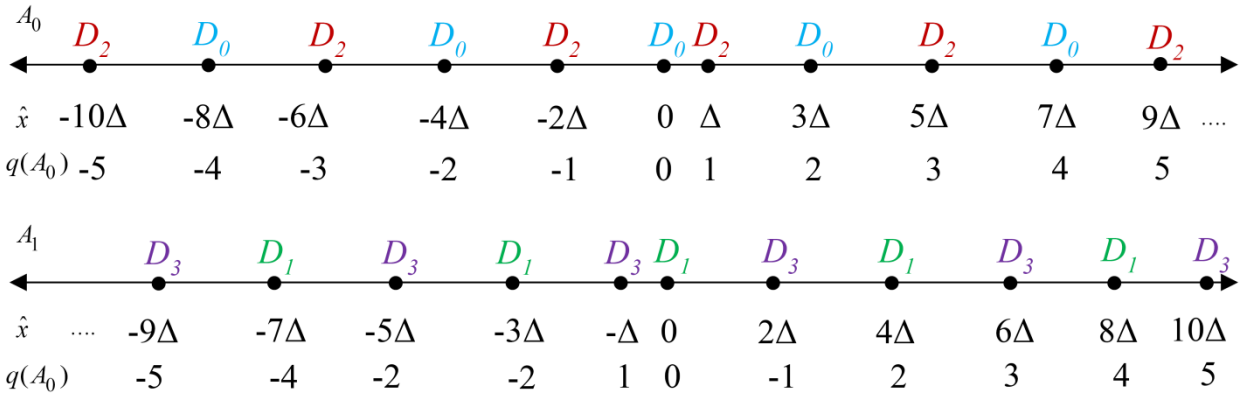


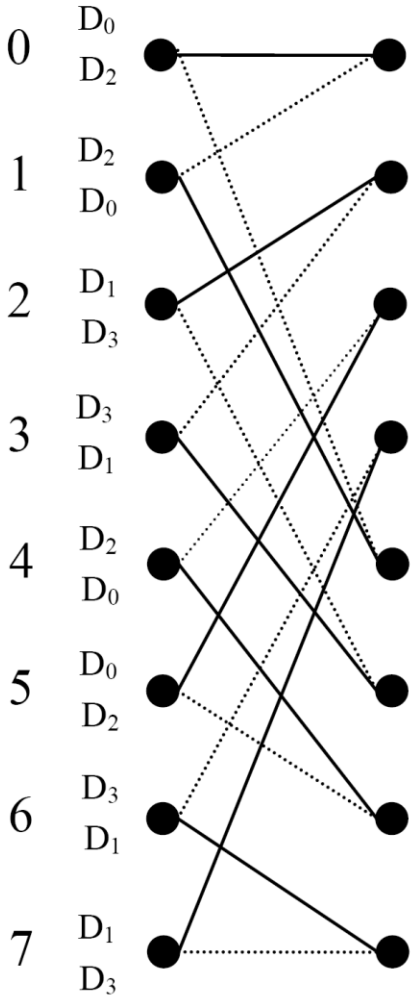
The joint JPEG2000 encoder/watermark embedding scheme.

Trellis Coded Quantization (TCQ) in JPEG2000 part 2

Partitioning of a scalar quantizer into 4 subsets conbined to form 2 union quantizers:

$$A_0 = D_0 \cup D_2 \quad \& \quad A_1 = D_1 \cup D_3$$





Watermarking strategy

The TCQ quantization used in the proposed joint scheme

- Use of shifted TCQ quantizers
- 2 groups of union quantizers :

