Conditional Coding for Flexible Learned Video Compression

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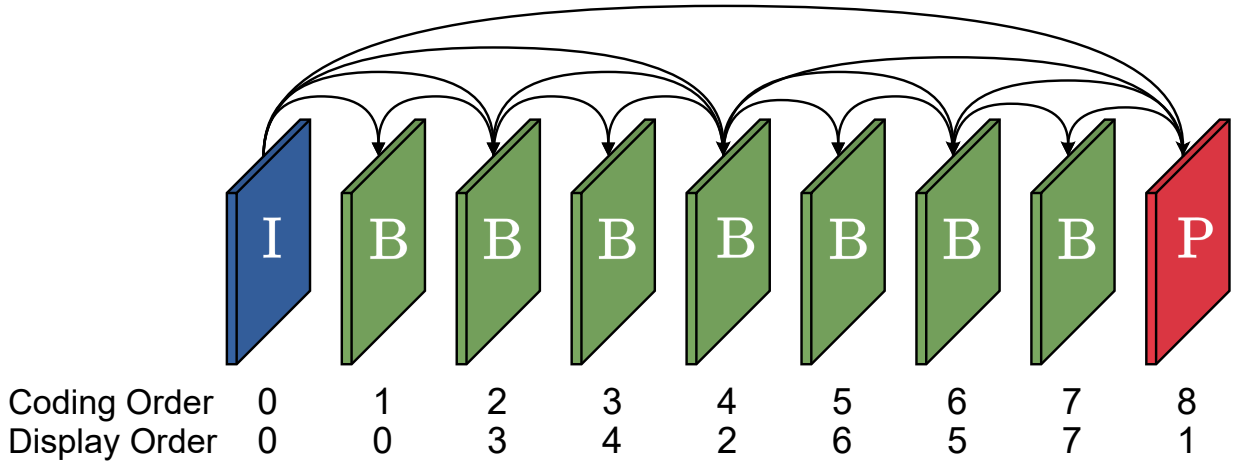
ICLR 2021 – Neural Compression Workshop, 7 May 2021

Context & Contributions

- **Learned** Video Coding



- 2 types of frame $\begin{cases} \text{Intra} & : \text{0 reference (I)} \\ \text{Inter} & : \text{1 ref. (P) or 2 ref. (B)} \end{cases}$

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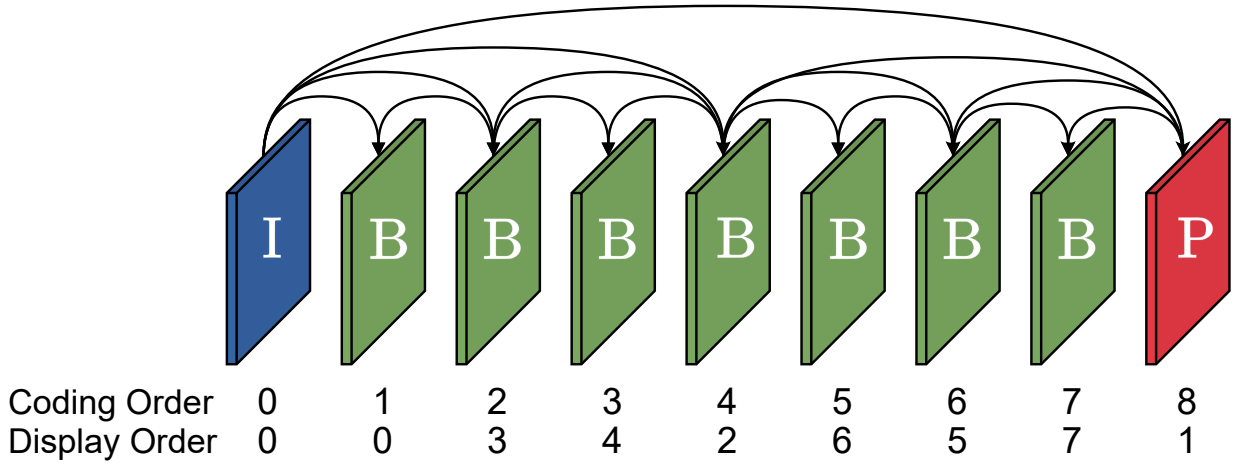

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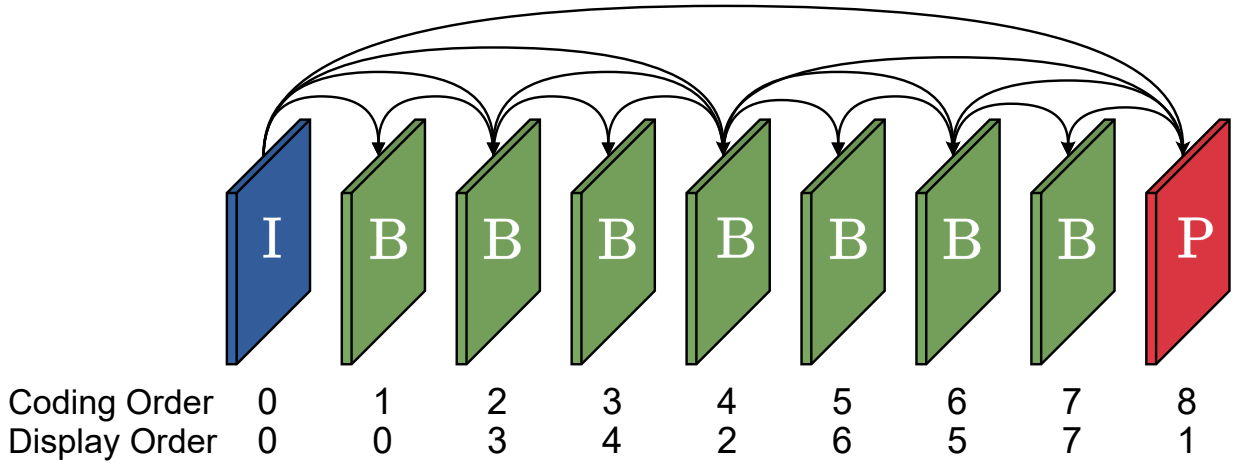

