

Towards robust watermarking of scalable video

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Overview

- Looking back...
- Looking forward...
- Scalable Watermarking
- Robustness results
- Conclusion

E. Lin, EI '01

- “Streaming video and rate scalable compression: what are the challenges for watermarking?”
- Robustness
- Where to embed the watermark? Sender, Network or Receiver?
- Fingerprinting & Multicast
- Authentication
- Synchronization
- Error concealment as attack

E.T. Lin et al., “Streaming video and rate scalable compression: what are the challenges for watermarking?”, Proc. SPIE, vol. 4314, pp. 116-127, Jan. 2001.

Scalable video coding

- To support
 - temporal scalability
 - spatial scalability
 - SNR/quality scalability
 - combined scalability
- Scalable H.264 / SVC
 - Amendment to H.264/MPEG-4 AVC
- Codecs based on MC-TF, eg. MC-EZBC

H. Schwarz et al., “Overview of the Scalable Video Coding Extension of the H.264/AVC Standard”, IEEE Tran. CSVT, vol. 17, no. 9, pp. 1103-1120, 2007.

S.-T. Hsiang et al, “Embedded video coding using motion compensated 3-D subband/wavelet filter bank”, Signal Processing: Image Comm., vol. 16, pp. 705-724, 2001.

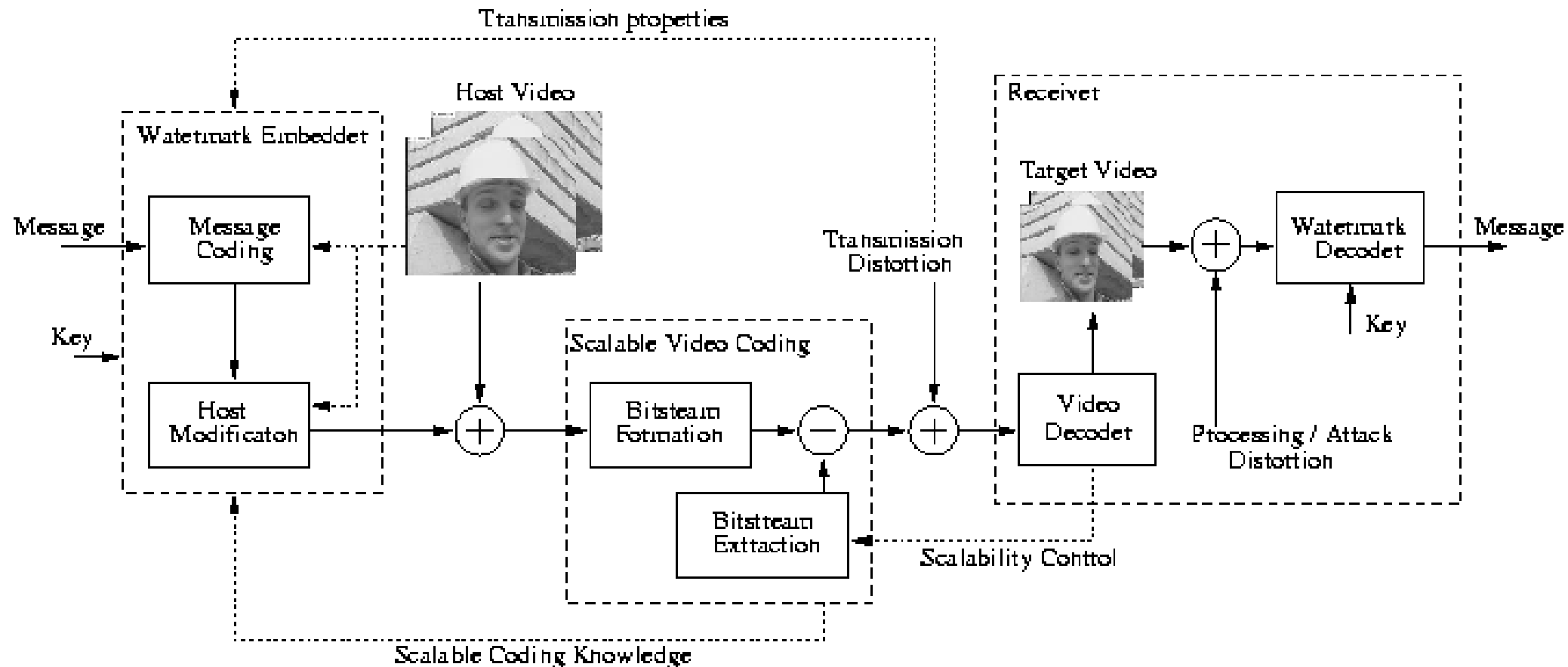
Scalable Watermarking

- Scalability of the watermarking **system** with regards to
 - Complexity: eg. search space, geom. attack
 - Detection progressiveness
 - Robustness against scalable video codecs
 - quality scalability
 - spatial and temporal scalability
 - Integration with scalable video codecs
 - Distribution scalability: fingerprinting...
 - New application scenarios

Scalable Watermark

- Scalability of the watermark signal
- Two Properties (definition):
 - The watermark is detectable in any portion of the scaled content which is of acceptable quality.
 - Increased portions of the scaled content provide reduced an error rate proportionate to the improved content quality.

