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

- 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

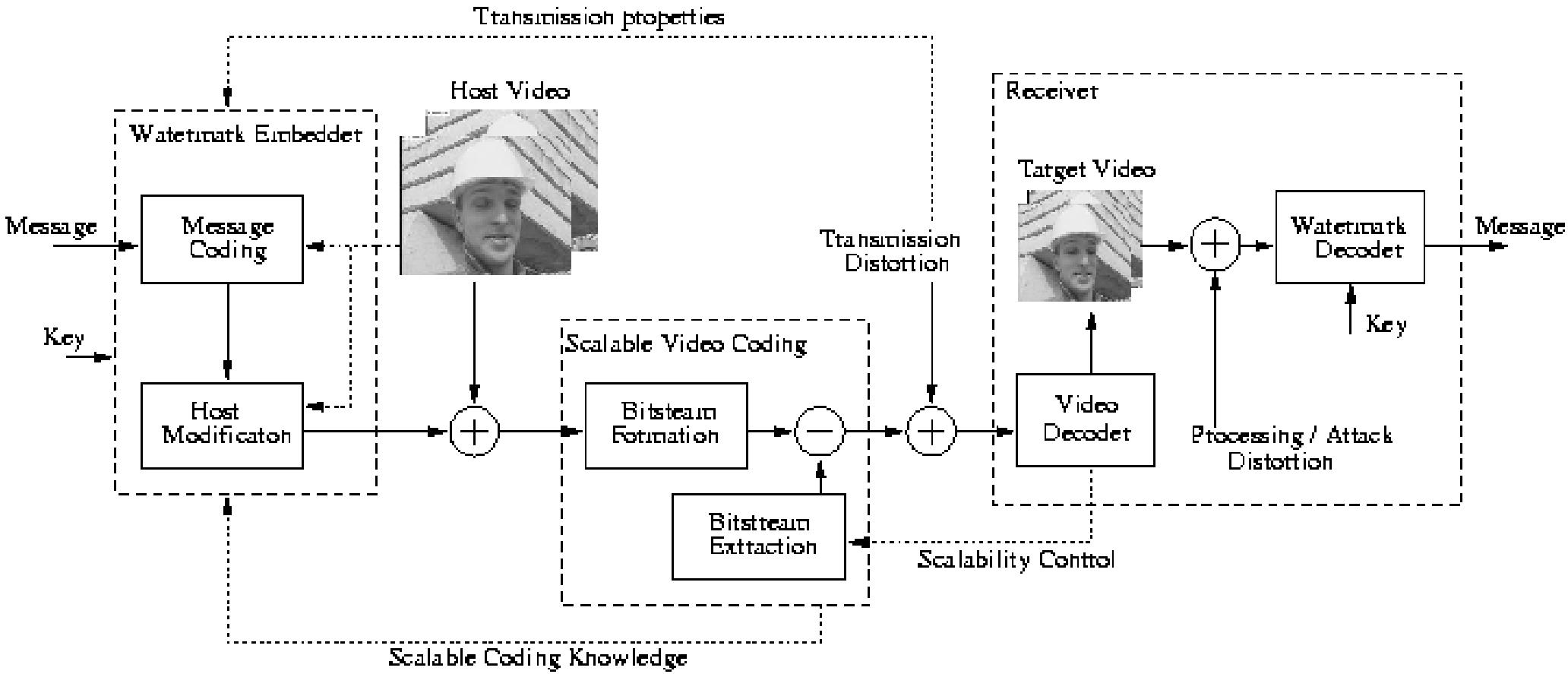
- Scalability of the watermarking **system** with regards to
  - Complexity: eg. search space, geom. attack
  - Detection progressiveness
  - Robustness against scalable video codecs
    - quality scalability
    - spatial and temporal scalability
  - Integration with scalable video codecs
  - Distribution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

Piper et al., “Resolution and quality scalable spread spectrum image watermarking”, ACM Workshop on Multimedia and Security, 2005.