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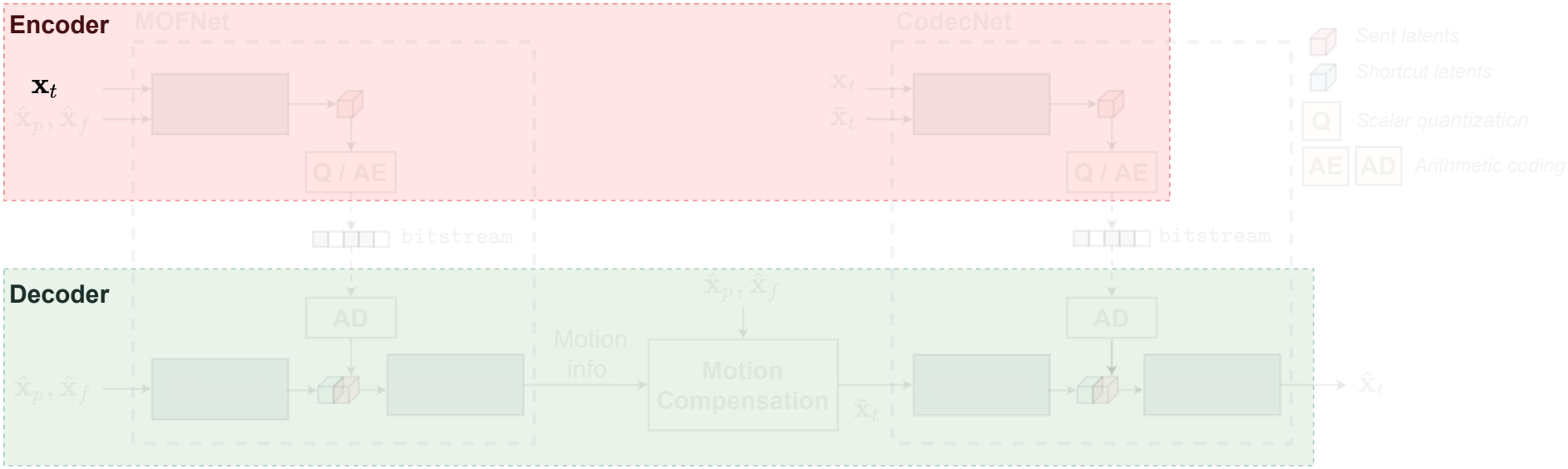
- Previous work: **2 separate coders** for intra and inter-frames
- Contribution: **conditional coding**
  - Leverage 0, 1 or 2 ref. with a **unique** coder
  - **Flexible** coder on par with HEVC

Coding Scheme Overview



- Coding $\mathbf{x}_t$

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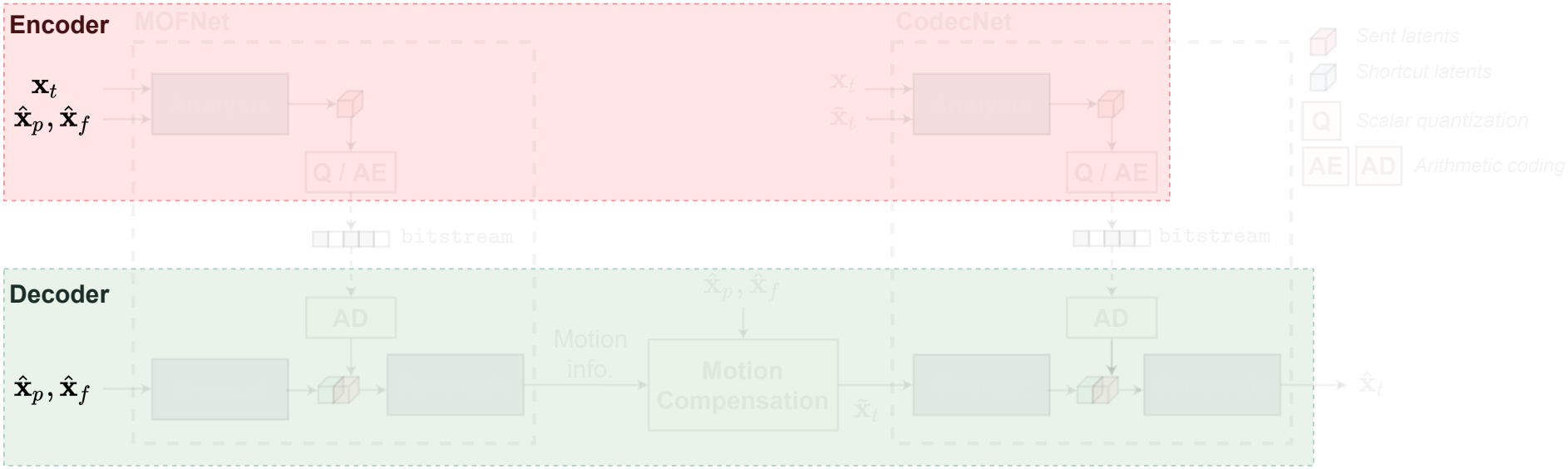

