Neural Network-based Error Concealment for VVC

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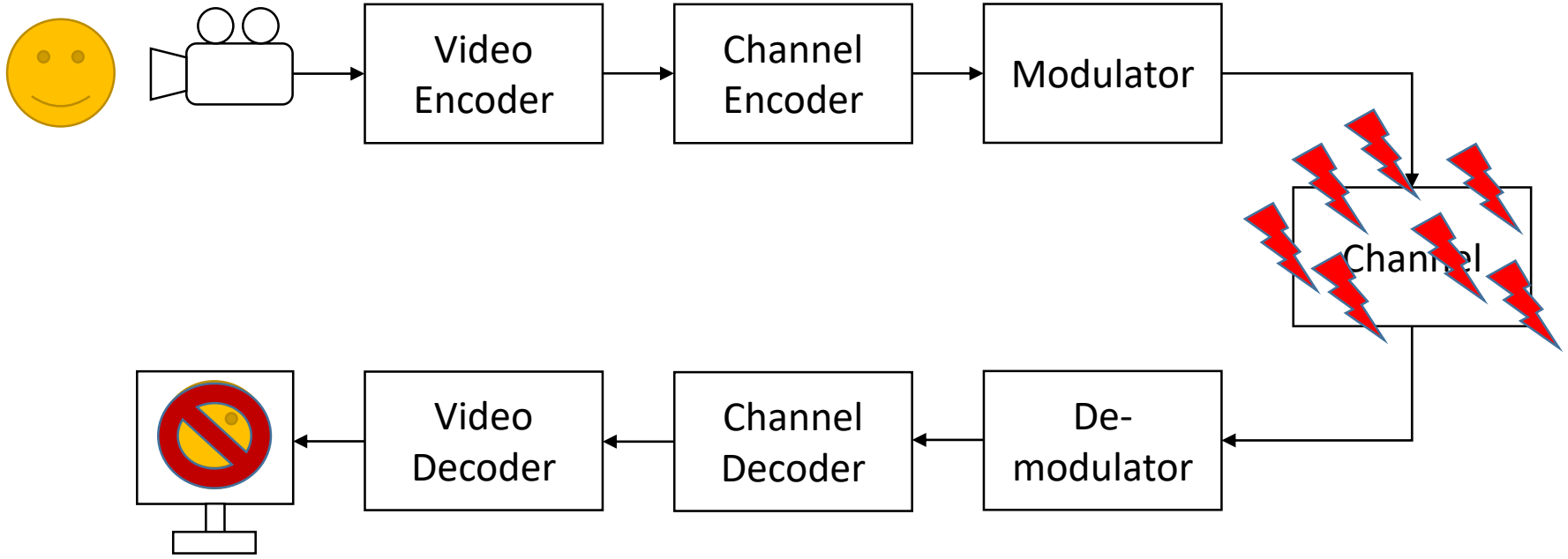
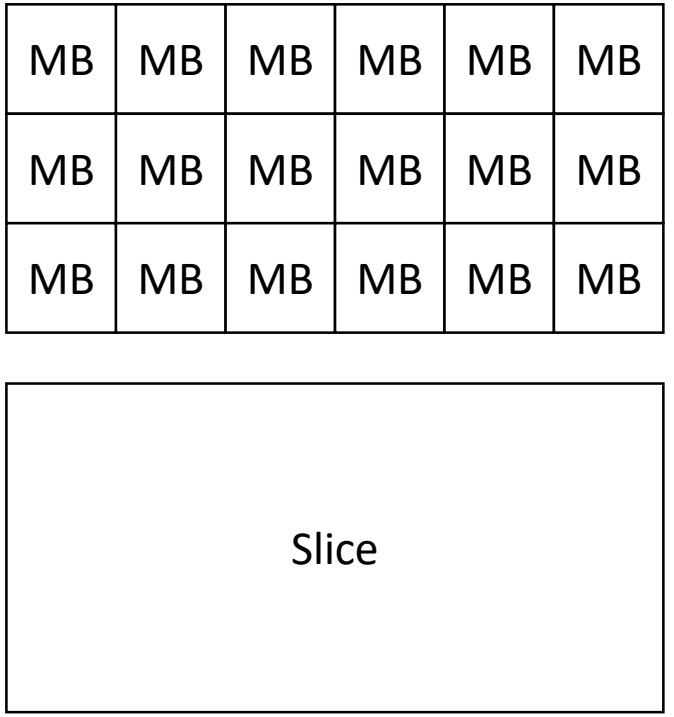
Why Error Concealment?