  - Group 0 : The bit to be embedded is 0

$$A_0^0 = D_0^0 \cup D_2^0, A_1^0 = D_1^0 \cup D_3^0$$

  - Group 1: The bit to be embedded is 1

$$A_0^1 = D_0^1 \cup D_2^1, A_1^1 = D_1^1 \cup D_3^1$$

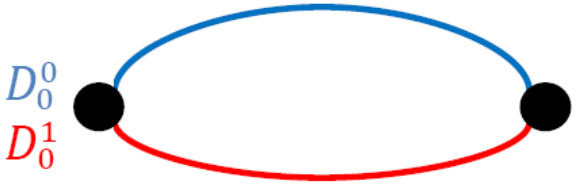
- Modification of the trellis structure

Watermarking strategy

The TCQ quantization used in the proposed joint scheme

- Modification of the trellis structure

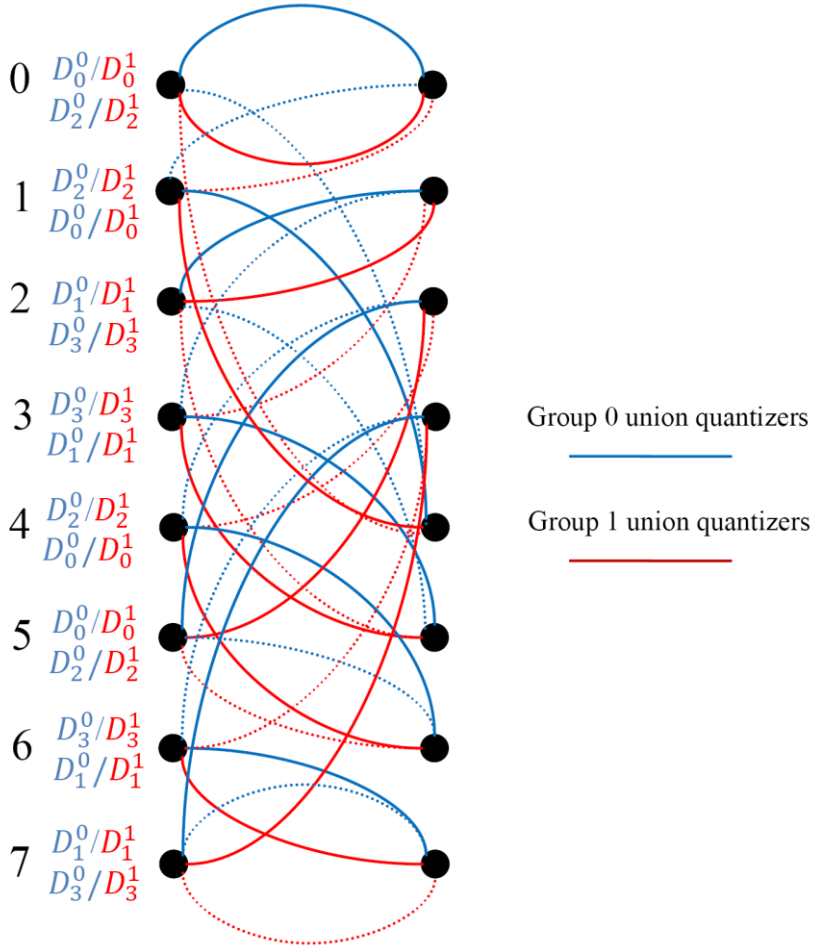
Labeling with the trellis used in JPEG2000



Labeling with the modified trellis used in our joint scheme

Watermarking strategy

- Modification of the trellis structure



Watermarking strategy

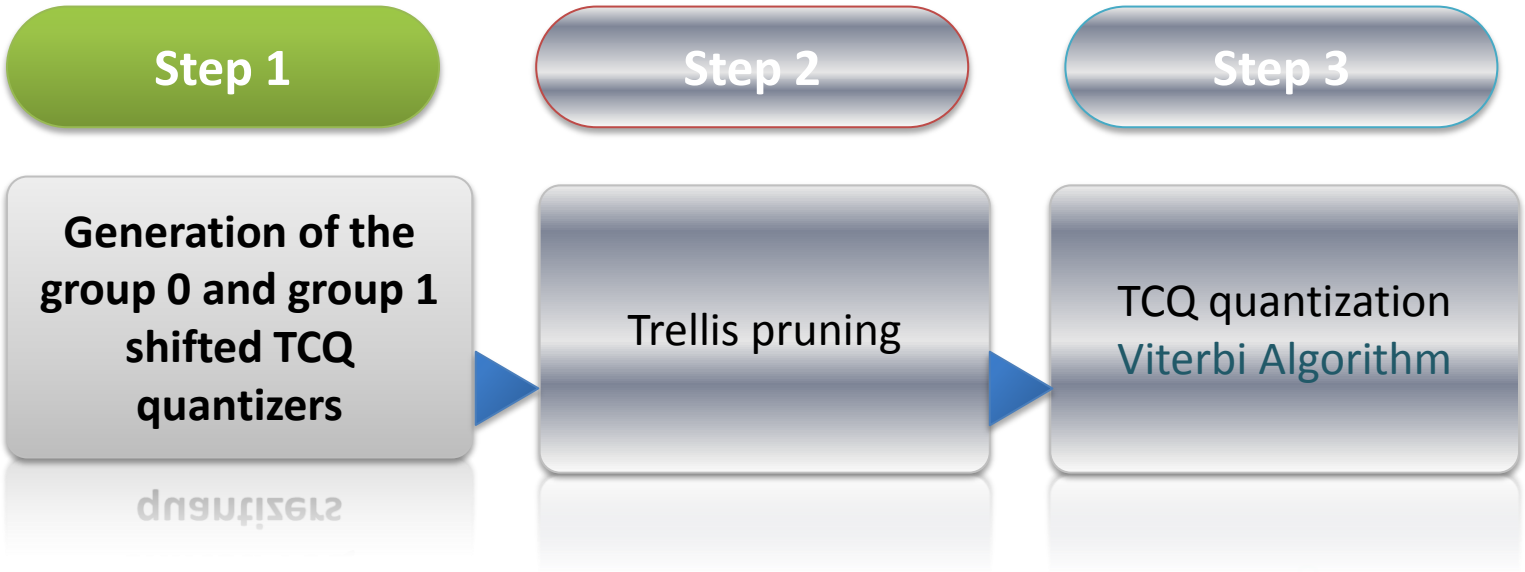
The message is embedded by choosing between two TCQ quantizers from the 2 groups of union quantizers at each transition in the trellis