- Coding $\mathbf{x}_t$ knowing **up to 2** references $\hat{\mathbf{x}}_p$, $\hat{\mathbf{x}}_f$

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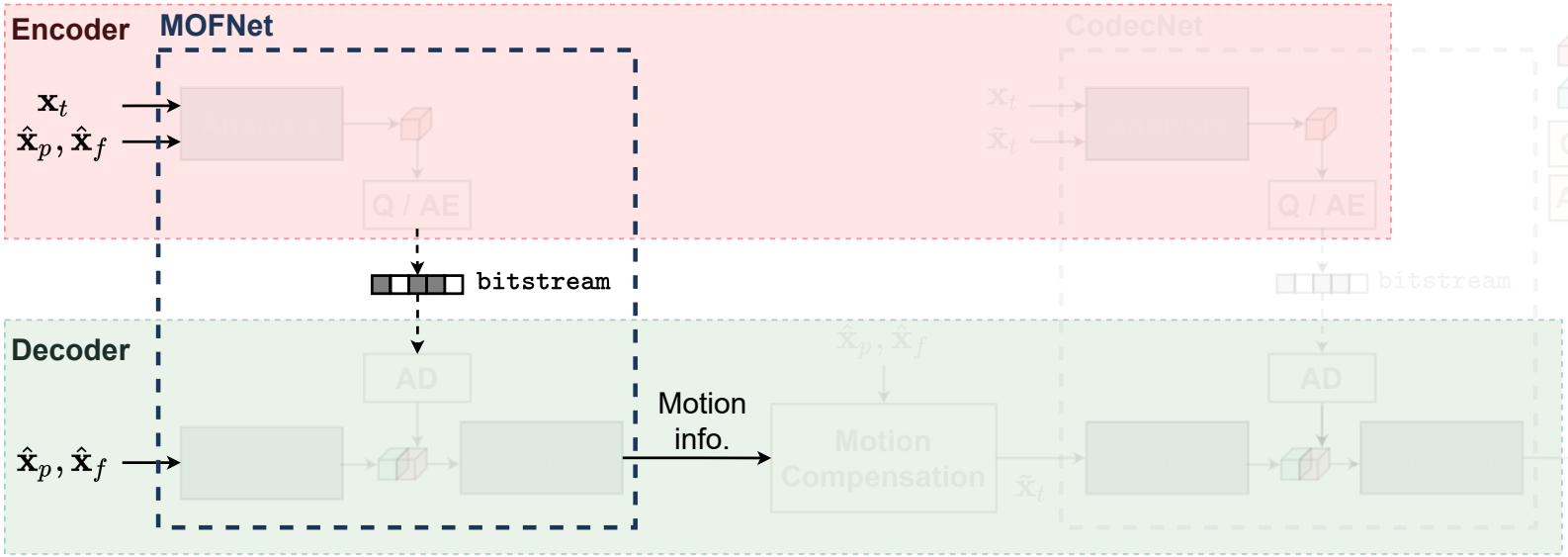

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Optical flow for motion compensation

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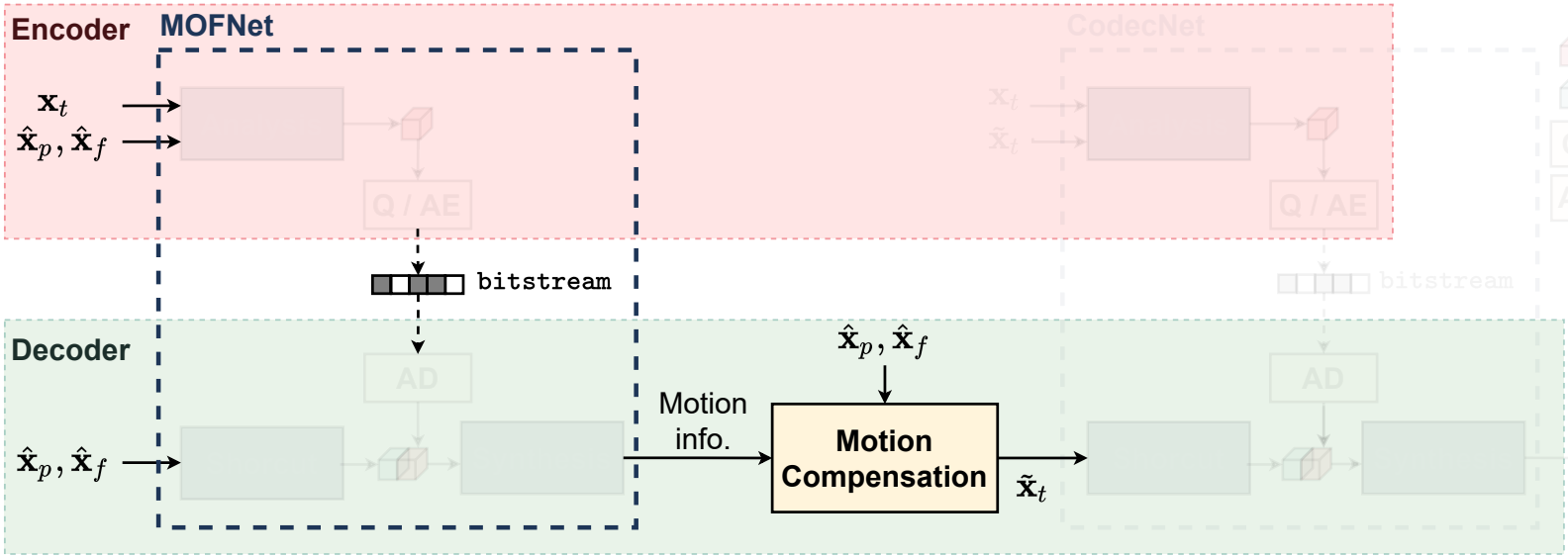