Error Concealment in VVC

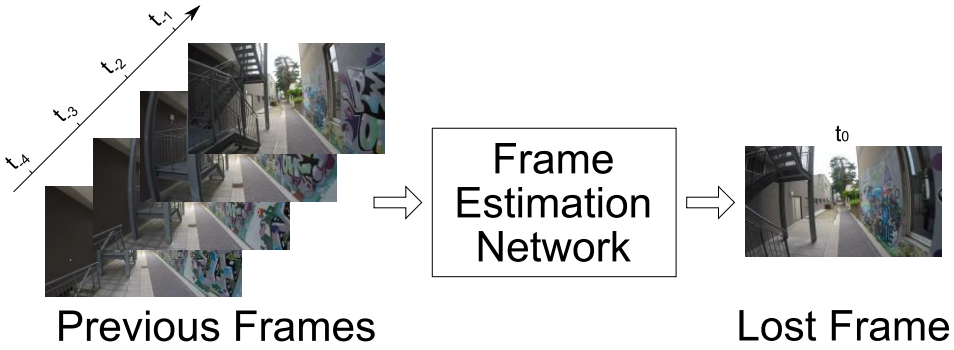
- Error Concealment in AVC is based on macro blocks (MB)
  - Spatio-temporal correlation can be exploited

- HEVC and VVC do not contain macro blocks
  - Spatial correlation cannot be exploited within a slice