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

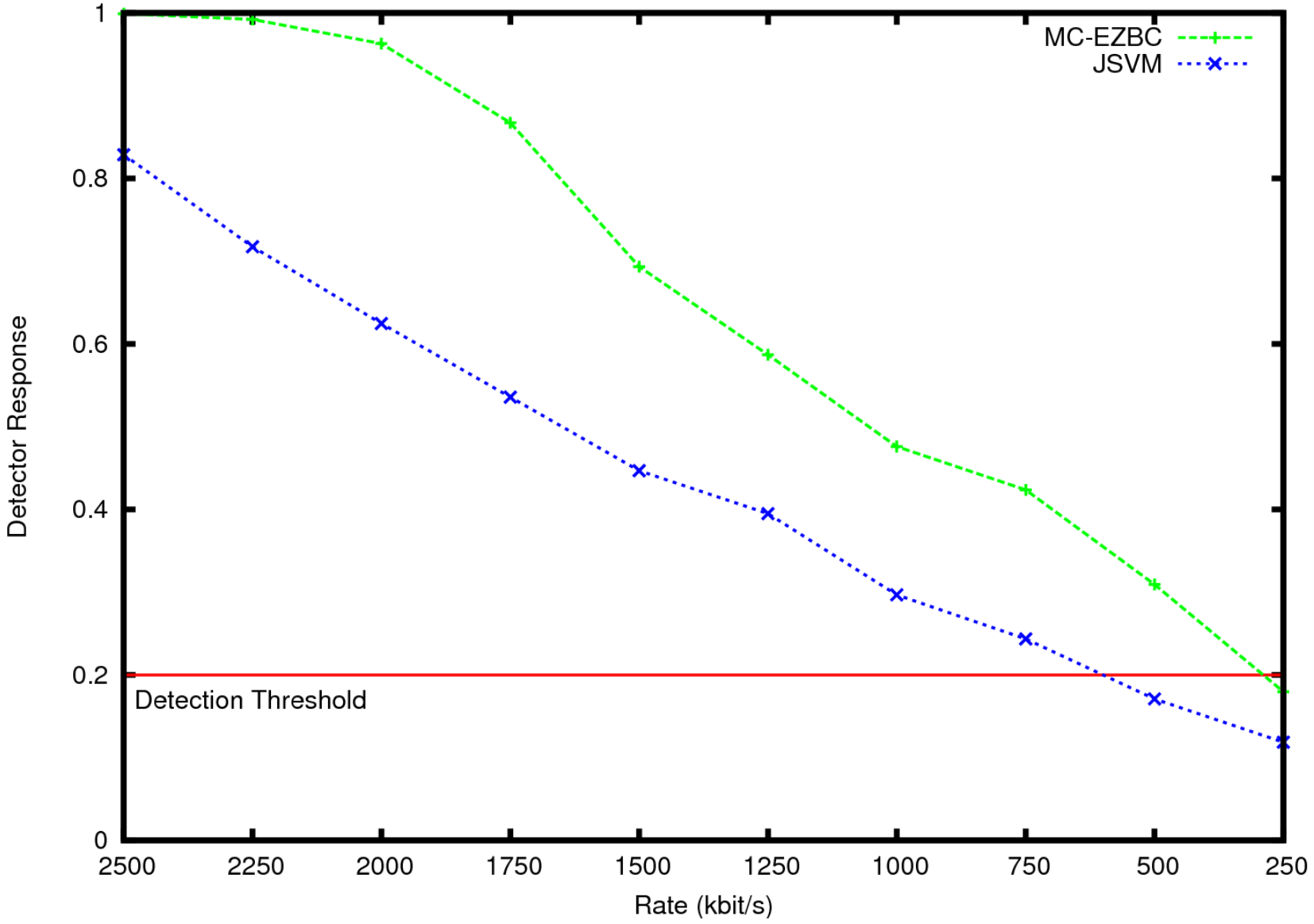
A simple, blind watermarking scheme

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