- Coding $\mathbf{x}_t$ knowing **up to 2** references $\hat{\mathbf{x}}_p$, $\hat{\mathbf{x}}_f$
- MOFNet transmits **motion info** to compute the prediction $\tilde{\mathbf{x}}_t$

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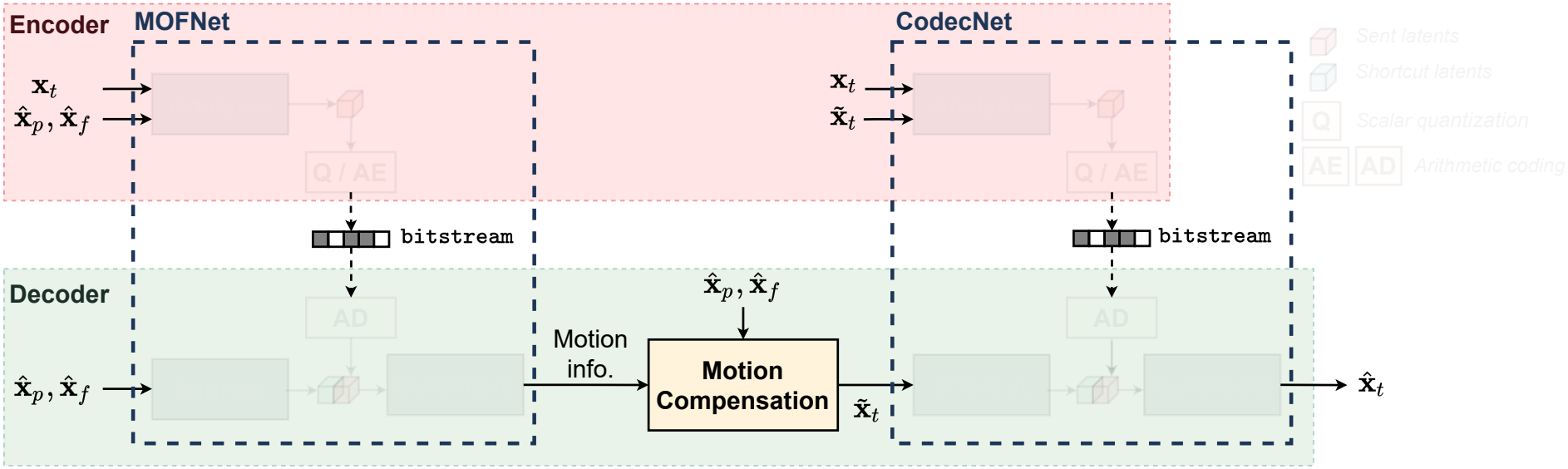
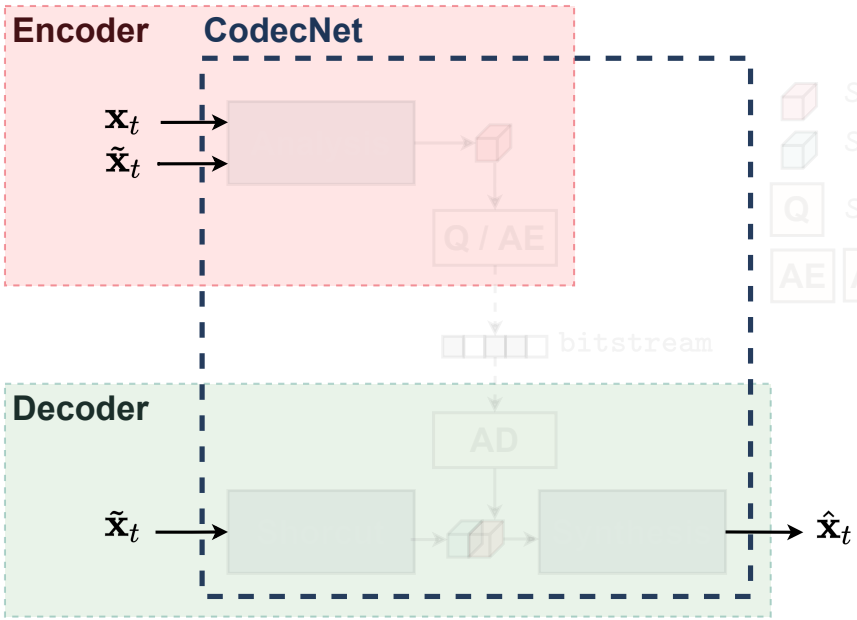


- Coding $\mathbf{x}_t$ knowing **up to 2** references $\hat{\mathbf{x}}_p$, $\hat{\mathbf{x}}_f$
- MOFNet transmits **motion info**
- CodecNet sends the **unpredictable** part to get the decoded frame $\hat{\mathbf{x}}_t$

