Neural Network-based Error Concealment for B-Frames in VVC

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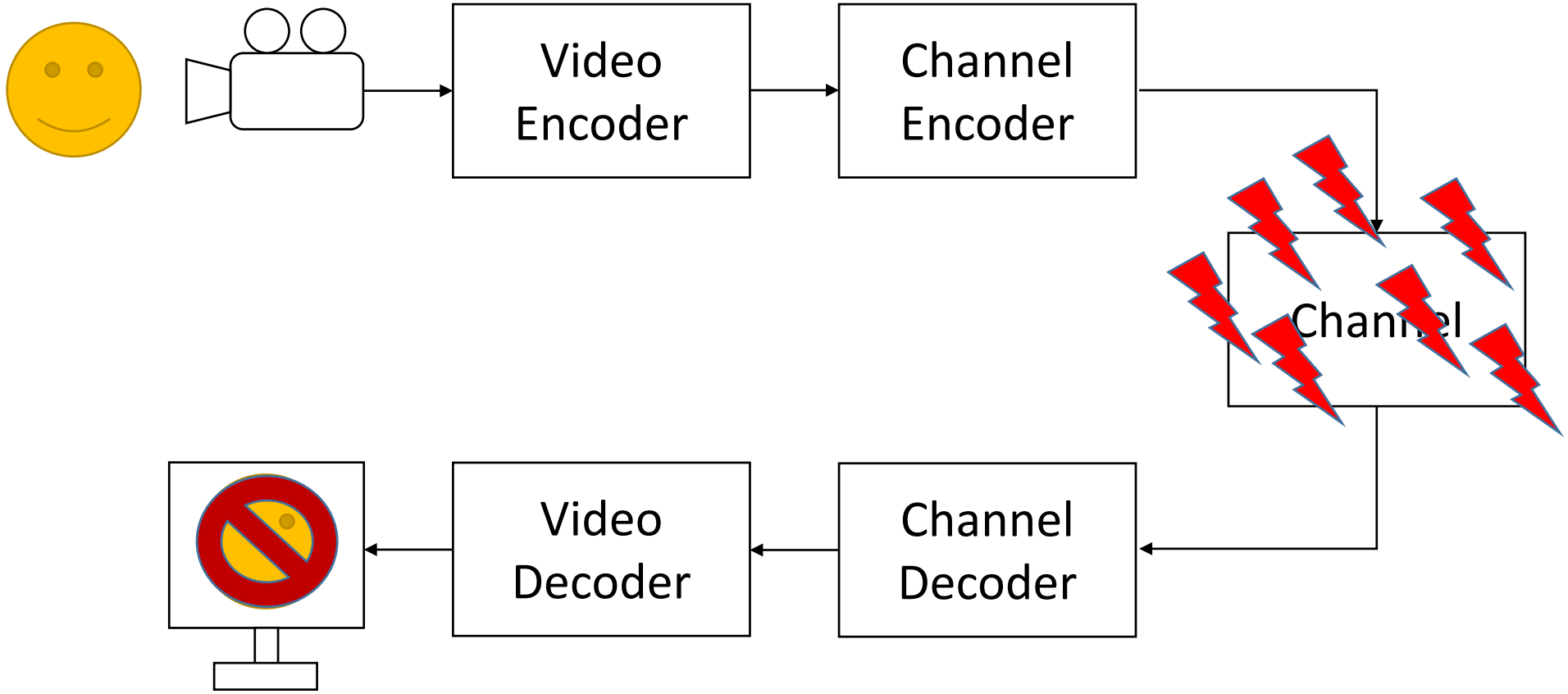
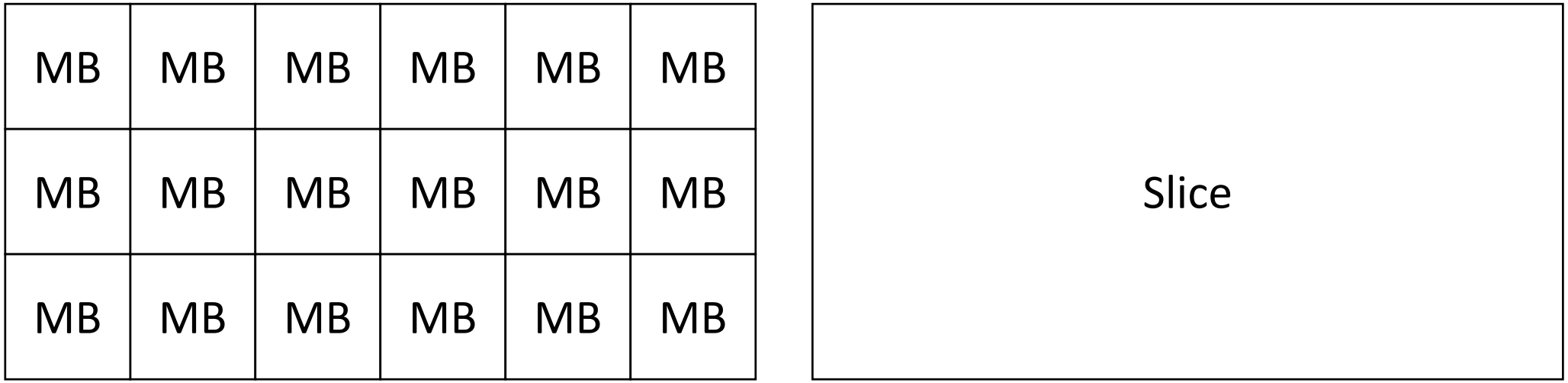
Why Error Concealment?