The proposed joint JPEG2000 compression and watermarking scheme

Quantization and watermark embedding

The proposed joint JPEG2000 compression and watermarking scheme

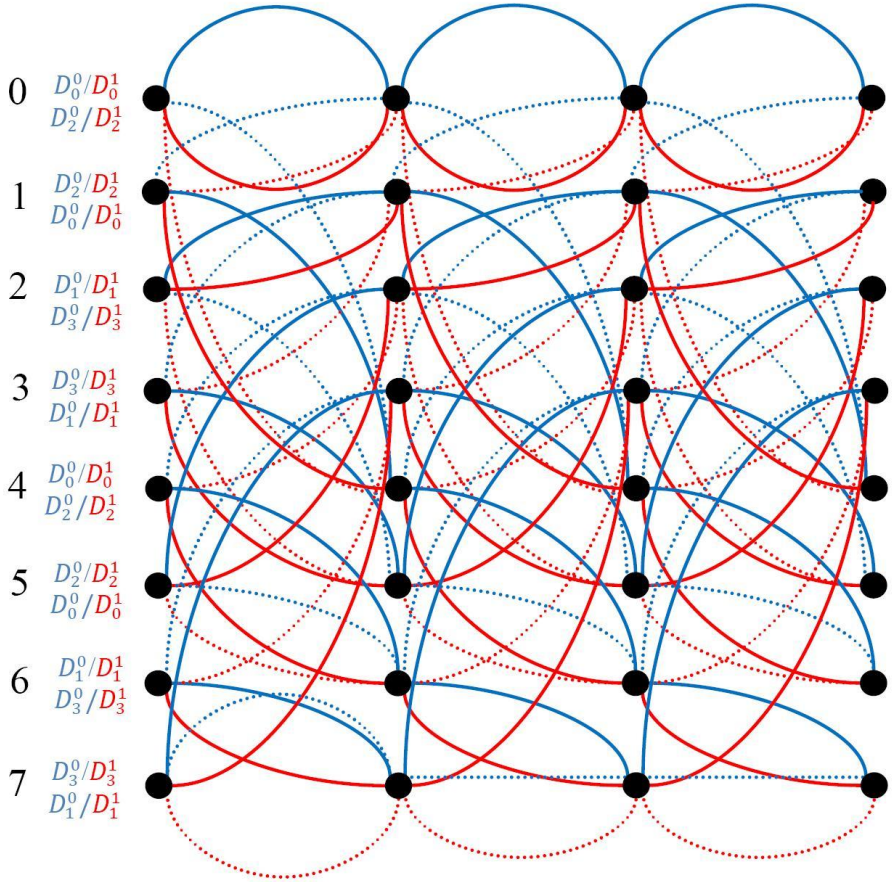
Quantization and watermark embedding



The proposed joint JPEG2000 compression and watermarking scheme

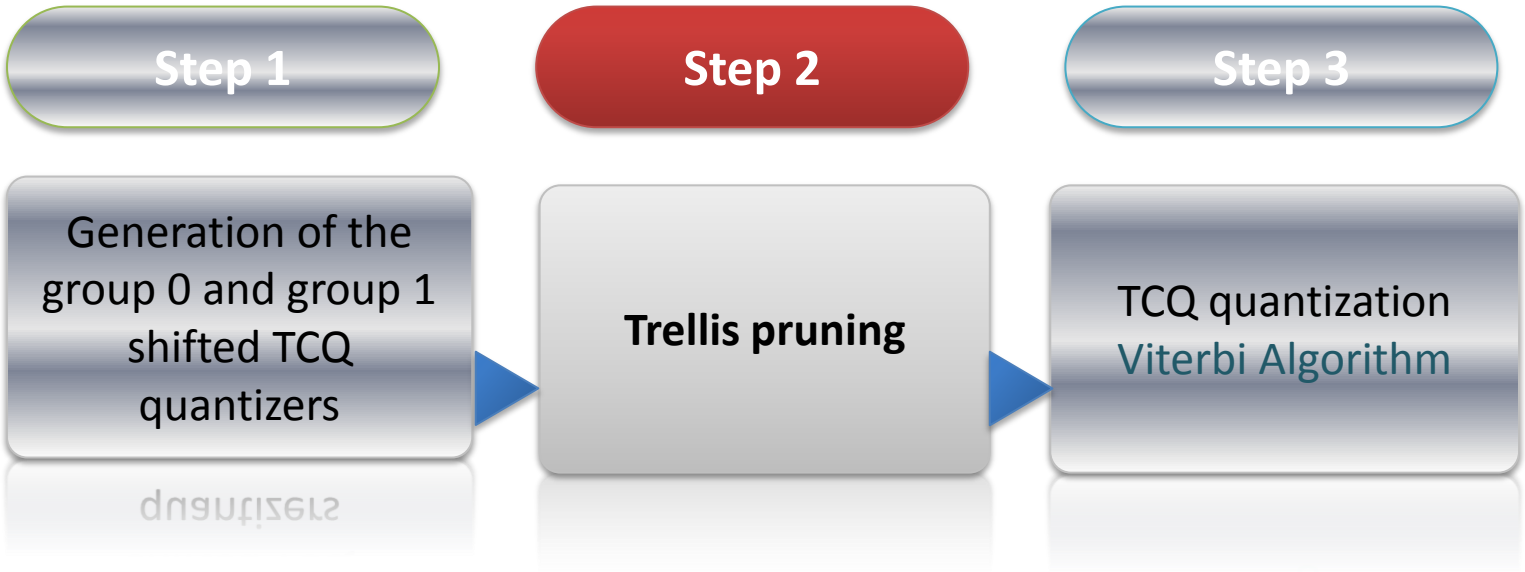
Step 1

Trellis construction with branch labelling