Conditional Coding



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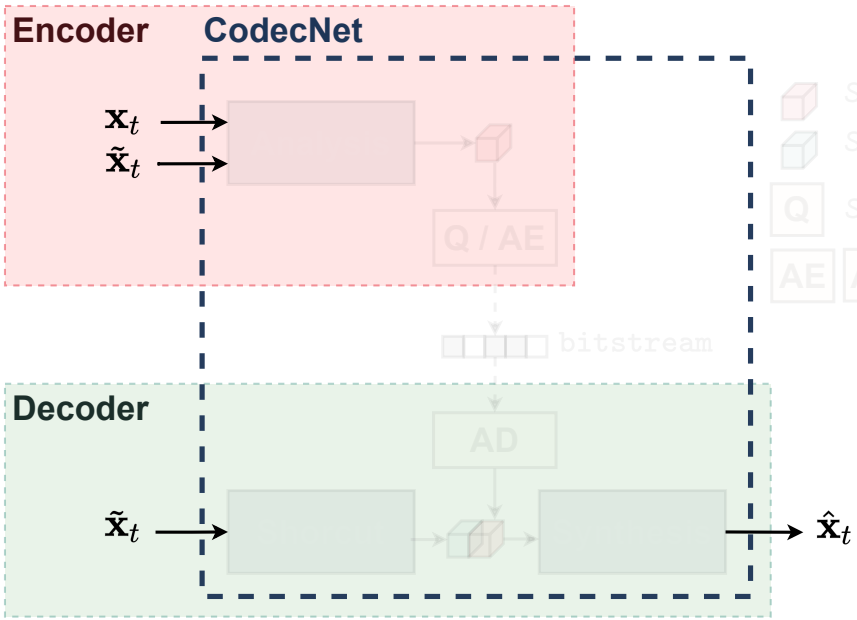

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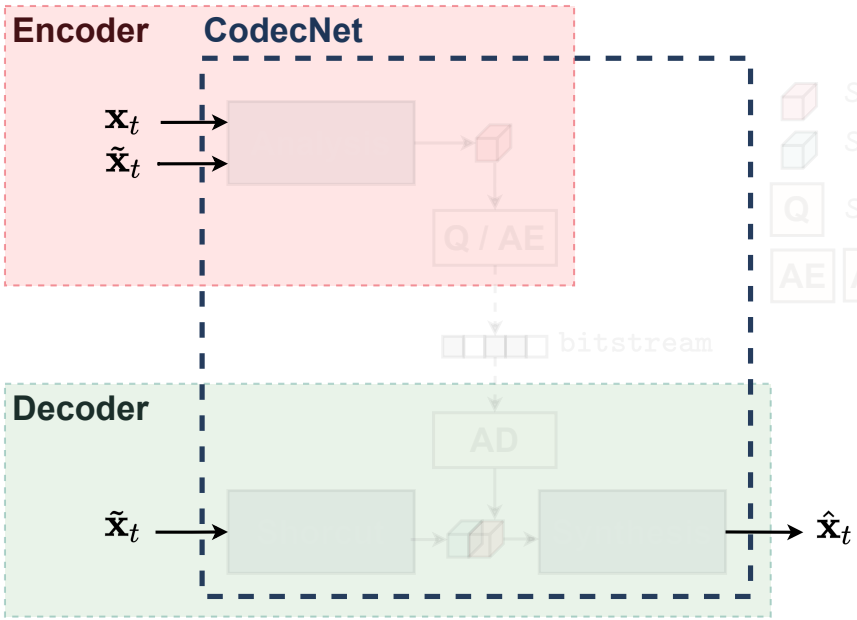

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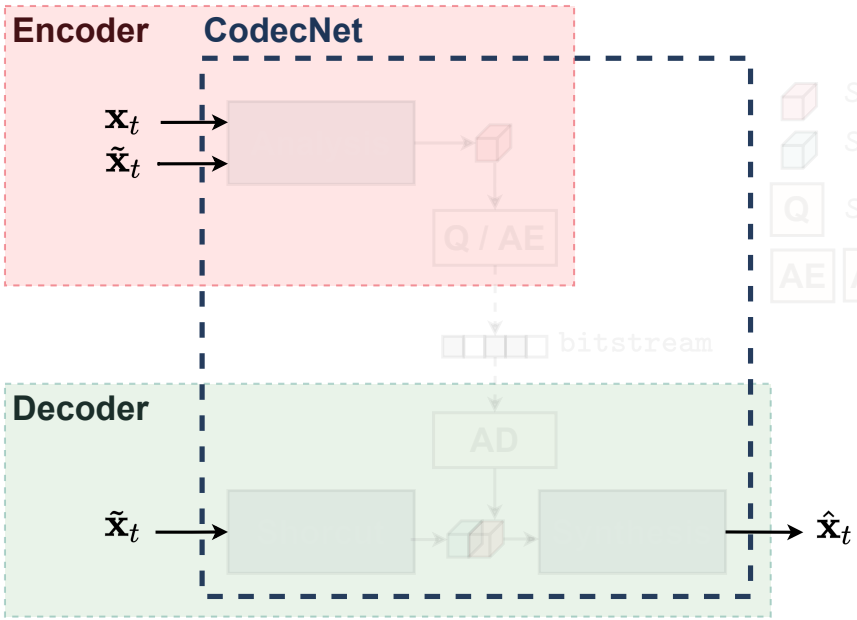