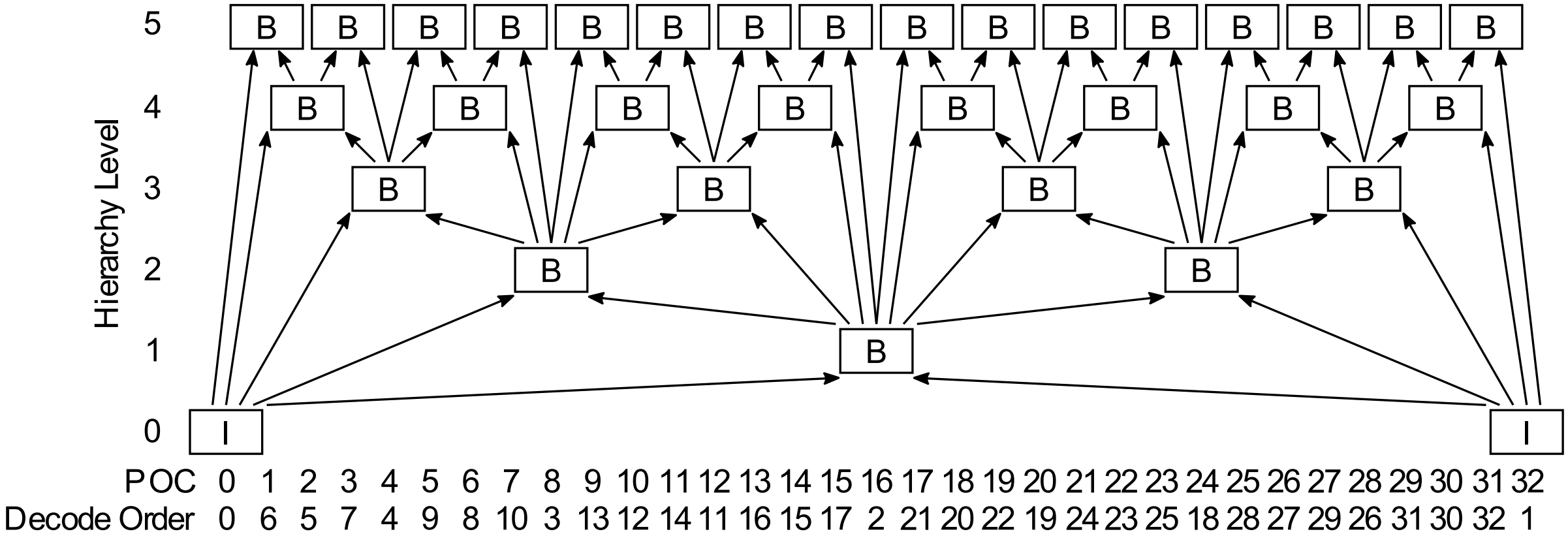
Error Concealment in VVC

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

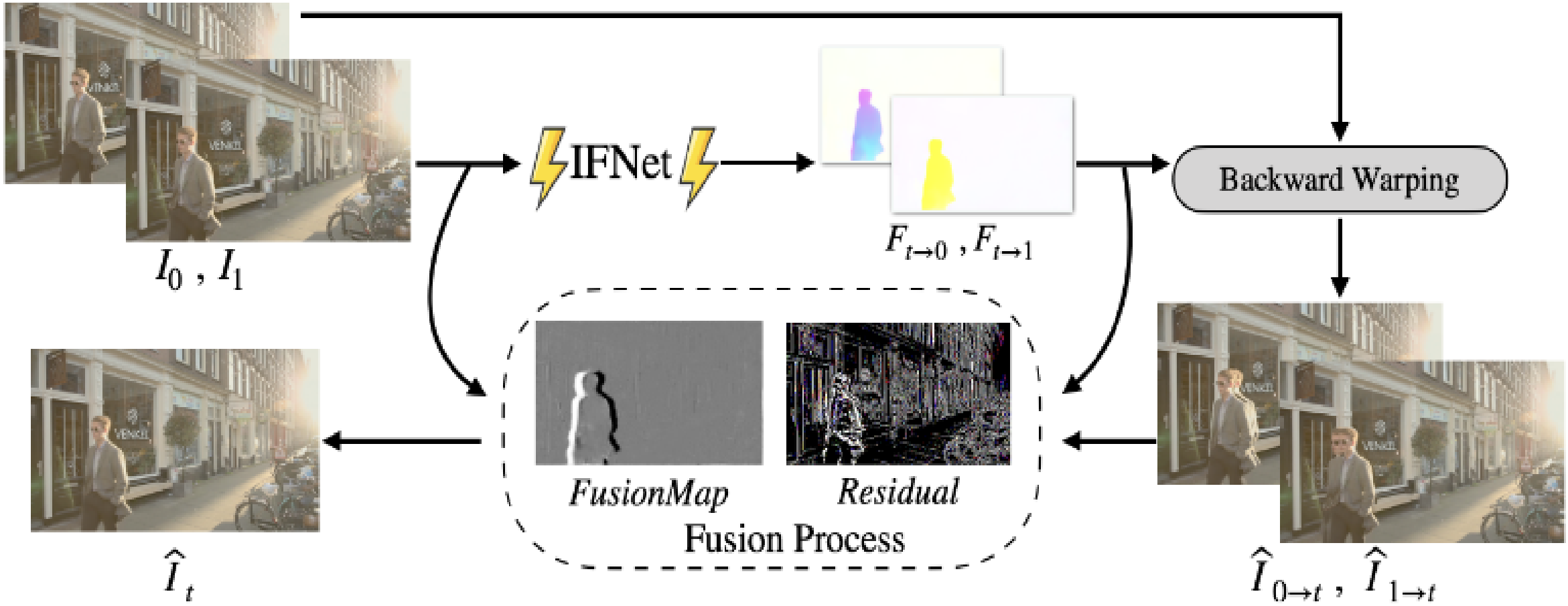
- HEVC and VVC do not contain macro blocks
  - Spatial correlation cannot be exploited within a slice



What are B-frames?



How to predict B-frames?



Source : *Huang et al.* “RIFE: Real-Time Intermediate Flow Estimation for Video Frame Interpolation”, 2020.