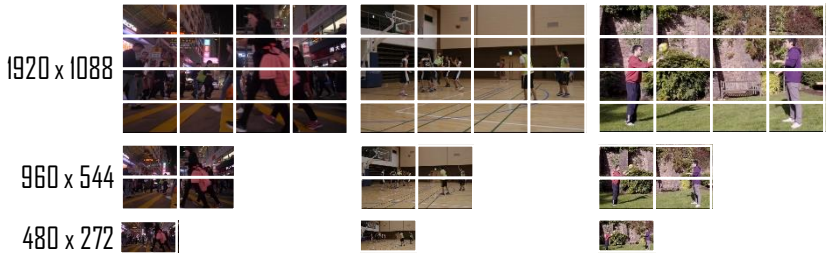


Frame Estimation

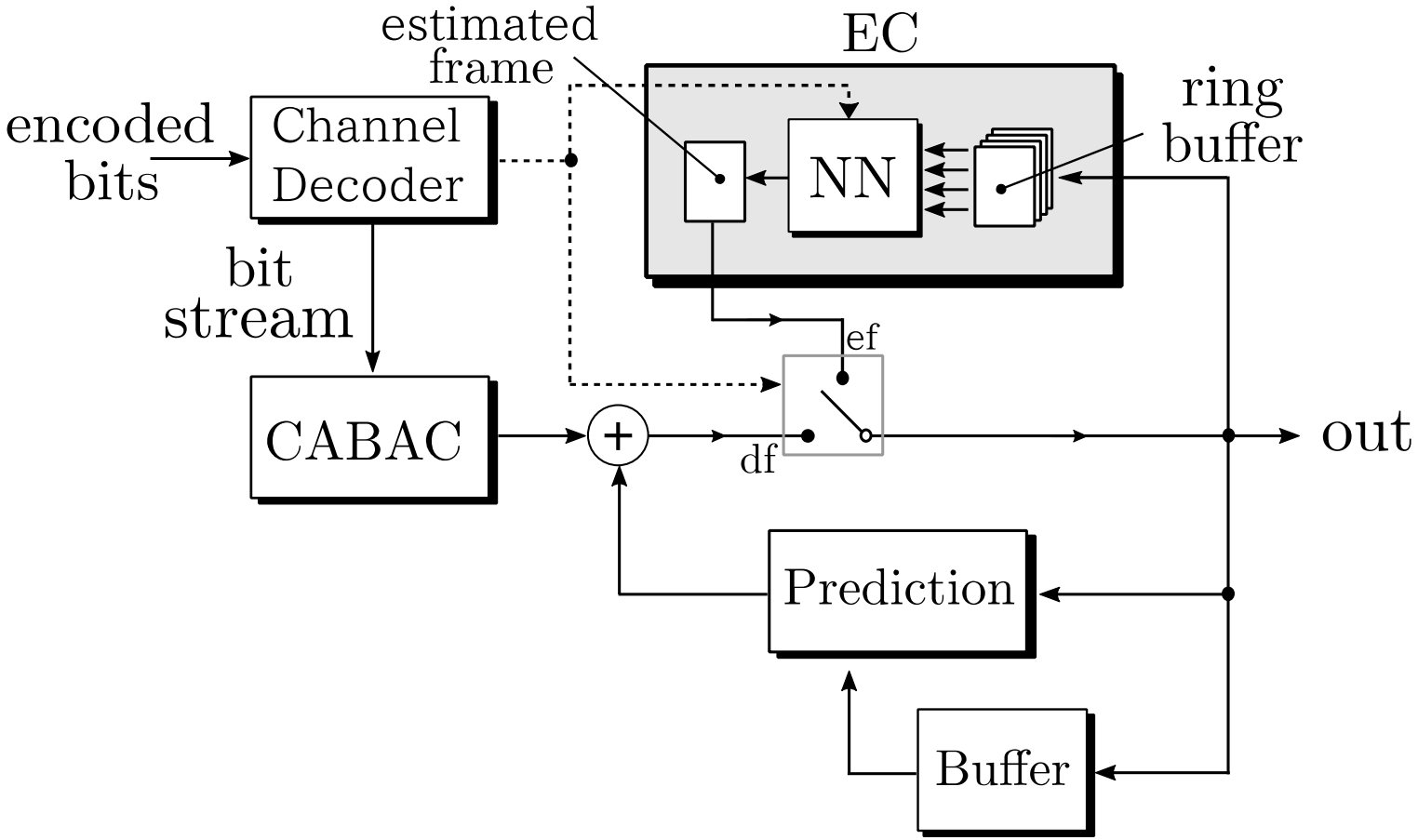
- Lost frames are estimated using the recurrent neural network PredNet