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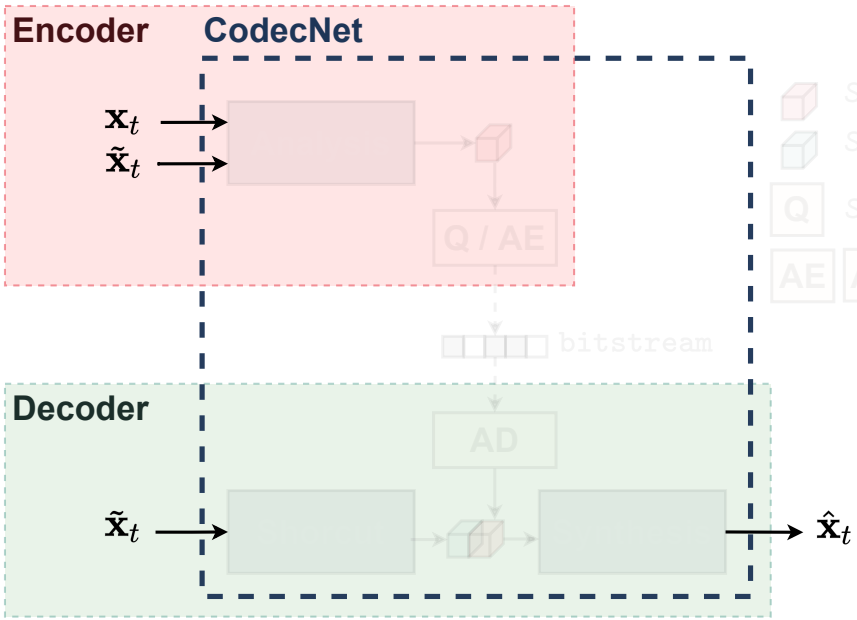

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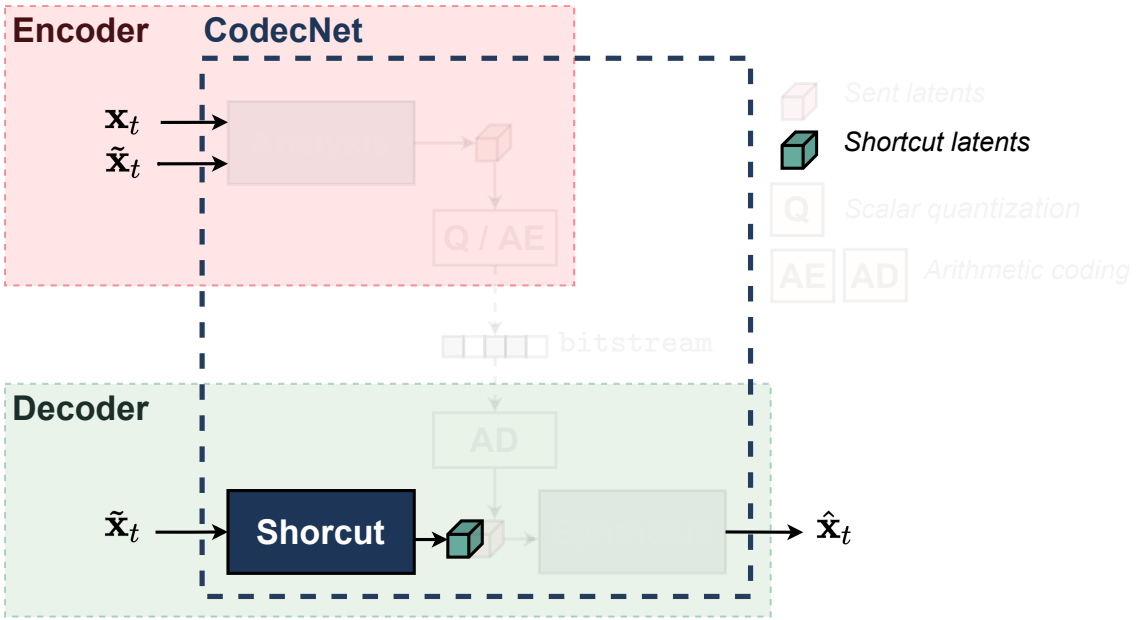
- Conditional coding: **generalization** of residual coding
  - Always process image-domain inputs $\rightarrow$ **single coder**
  - Offer better performance[1]

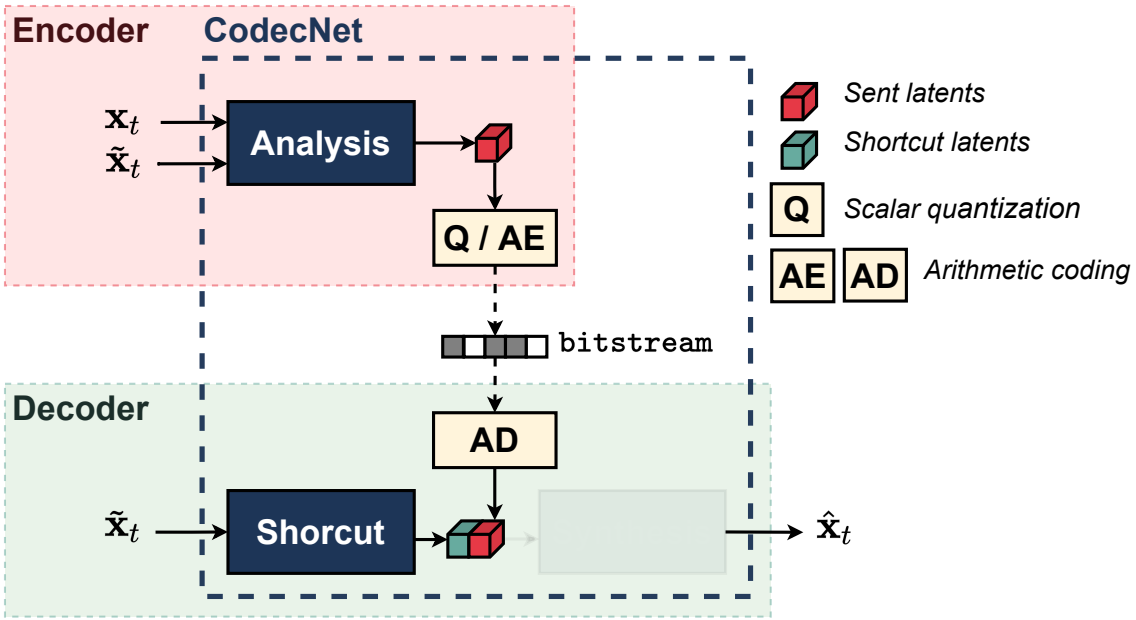
[1] Ladune, *Optical Flow and Mode Selection for Learning-based Video Coding*, MMSP 2020