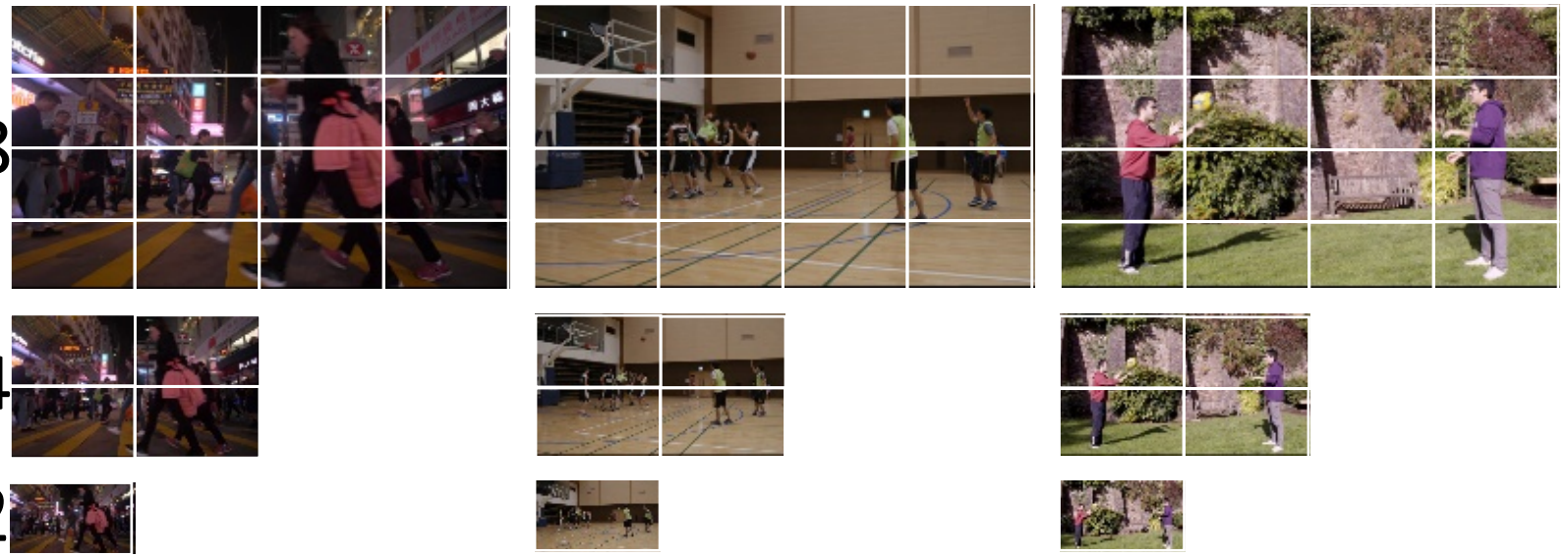
Training of RIFE

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

1920 x 1088

960 x 544

480 x 272

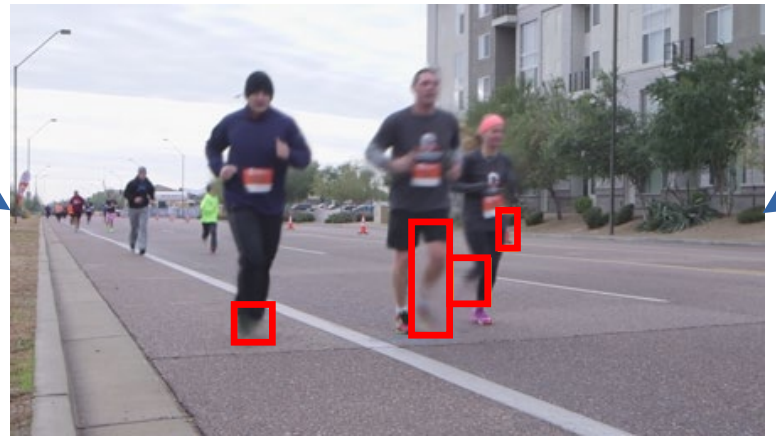


How to predict B-frames?