The proposed joint JPEG2000 compression and watermarking scheme

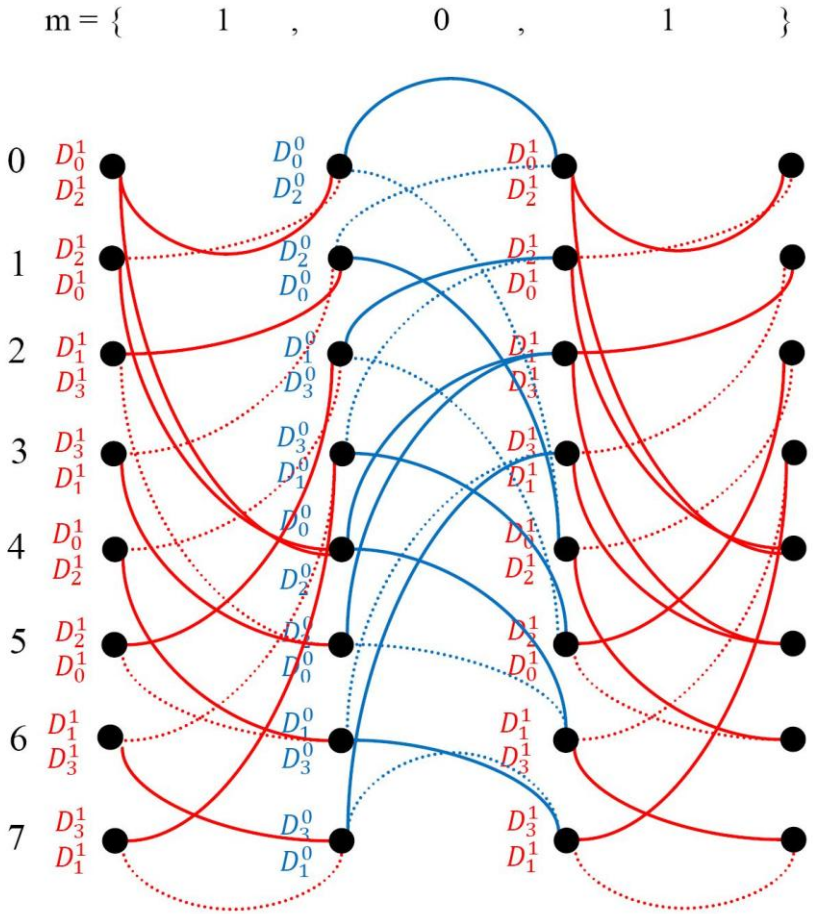
Quantization and watermark embedding



The proposed joint JPEG2000 compression and watermarking scheme

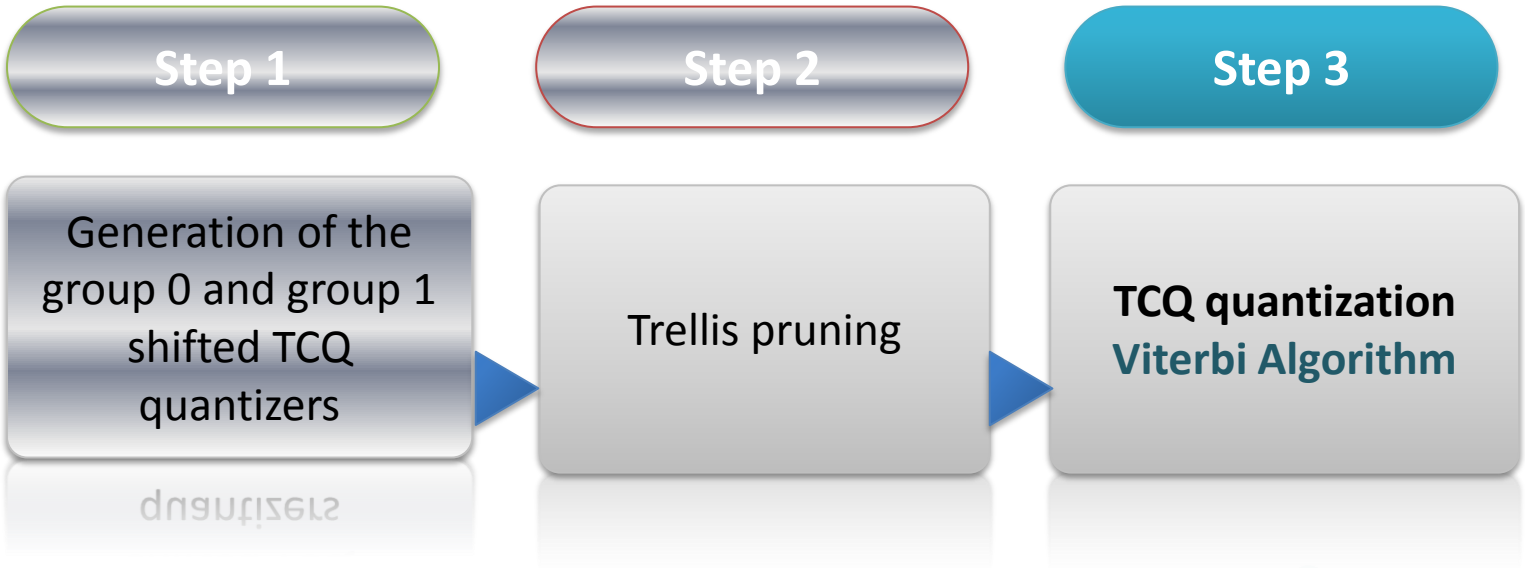
Step 2

Trellis pruning



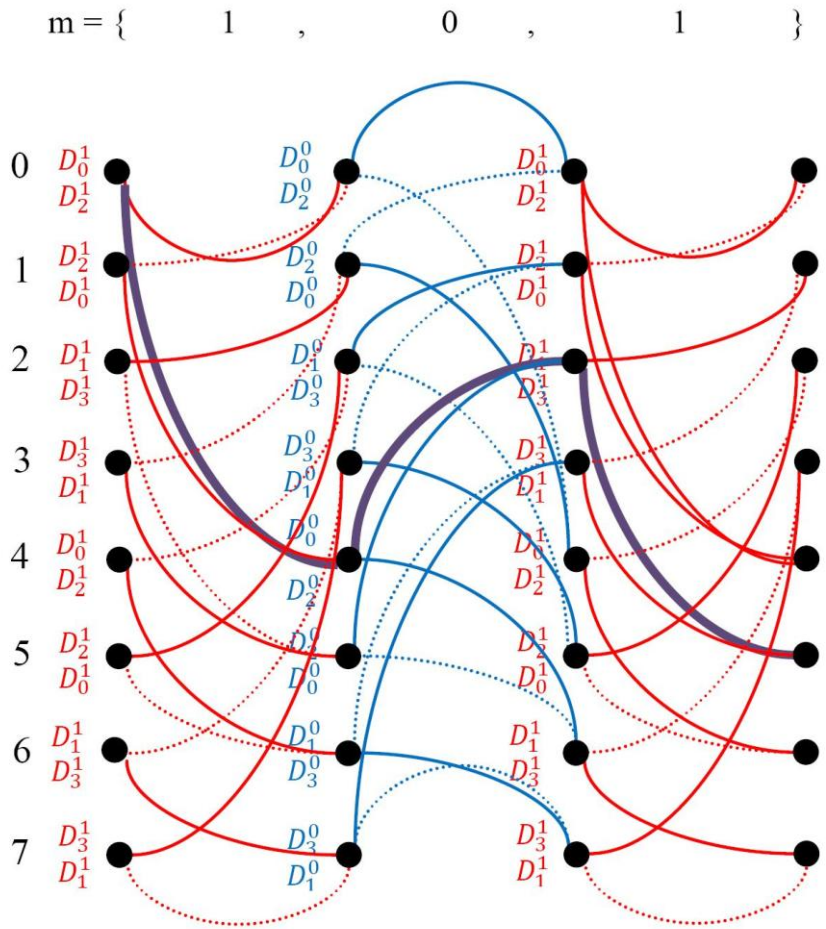
The proposed joint JPEG2000 compression and watermarking scheme

Quantization and watermark embedding



The proposed joint JPEG2000 compression and watermarking scheme

Step 3 Viterbi Algorithm



The proposed joint JPEG2000 compression and watermarking scheme

Watermark extraction

During JPEG2000 decompression

- Dequantization by using the simplified trellis

← **JPEG2000 bitstream**

After JPEG2000 decompression

- Discrete Wavelet Transform (DWT)
- Viterbi Algorithm applied onto the whole trellis