Conditional Coding



- Shortcut: exploit decoder information

Conditional Coding



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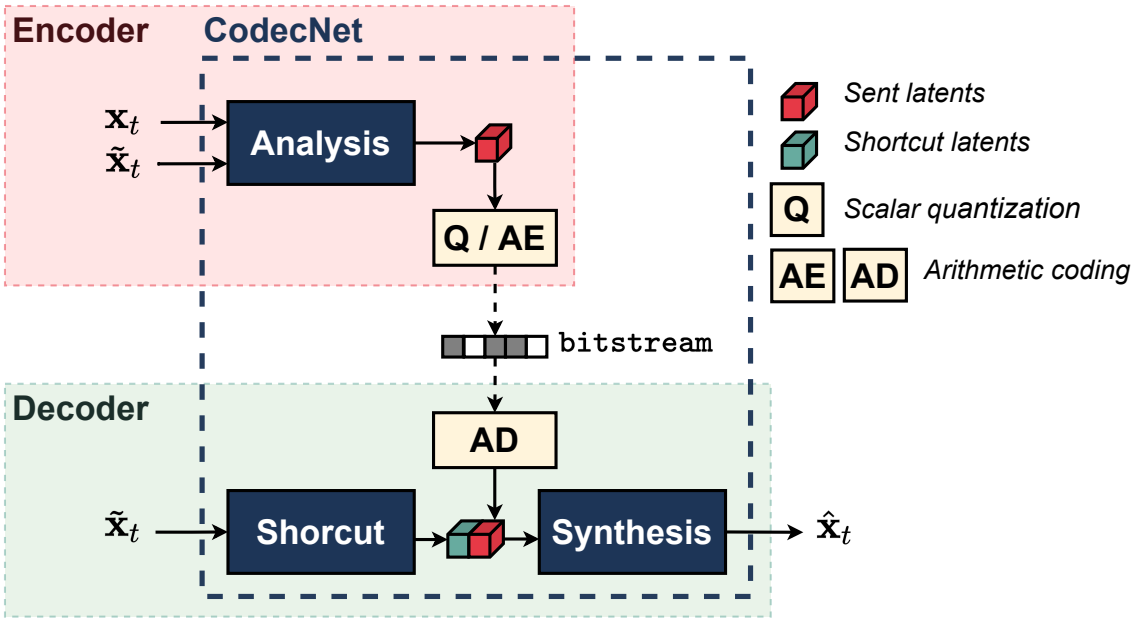

- Shortcut: exploit decoder information
- Analysis: transmit information not present at the decoder
- Synthesis: process both shortcut and analysis latents

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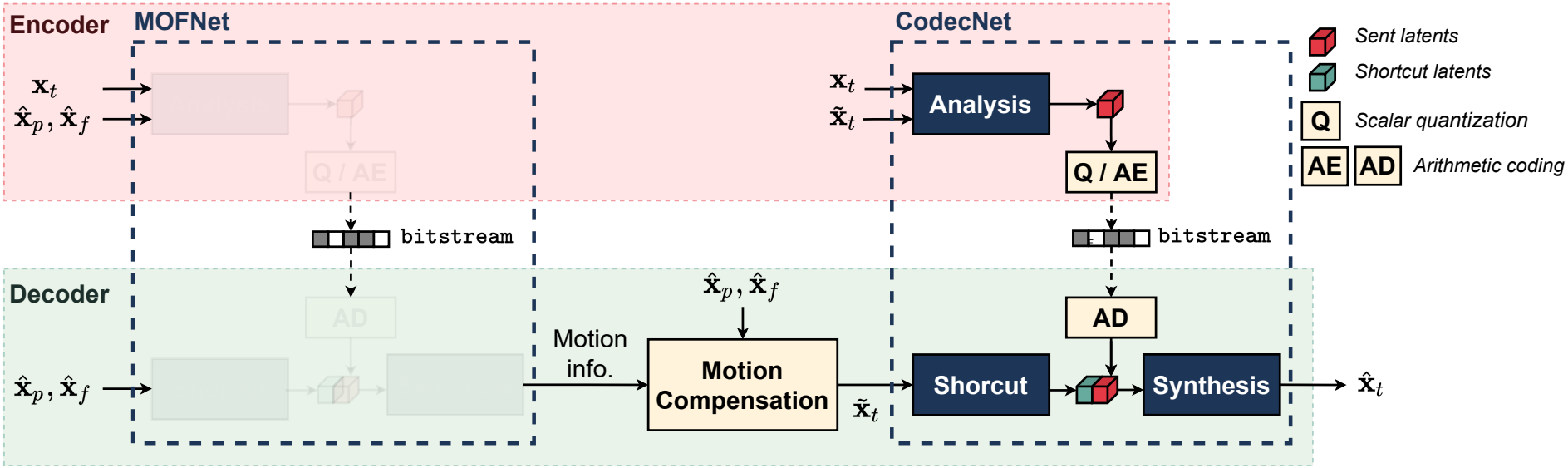