Watermark Channel



Watermark Design

- Multiple channels: base layer + enhancement layers
- Matching transform structure of codec allows for integration
 - temporal prediction (I/P/B frames) DCT block transform, or
 - MC-TF + 2D wavelet transform

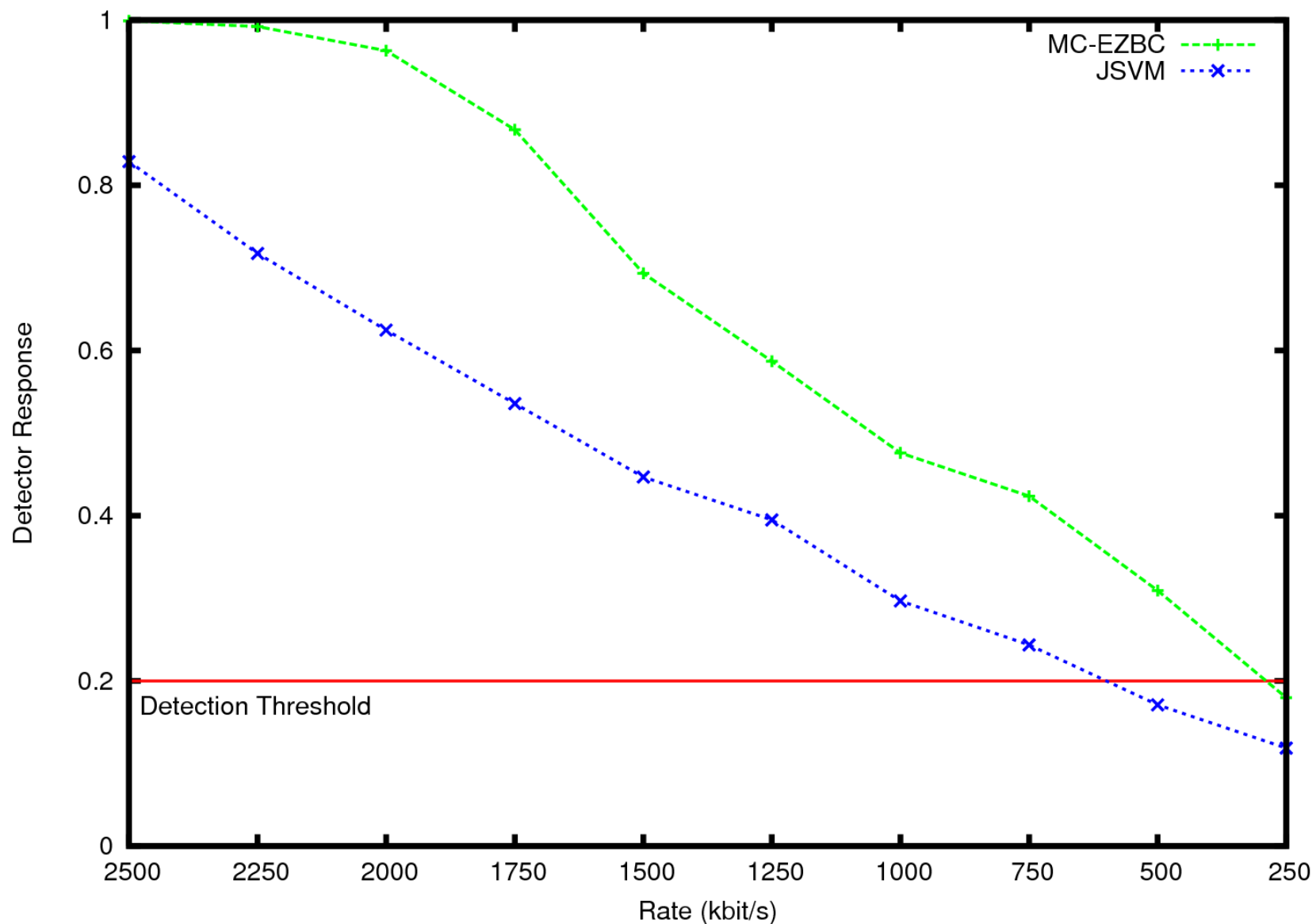
A simple, blind watermarking scheme

- frame-by-frame watermarking
- two-level wavelet transform
- separate watermark in
 - approximation subband: ST-SCS
 - details subbands: additive spread-spectrum
- perceptual mask
- 3x3 pre-filter for detection in detail subband