← **Decompressed/marked image**

Experimental evaluations

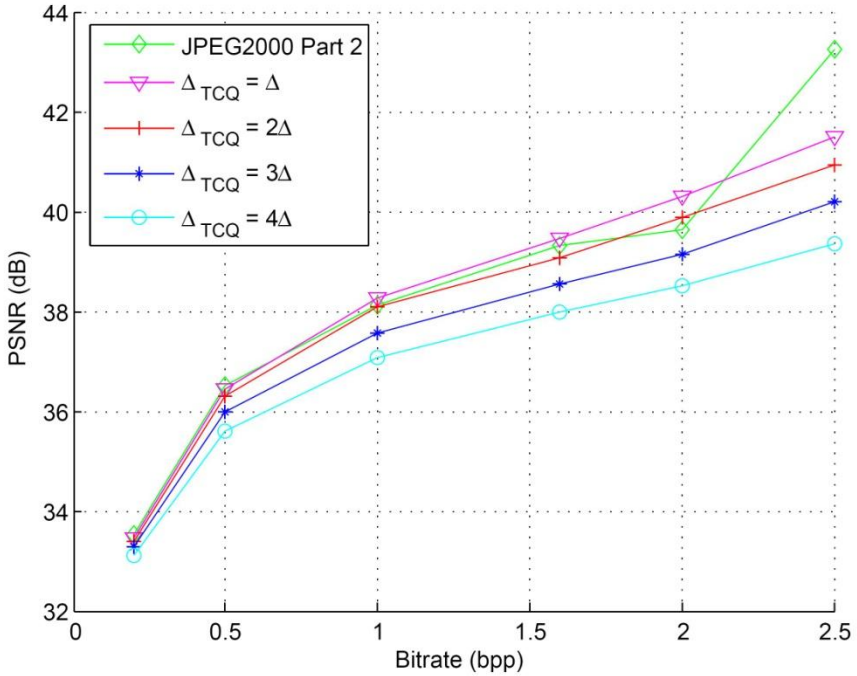
Experimental evaluations

Evaluation protocol 1:

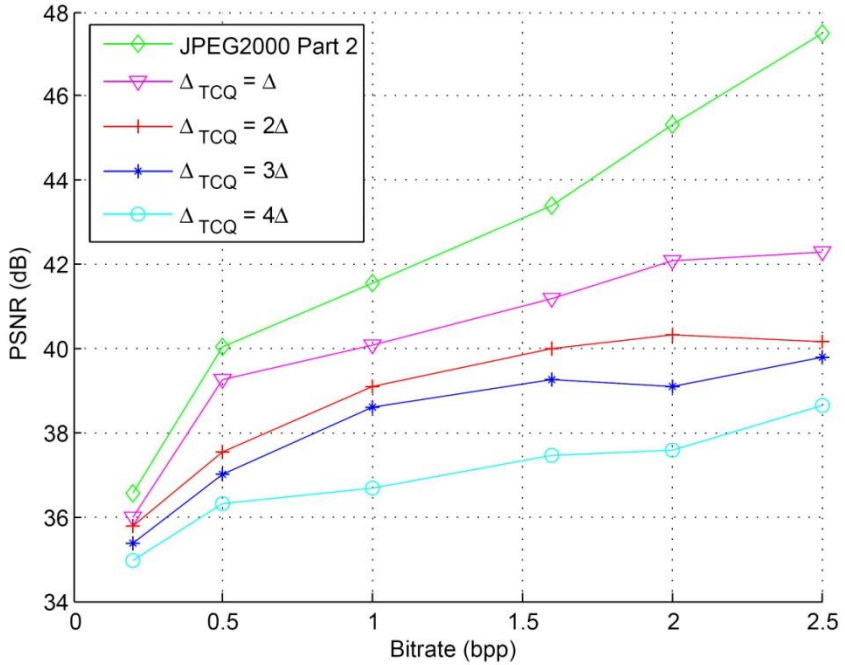
- 4 test images of size 512 x 512
- 5 levels of wavelet decomposition , one tile, no ROI coding
- Variation of the bitrate from 2.5 bpp to 0.2 bpp
- Payload = 1 bit (message) for 16 pixels
  - 1024 bits embedded in the HL sub-band of the second resolution level

Experimental evaluations

Visual quality performances under various compression bitrates



Bike image

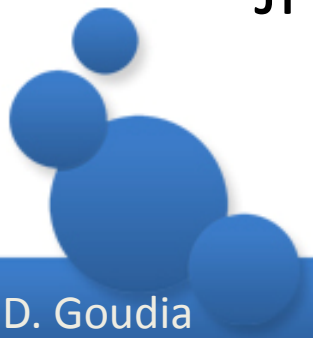


Lena image

Experimental evaluations

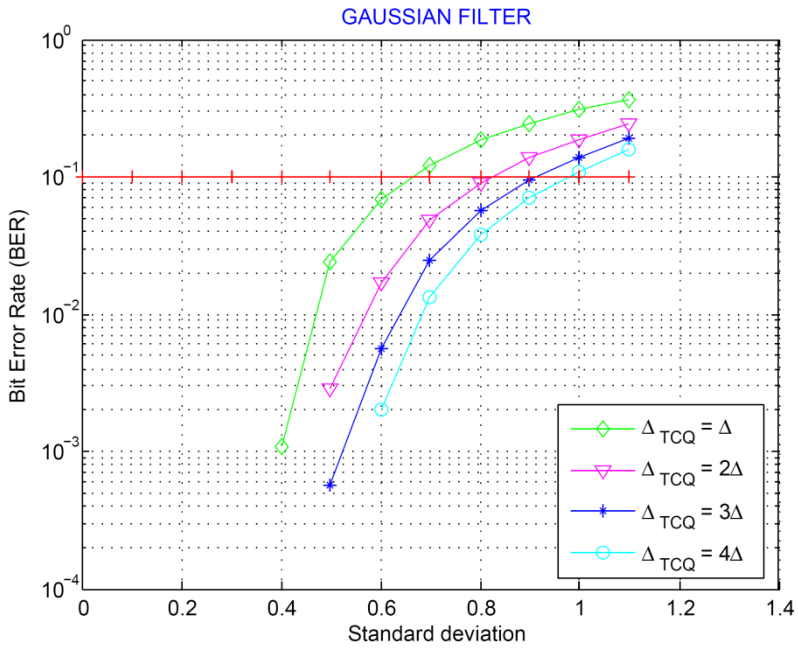
Evaluation protocol 2:

