

Systematic Lossy Error Protection based on H.264/AVC Redundant Slices and FMO

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Outline

- Systematic Lossy Error Protection
- H.264/AVC implementation
- ROI-enhancement for low-motion sequences
- Simulation results

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Systematic Lossy Error Protection (1/5)

The diagram shows a source S being processed by a Video Encoder (containing a Coarse Quantizer and Slepian-Wolf Encoder) to produce a stream that passes through an Error-Prone channel. The output is then processed by a Video Decoder with Error Concealment (containing a Slepian-Wolf Decoder and Reconstruction) to produce S' . A side information path also feeds into the decoder. The final output is S'' .

- Analogous to systematic source/channel coding [Shamai, Verdú, Zamir, 1998]
- Error corrected up to a distortion introduced by coarse WZ quantizer, hence lossy protection [Rane, Aaron, Girod, ICIP 2003]

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Systematic Lossy Error Protection (2/5)

- H.264/AVC codec implementation -

The diagram illustrates the integration of SLEP into the H.264/AVC codec. The H.264/AVC Encoder (left) includes an 'Encode primary slices' block and a 'Determine ROI' block. The Wyner-Ziv Encoder (bottom left) includes an 'RS Encoder' and 'Parity slices + QP + Slice boundaries'. The H.264/AVC Decoder (right) includes an 'Entropy Decoding' block and an 'MC' block. The Wyner-Ziv Decoder (bottom right) includes an 'RS Decoder', 'Entropy Decoding', and 'Decode redundant slice' block. The system uses an 'Error-prone channel' and 'Side info' for error protection.

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Systematic Lossy Error Protection (3/5)

- Reed-Solomon Encoder -

The diagram shows the Reed-Solomon encoding process. It starts with a primary slice (yellow) and a filler byte (green). These are combined with parity bytes (cyan) to create a set of k redundant slices. The total number of slices is n . The diagram indicates that only the SLEP slices are transmitted in the Wyner-Ziv bit stream, along with some helper information.

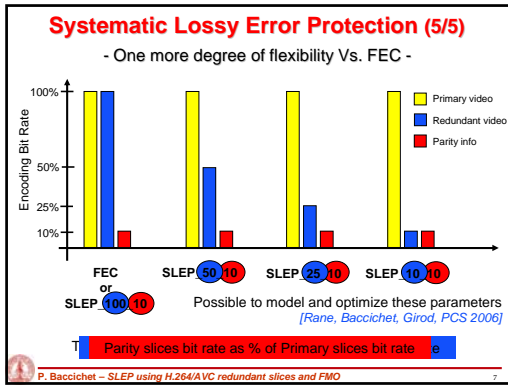
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Systematic Lossy Error Protection (4/5)

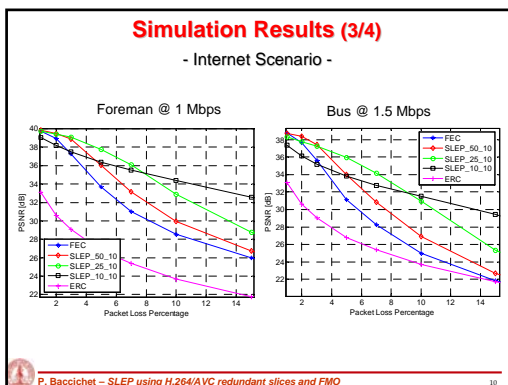
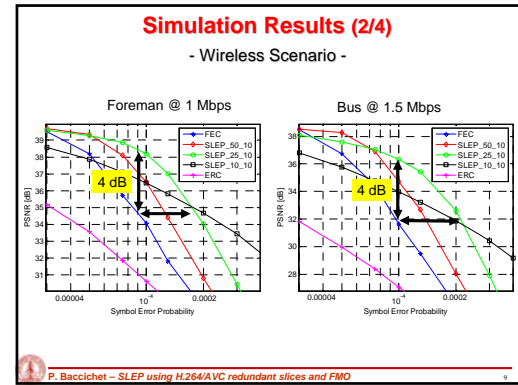
- Reed-Solomon Decoder -

The diagram shows the Reed-Solomon decoding process. It receives a set of k redundant slices and n SLEP parity symbols. The decoder uses these to regenerate a lost primary slice (indicated by a red arrow) and displays it in place of the lost slice.

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- ### Simulation Results (1/4)
- Experimental setup -
- H.264/AVC (JM 10.1) "primary" bitstream at constant bit-rate
 - WZ Codec → Redundant slice generation tool (Coarse QP) + Reed-Solomon codec
 - GOP structure : I-P-P-P... with one forced intra MB line per frame
 - JVT non-normative error concealment
 - Two Considered Scenarios
 - Wireless transmission with symbol errors
 - Internet video transmission with packet losses due to congestion
 - Average over 30 independent random traces
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Simulation Results (4/4)

Primary rate 1Mbps, Parity bit rate 100 kbps
Symbol error probability = 2×10^{-4}

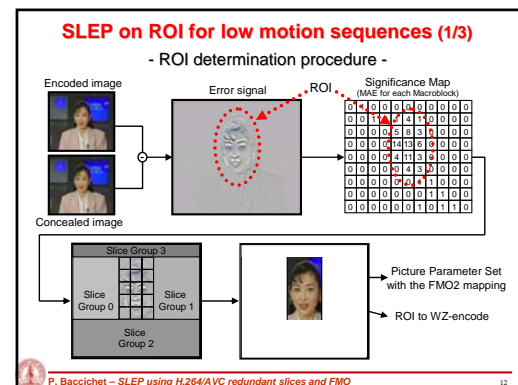
FEC SLEP_25_10

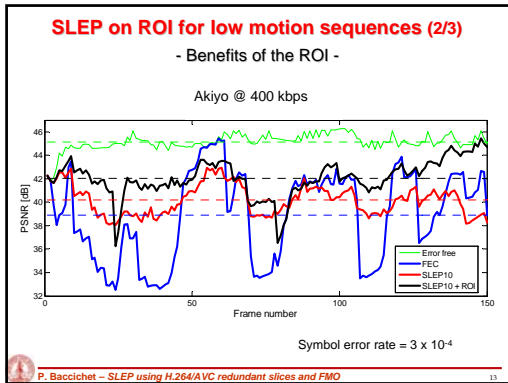
PSNR: 32.5 dB PSNR: 38.0 dB

Recovered MBs: 2539 Recovered MBs: 4561

Erroneous MBs: 2183 Erroneous MBs: 161

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SLEP on ROI for low motion sequences (3/3)

Primary bit rate 400 kbps, SLEP bit rate 40 kbps
Symbol error rate = 3×10^{-4}

Configuration	PSNR (dB)	Recovered MBs	Unrecovered MBs
SLEP_10_10	40.2	6826	0
SLEP_10_10 + ROI	42.1	737	5155

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- ### Conclusions
- ❑ SLEP mitigates the FEC cliff effect and ensures graceful degradation in error-prone environments
 - ❑ Proposed implementation exploits tradeoff between quality of the redundant representation and error resilience
 - ❑ SLEP on a Region-of-Interest improves performance for low motion sequences
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- SLEP standardization effort
- P. Baccichet - SLEP using H.264/AVC redundant slices and FMO