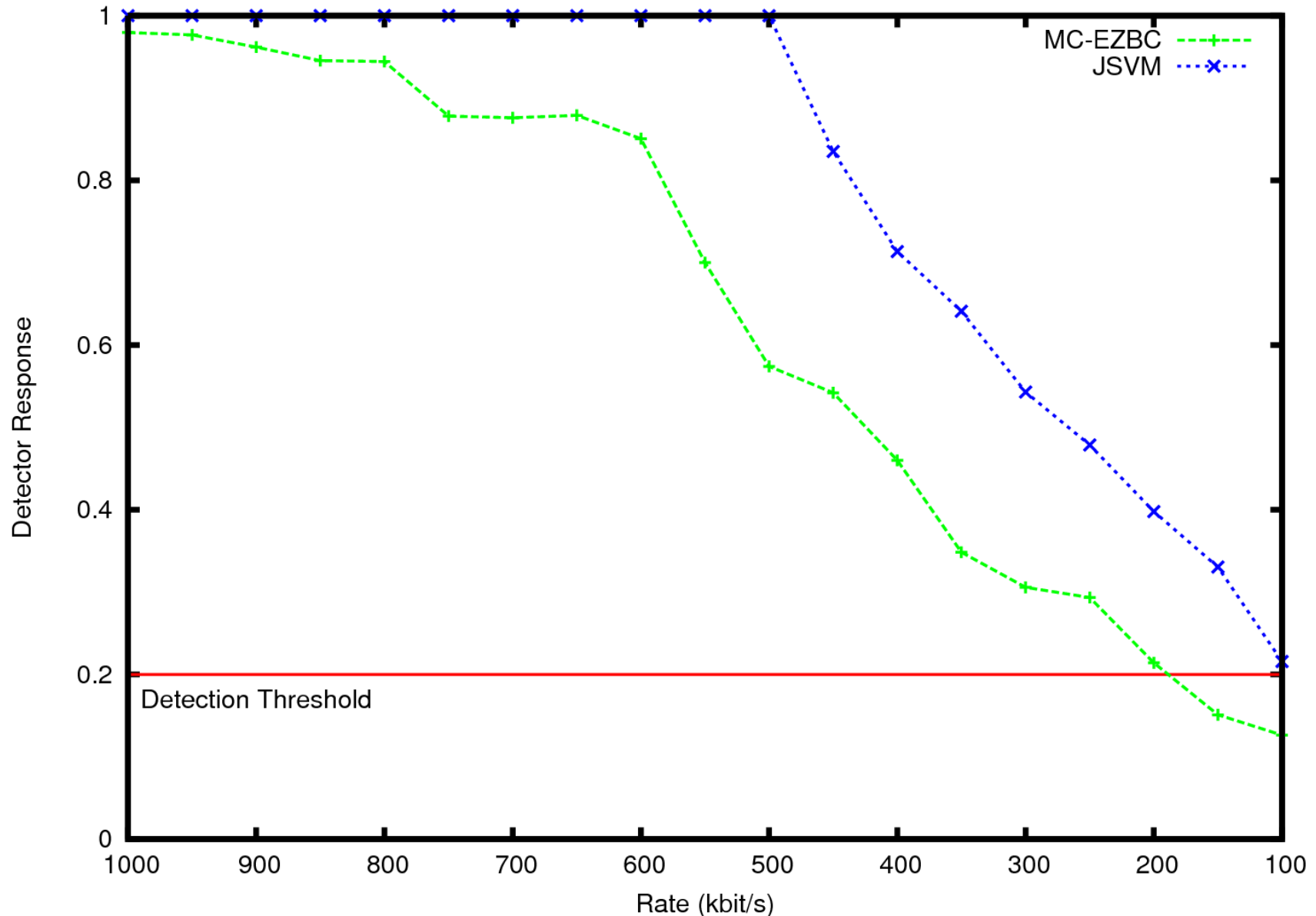
Experimental Setup

- Bitstream formation
 - H.264/SVC: GOP size 16, two resolution layers (QCIF and CIF), three FGS layers
 - MC-EZBC: 4 temporal decomposition levels
- Bitstream extraction
 - H.264/SVC:
`BitStreamExtract -e <res.>@<fps>:<bps>`
`QualityLevelAssigner`
 - MC-EZBC:
`pull -s <res. layer> -t <temp. layer> -r <bps>`