Frame 1

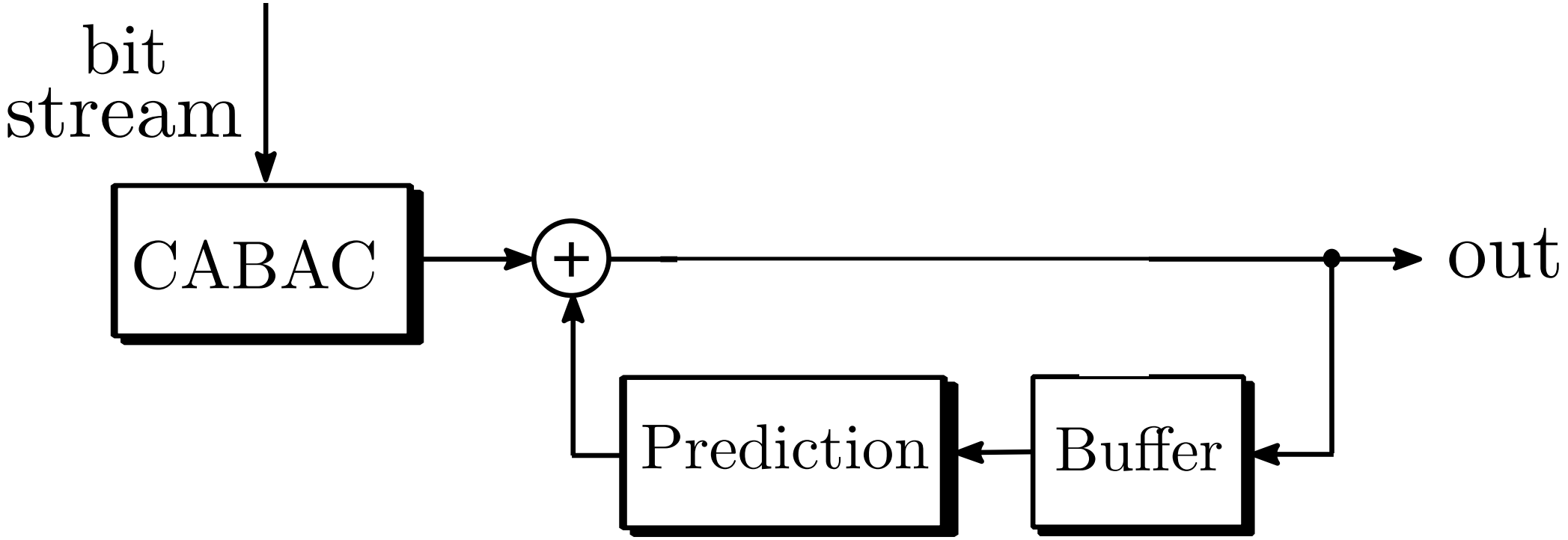
Frame 2

Frame 3

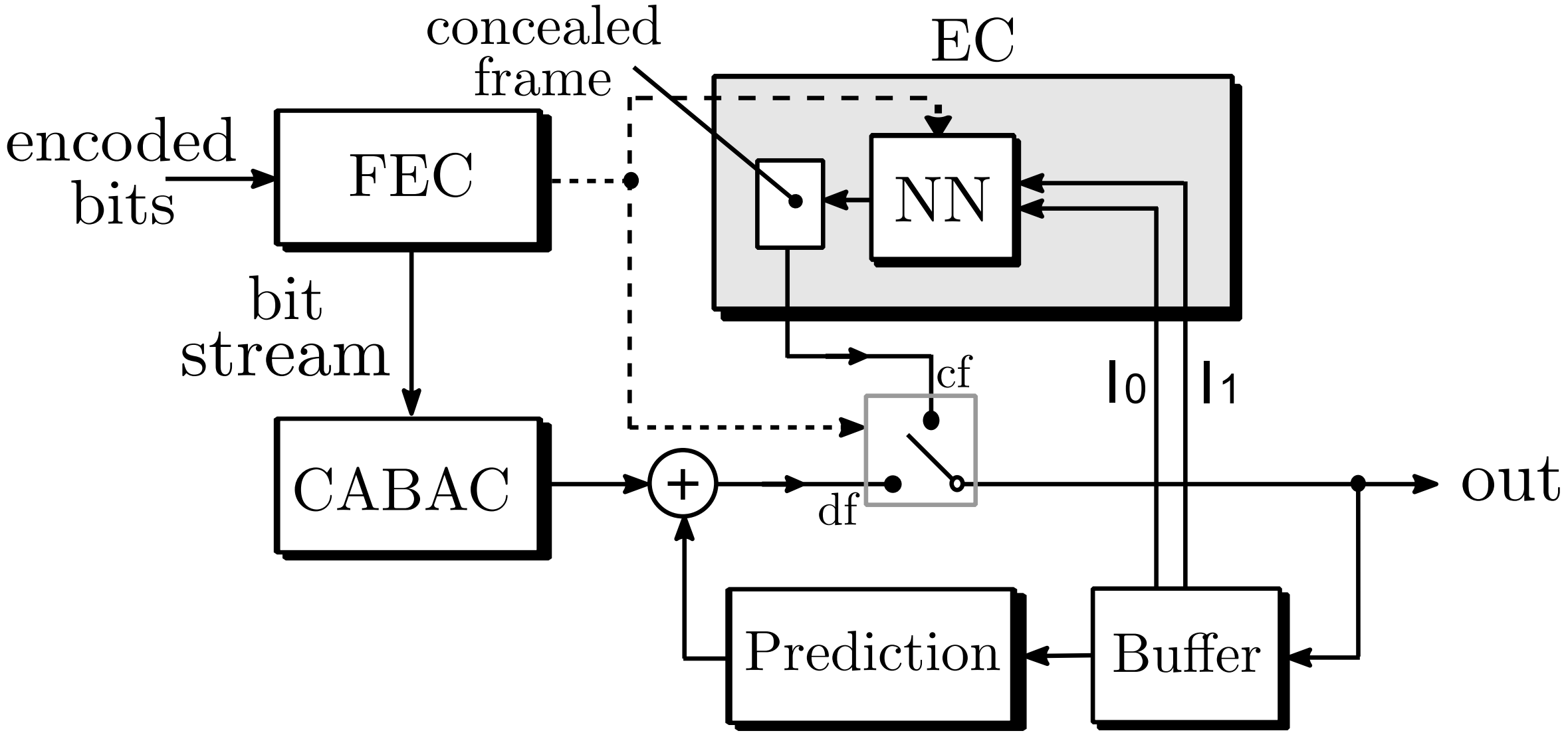


Interpolated Frame

Integration in VTM



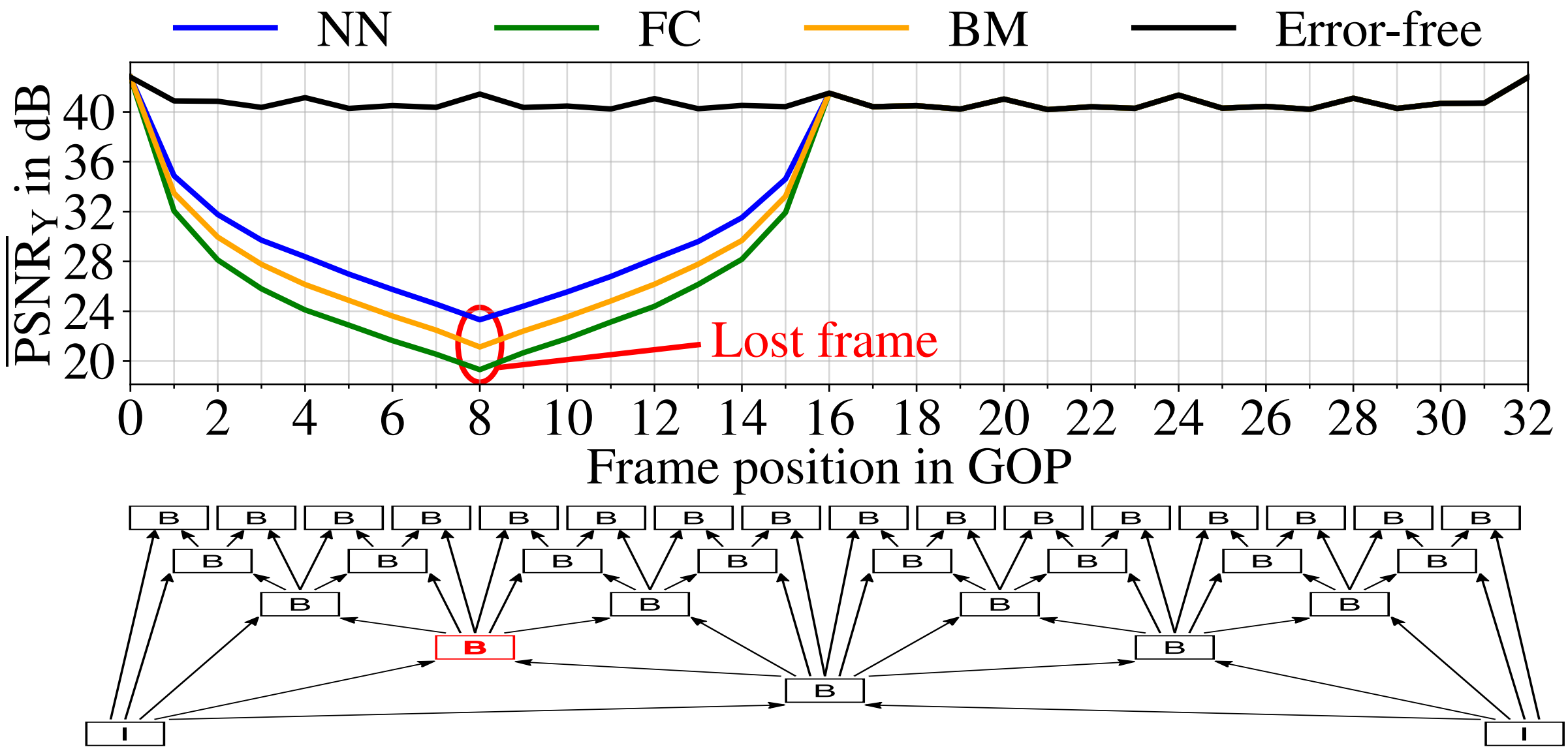
Integration in VTM



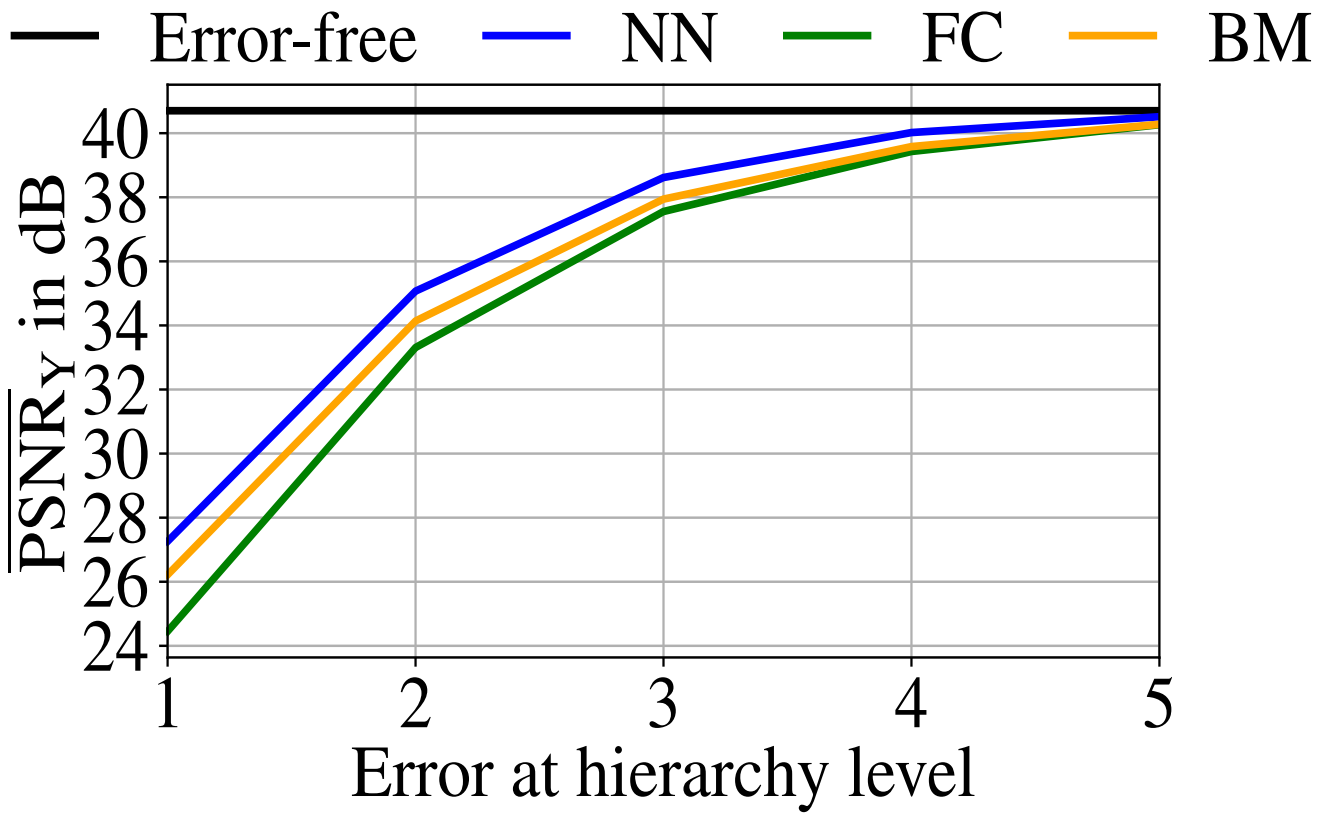
Evaluation

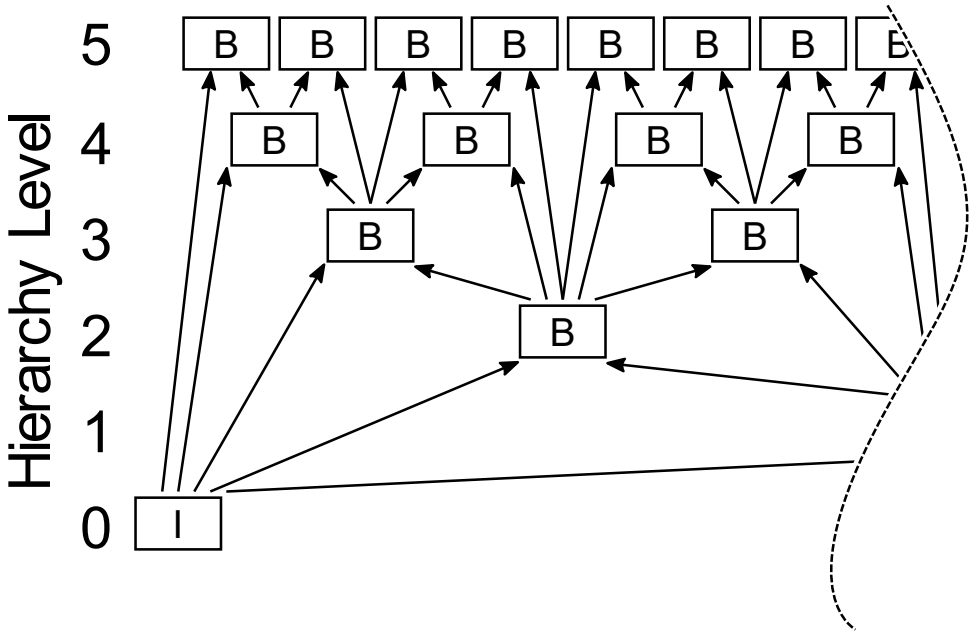
- Test conditions:
  - VTM 12.0
  - JVET Common Test Conditions classes B, C, D, E
  - QP 22, 27, 32, 37, 42
  - Random access configuration with GOP size 32
- Comparison with well-known EC methods:
  - Frame Copy (FC)
  - Block Matching (BM)
    - M. Usman, et al. “Frame interpolation for cloud-based mobile video streaming,” 2016.