- 200 images of size 512 x 512
- Robustness of the watermark: 4 attacks
  - Gaussian filtering
  - Gaussian noise
  - Valumetric scaling
  - JPEG attack

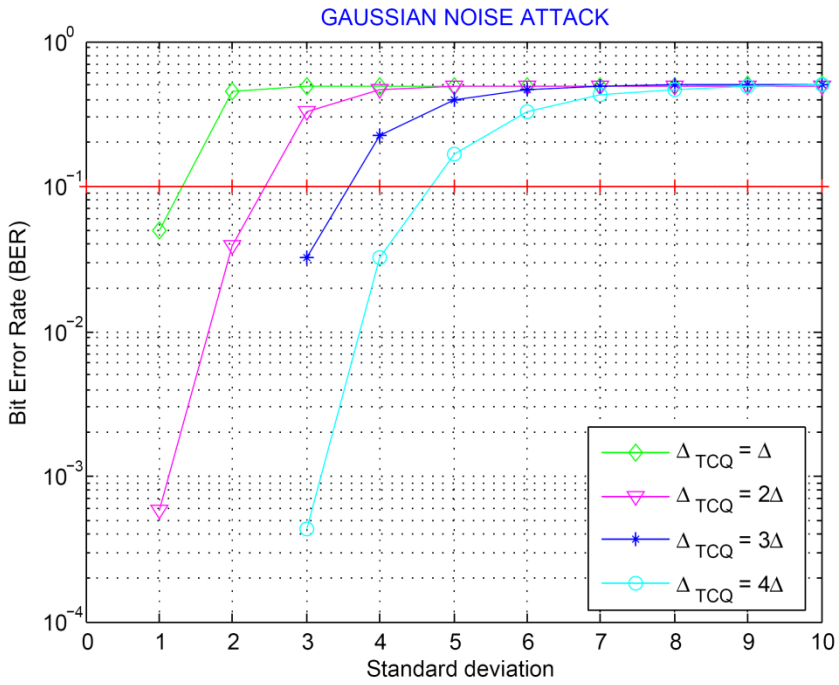


Experimental evaluations

Attacks (1)