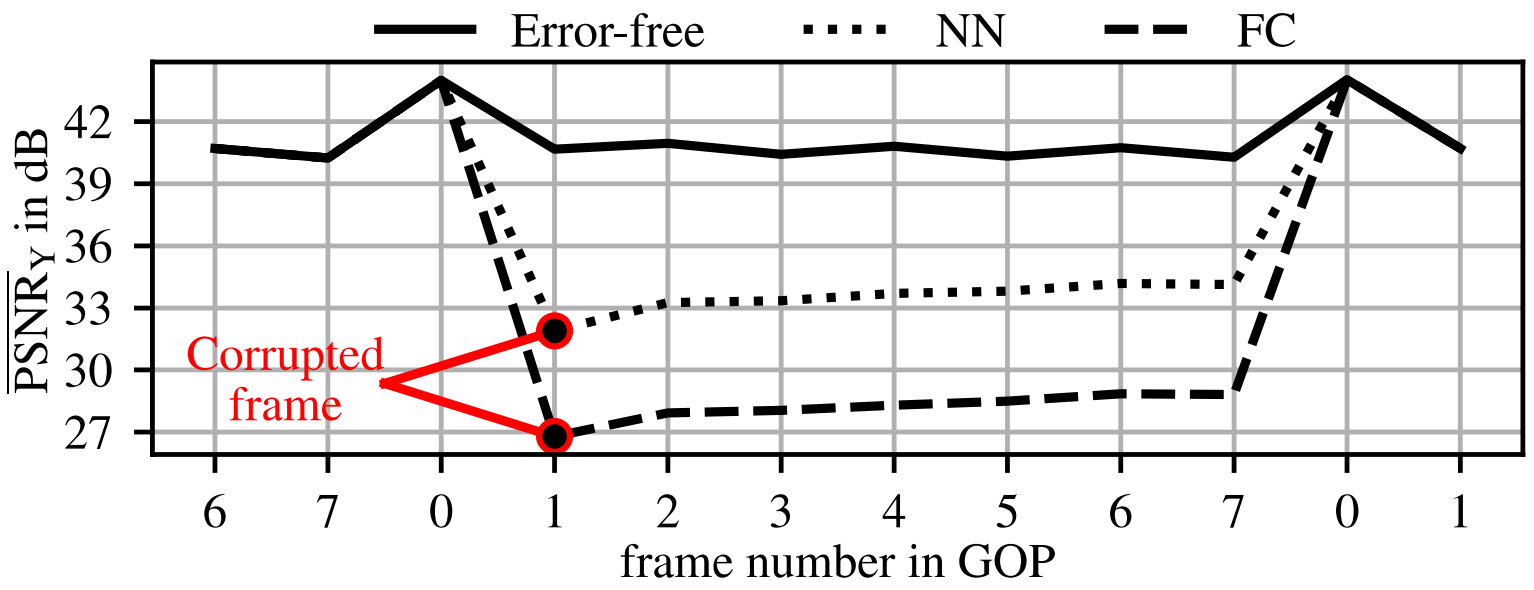
- Training with the BVI-DVC Dataset
  - multiple scales, to learn scale-independent features
  - Training resolution 480 x 272



Integration in VVC



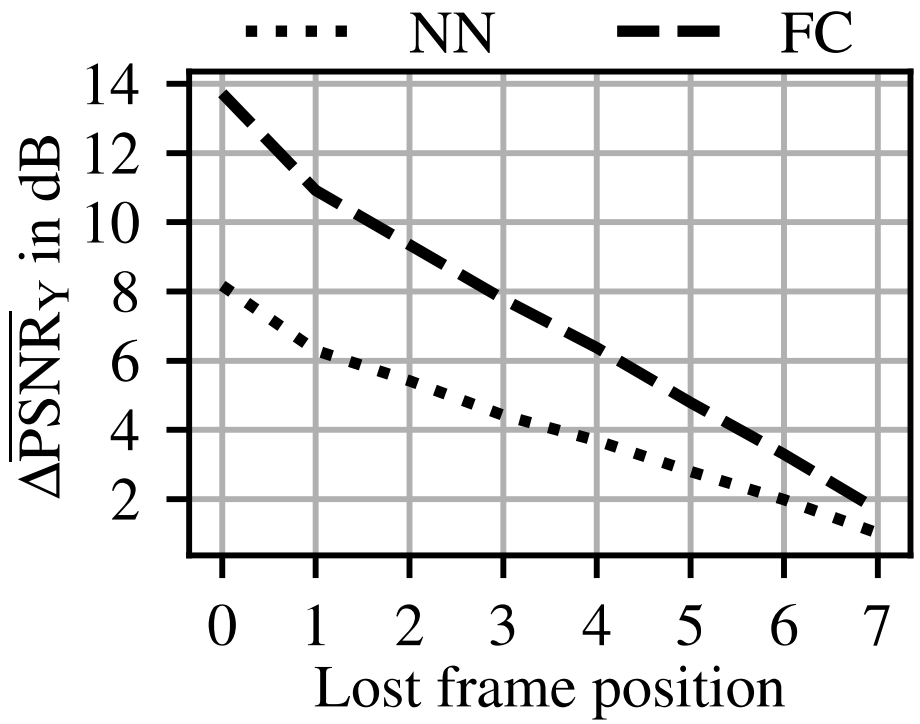
Evaluation



Experiment configuration	
Encoder configuration	Low delay, I and P-frames only
GOP size	8
Test data	JVET CTC class B-E
VTM version	10.0
QP	22