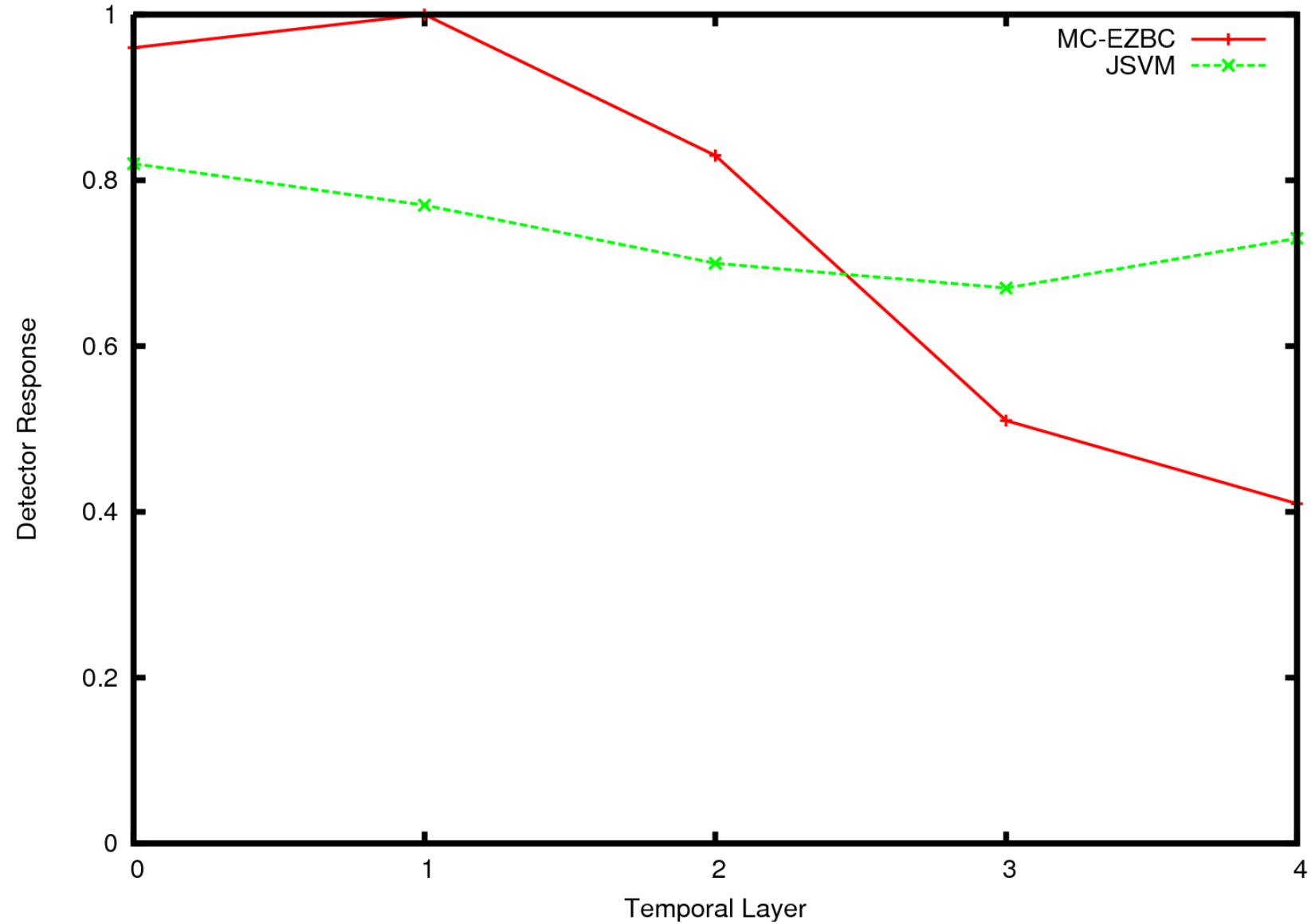
SNR scalability (CIF)



SNR + Spatial scalability (QCIF)



Temporal Scalability



Conclusion and further work

- Watermarking robust to bitstream adaptations
- Need to combine channel results
- Need better characterization of distortion due to scalability (inter-layer prediction, downsampling, motion-compensation)
- Integration with scalable video codecs
- What about authentication watermarking?