Single Errors

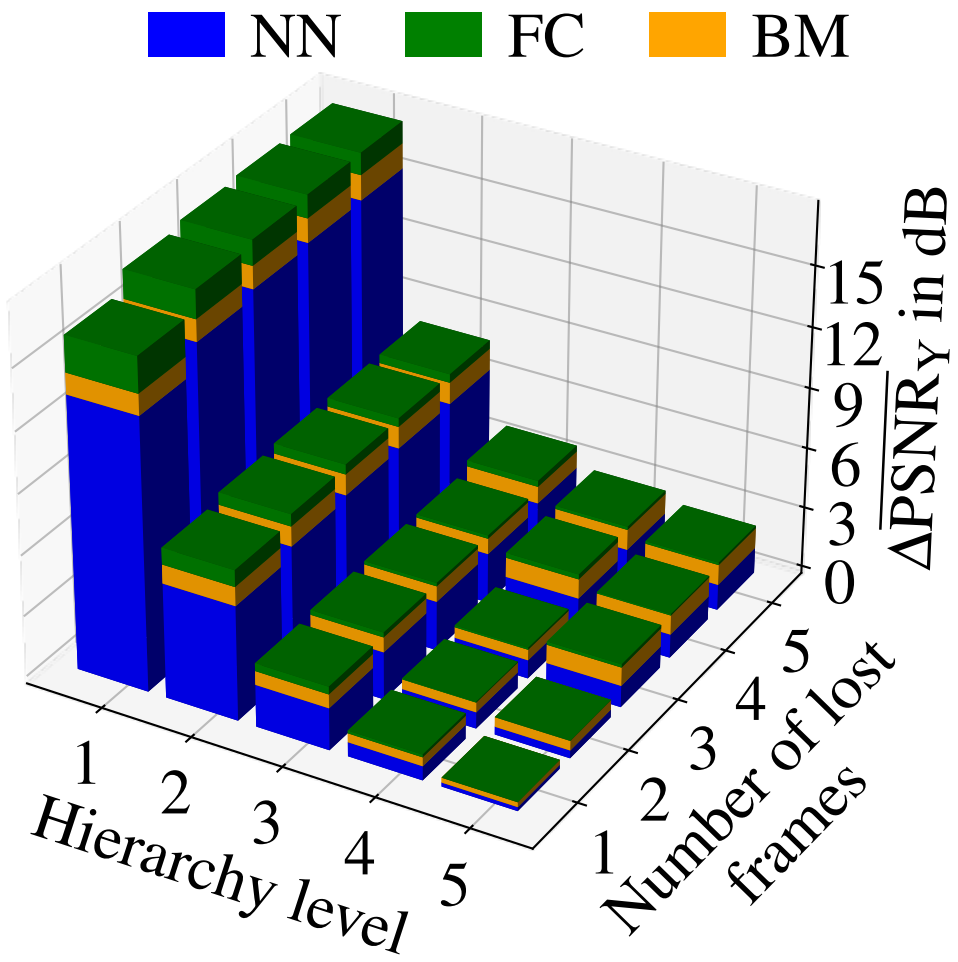


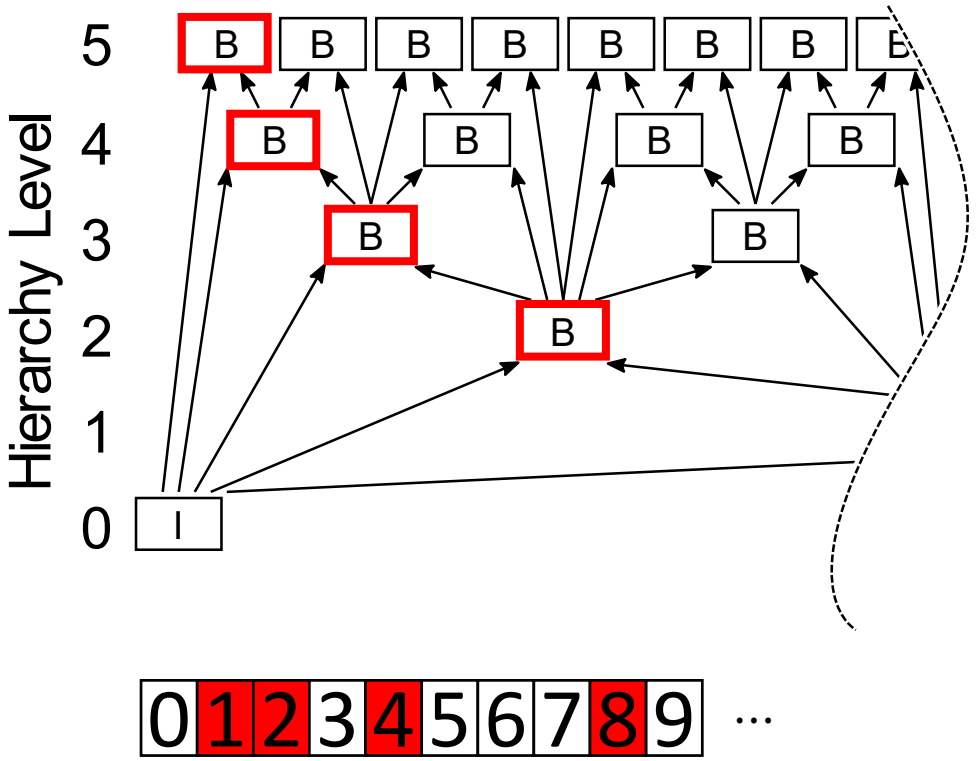
Single Errors



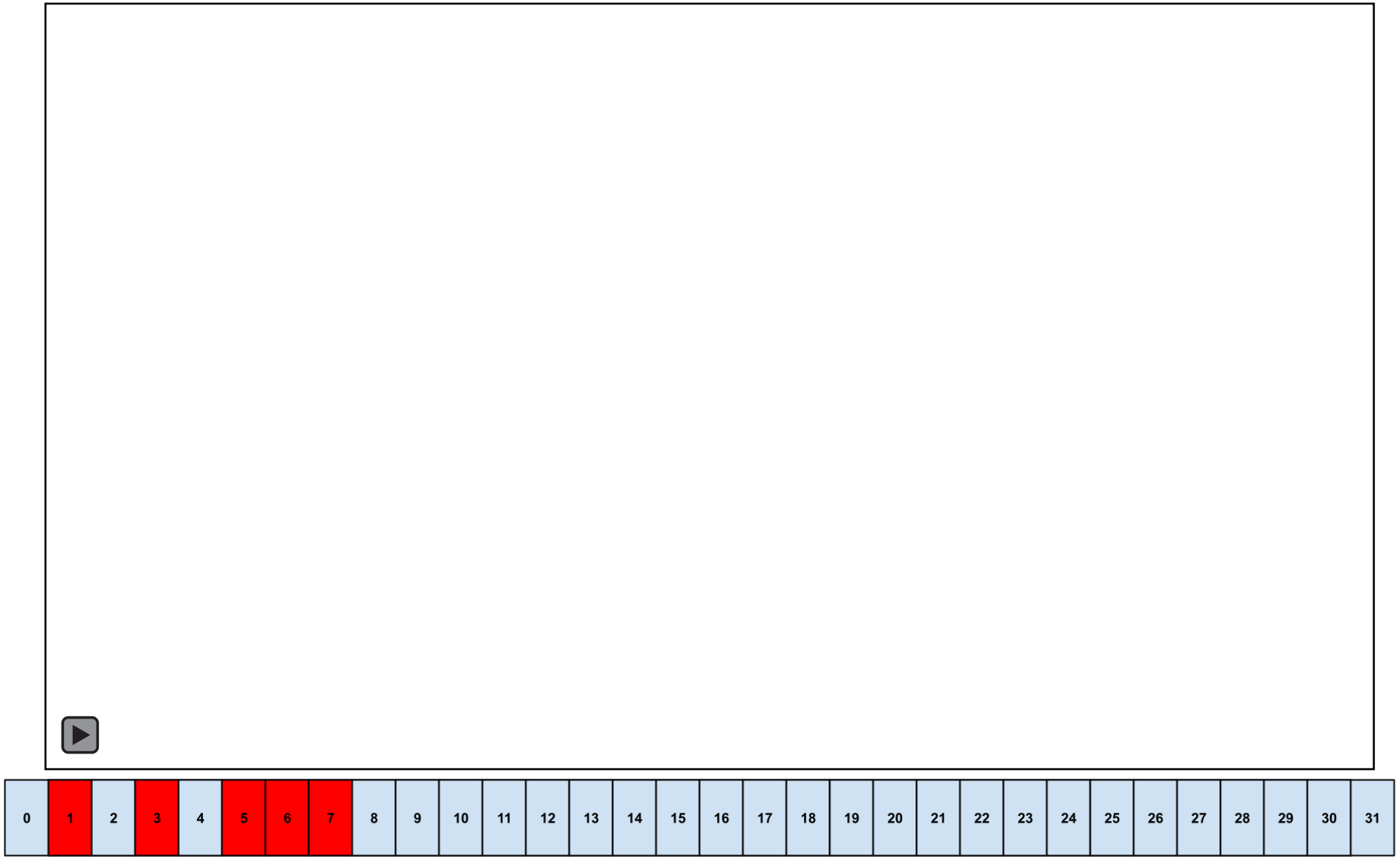


Burst Errors

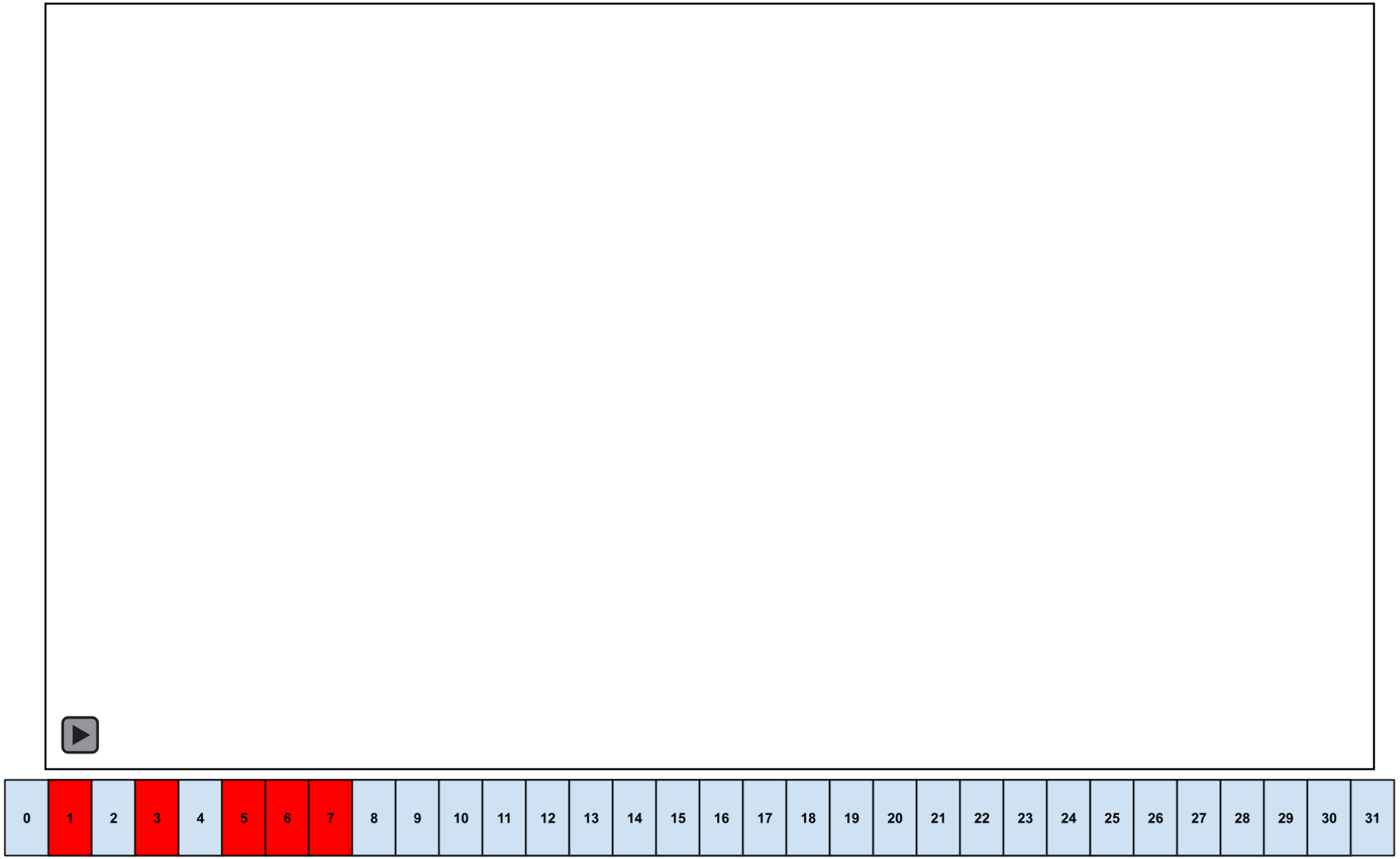