$\overline{\text{PSNR}}_Y$: Averaged over every third GOP over all test sequences

Evaluation

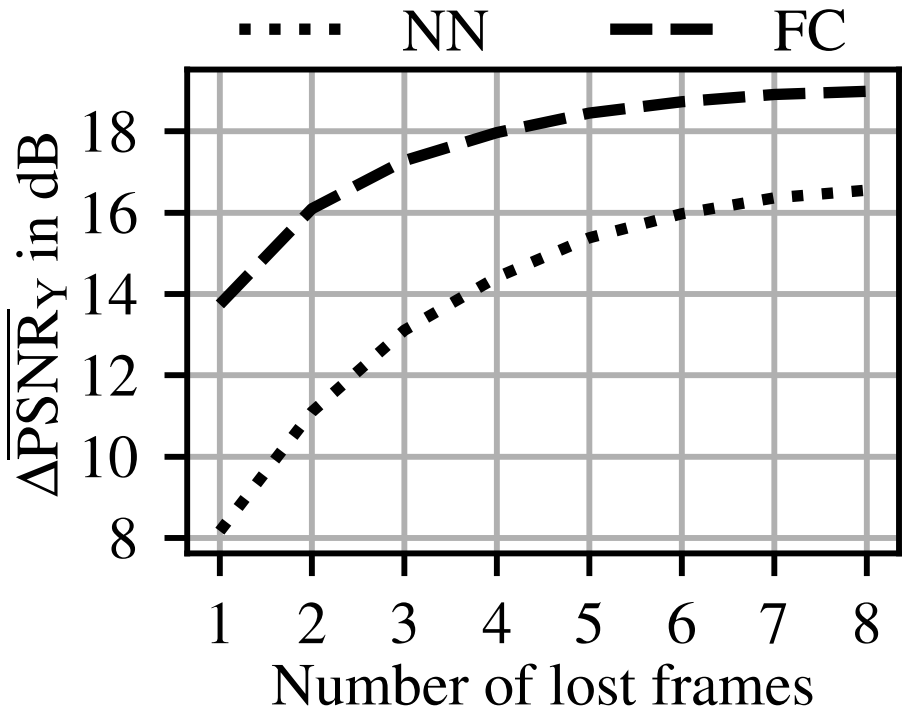


QP	$\Delta\overline{\mathrm{PSNR}}_{FC\leftrightarrow NN,Y}$	
	Lost frame pos. 0	Lost frame pos. 1
22	5.6 dB	4.6 dB
27	5.0 dB	4.0 dB
32	4.2 dB	3.4 dB
37	3.4 dB	2.8 dB
42	2.5 dB	2.1 dB

One frame is lost, the position of the lost frame in the GOP is Changed.

$\Delta\overline{\mathrm{PSNR}}_Y$: Averaged over all frames of all test sequences

Evaluation



A consecutive group of frames within a GOP is lost, starting with the first frame.

$\Delta\overline{\mathrm{PSNR}}_Y$: Averaged over all frames of all test sequences

Example Images

	Frame 14 (corrupted)	Frame 15	Frame 16
Error free	 40.0	 40.3	 40.1
NN	 29.5	 31.1	 31.4
FC	 22.5	 23.3	 23.5

Frame: 1
Frame 2 is corrupted

Conclusion

- We introduced a neural network-based error concealment method for P-Frames based on the RNN PredNet to VVC
- The performance was evaluated within VTM 10.0
- Our approach outperforms frame copy by 6 dB for I-frames and up to 5 dB for P-frames in terms of PSNR
- Visually, the quality of corrupted videos is improved