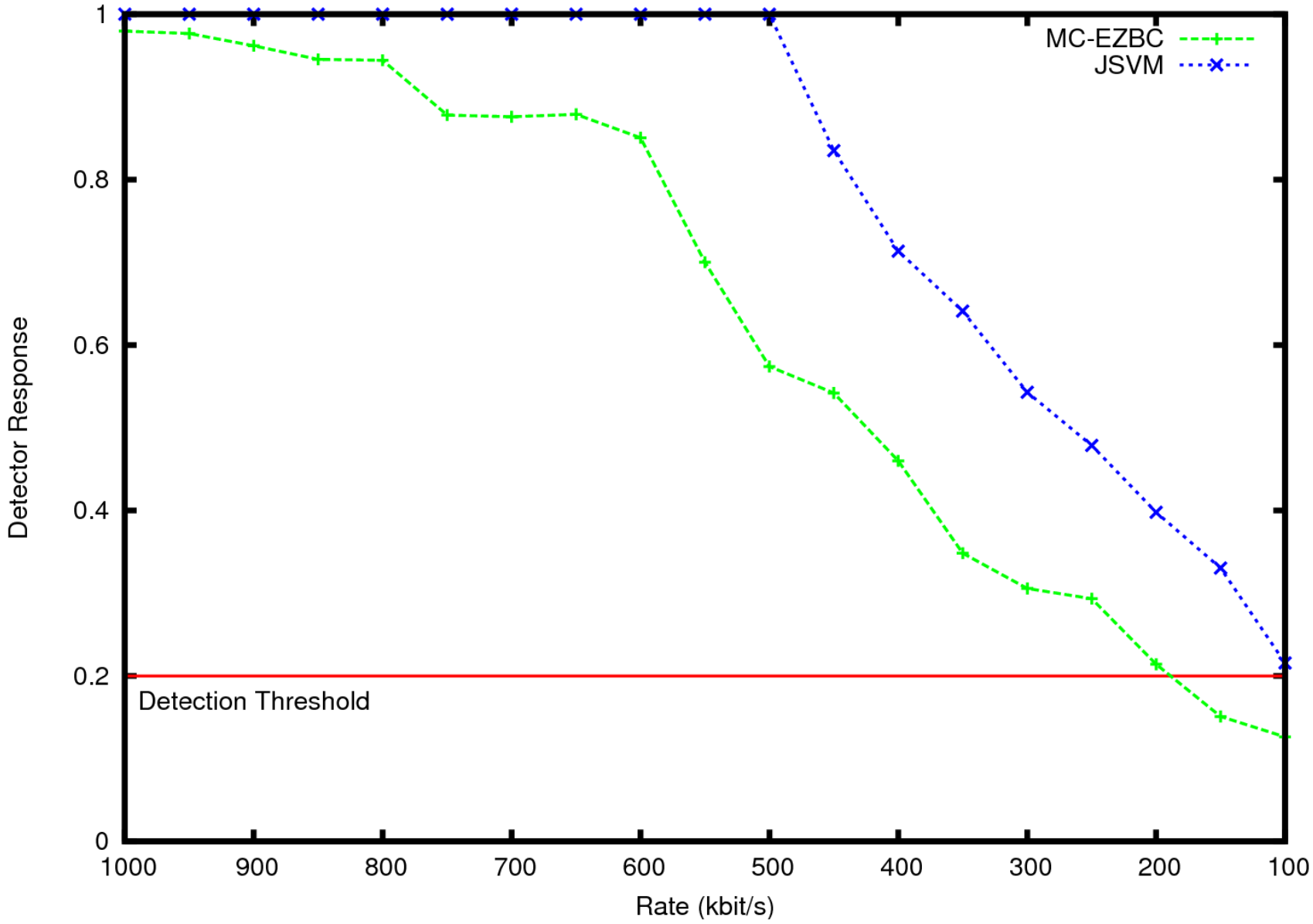
Experimental Setup

- 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>`

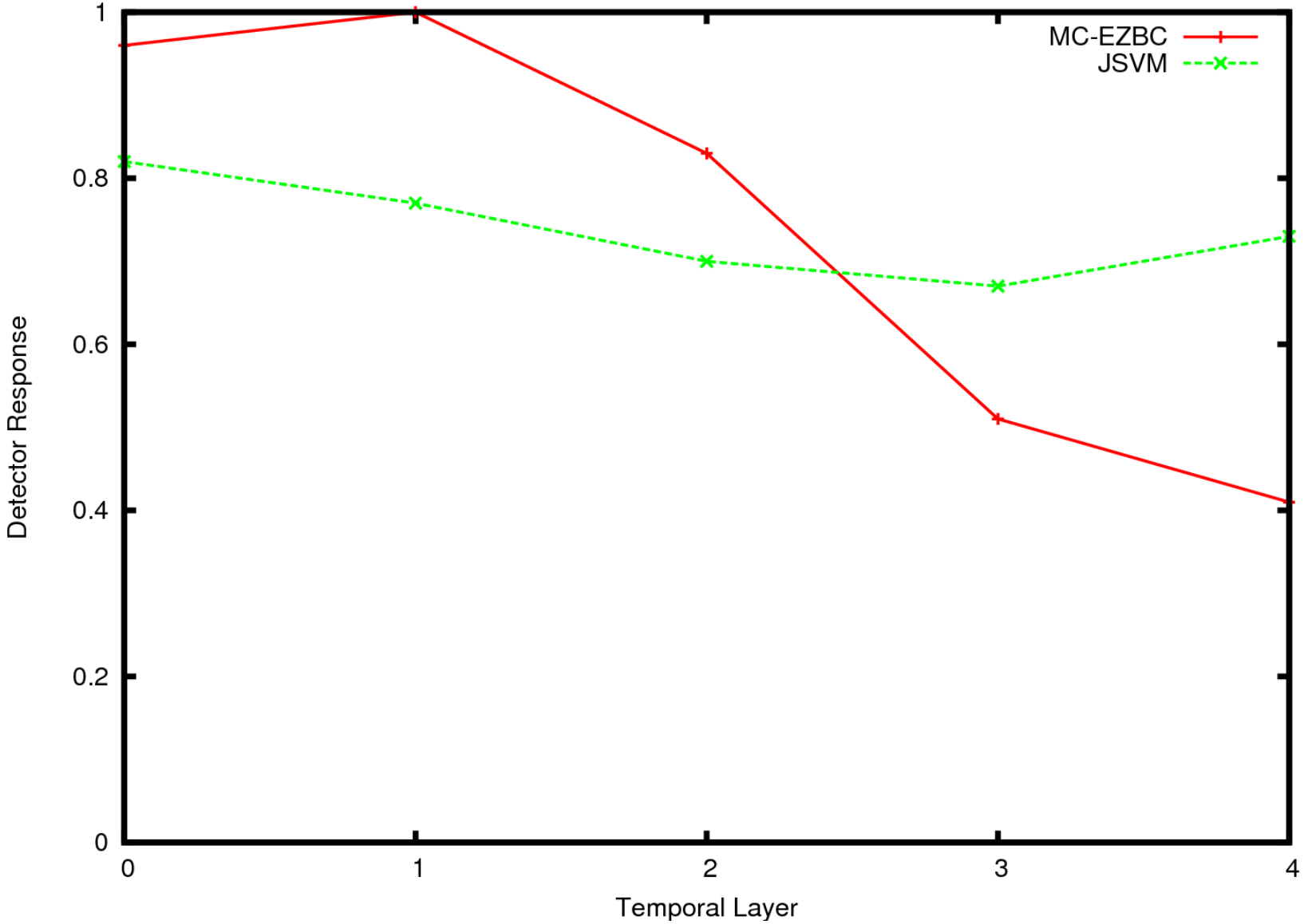
SNR scalability (CIF)



SNR + Spatial scalability (QCIF)



Temporal Scalability



Conclusion and further work

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