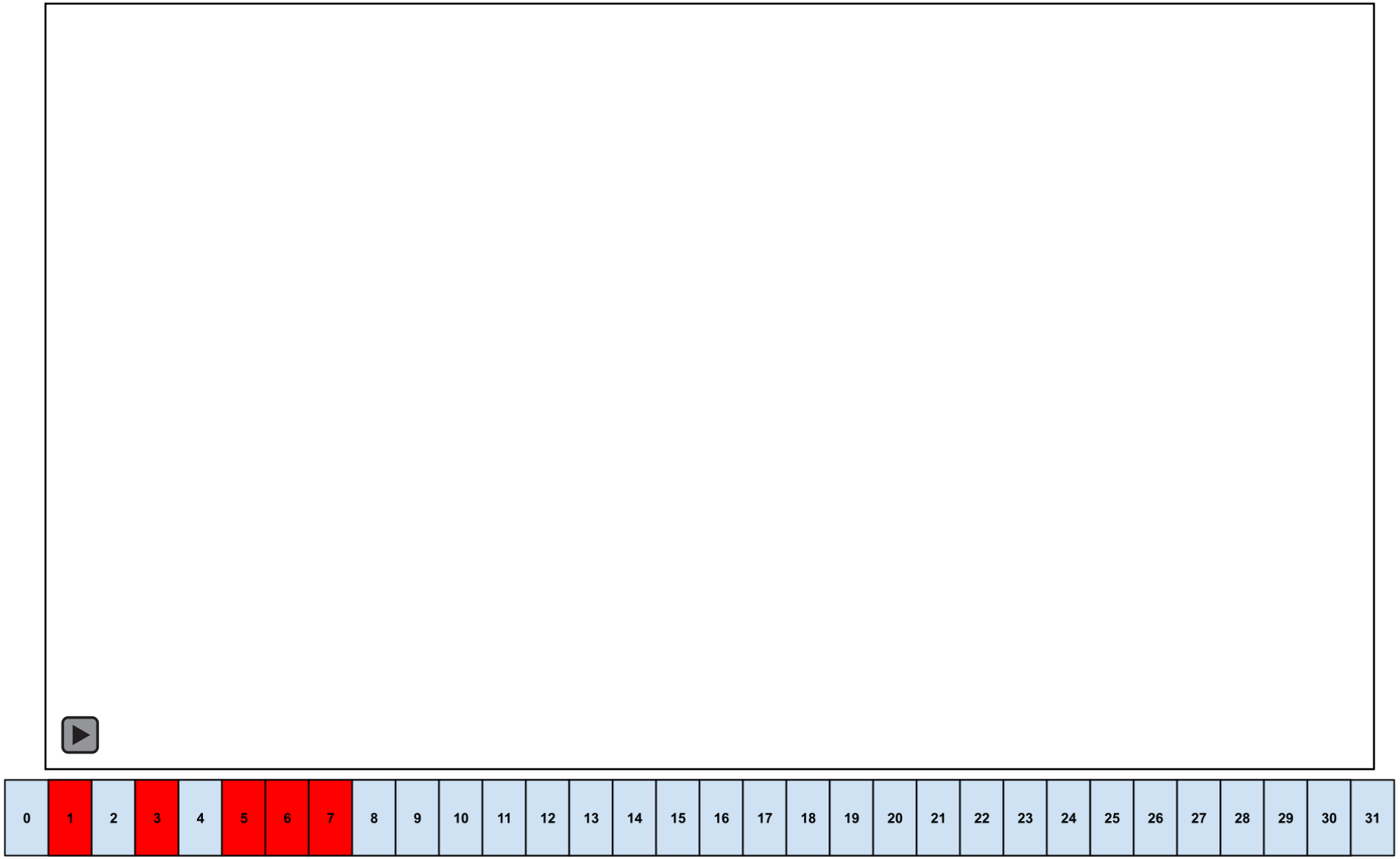
Burst Error Concealed using FC



Burst Error Concealed using BM



Burst Error Concealed using NN



Conclusion

- We introduced a neural network-based error concealment method for B-Frames in VVC
- The performance was evaluated within VTM 12.0
- PSNR of a corrupted GOP is improved by 2.8 dB compared to FC and 1 dB compared to BM
- Visually, the quality of corrupted videos is improved