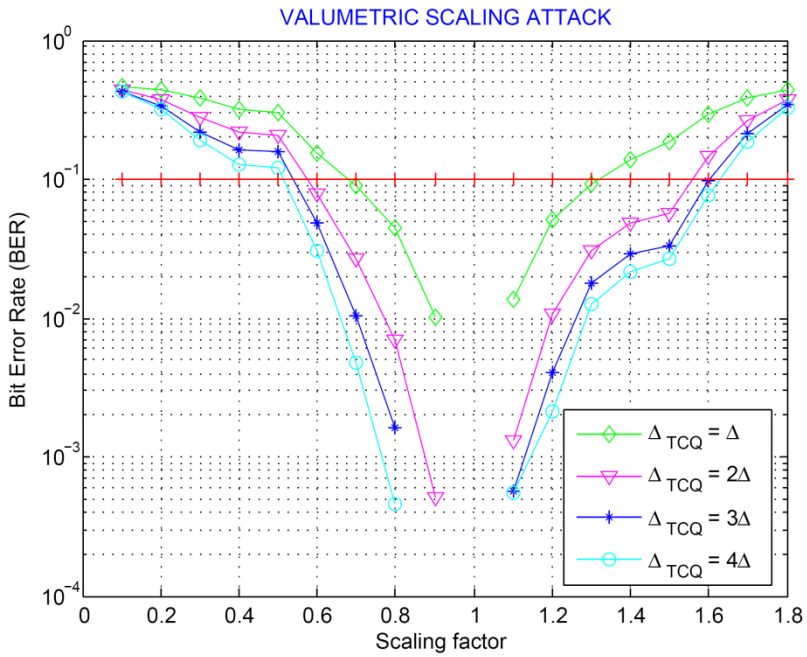
Gaussian filtering attack



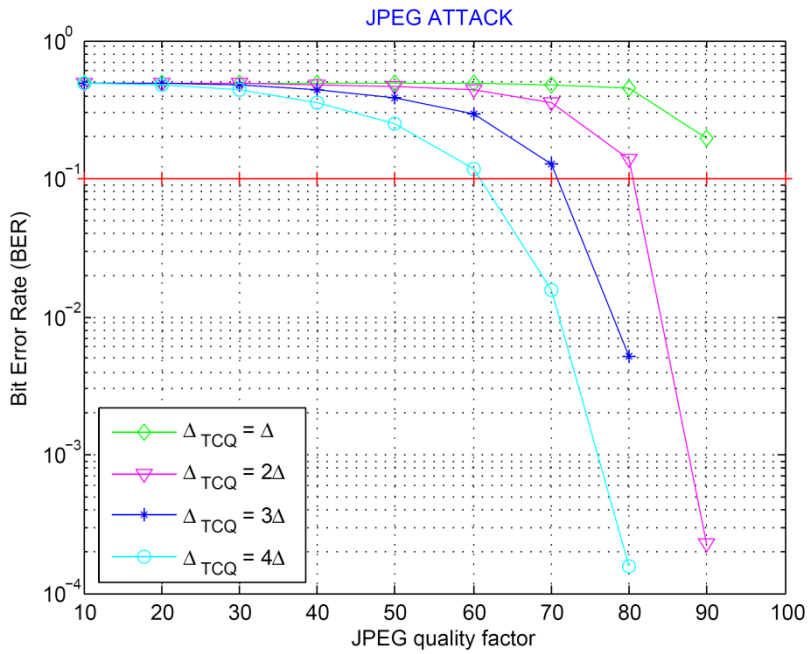
Gaussian noise attack

Experimental evaluations

Attacks (2)



Valumetric scaling attack



JPEG attack

Conclusions & Discussion

Conclusions & Discussion

- Quantization & watermarking at the same time
- 2 types of watermark extraction
- Good compression performances
- Robust to JPEG2000 compression at low bitrates
- Robustness to attacks: depends on the value of Δ_{TCQ}

- Prospects:
  - Sensitivity to valumetric & jpeg attacks
  - Integration of Turbo TCQ
  - Consider ROI processing and progressive transmission functionnality

Thank You!

Annexes

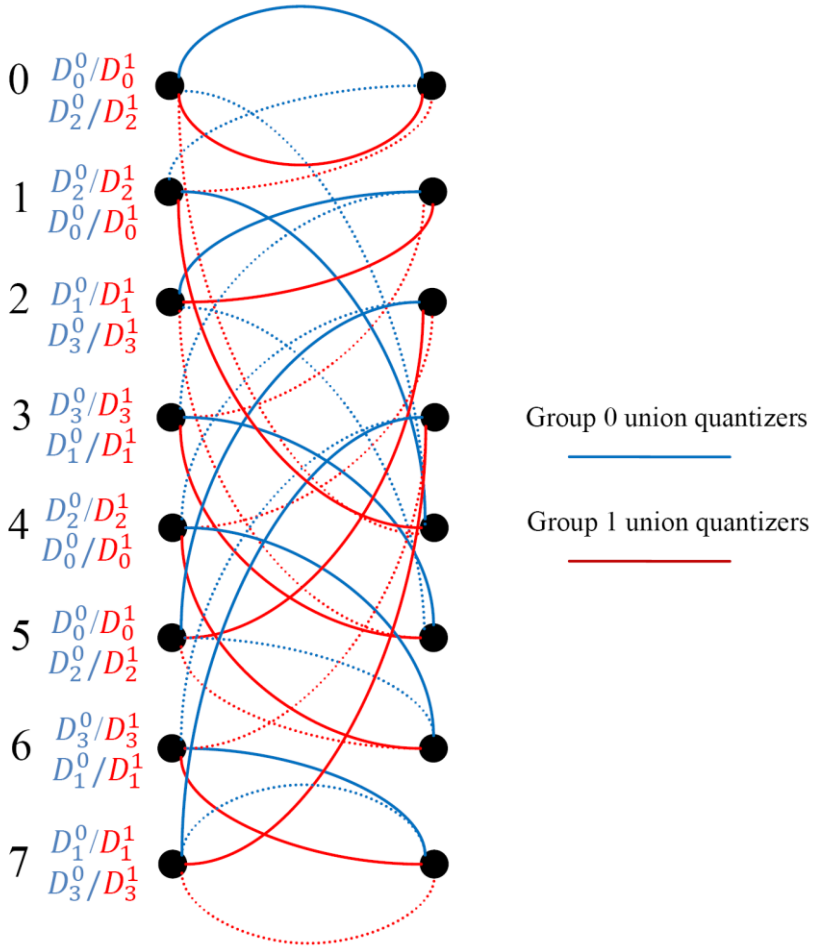
Trellis structure of the joint scheme

Group 0 : A_0^0 & A_1^0

$$\hat{x}[i] = Q_{D_j^0}(x[i] - d[0,i]) + d[0,i]$$

Group 1: A_0^1 & A_1^1

$$\hat{x}[i] = Q_{D_j^1}(x[i] - d[1,i]) + d[1,i] \ , \ \left| d[1,i] - d[0,i] \right| = \Delta/2$$



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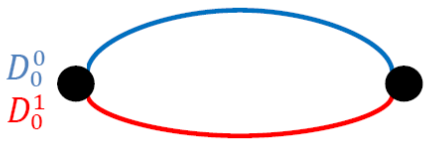

bit to be embedded: 0

bit to be embedded: 1