- Conditional Coding for CodecNet

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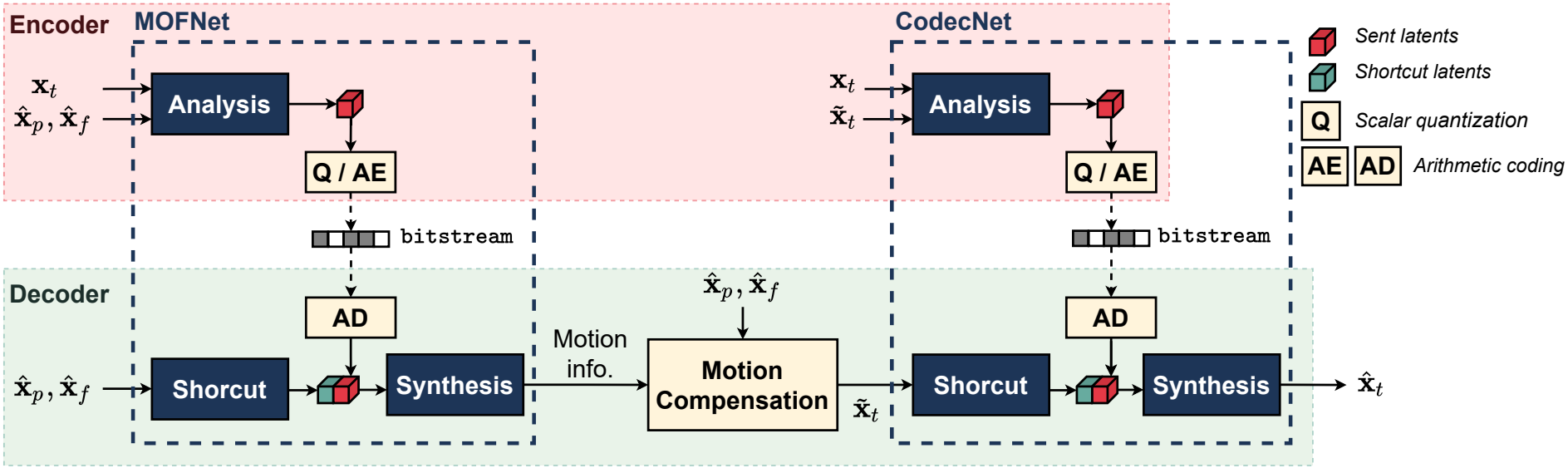

- Conditional Coding for CodecNet and MOFNet

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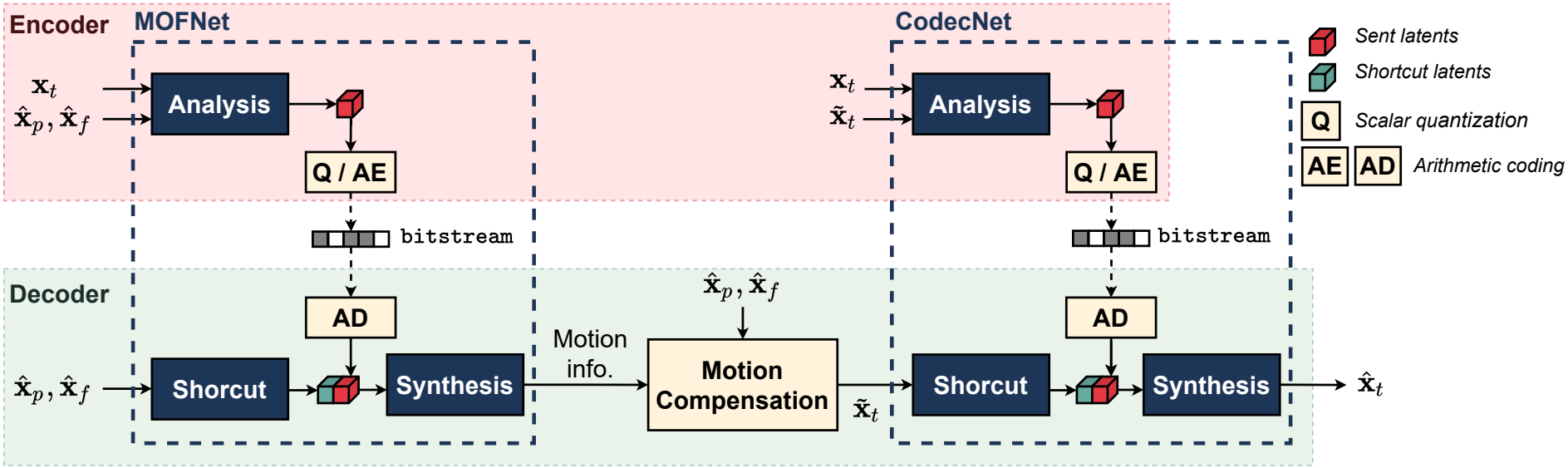

- Conditional Coding for CodecNet and MOFNet
  - **Retrieve motion information** from the references

Motion from the shortcut

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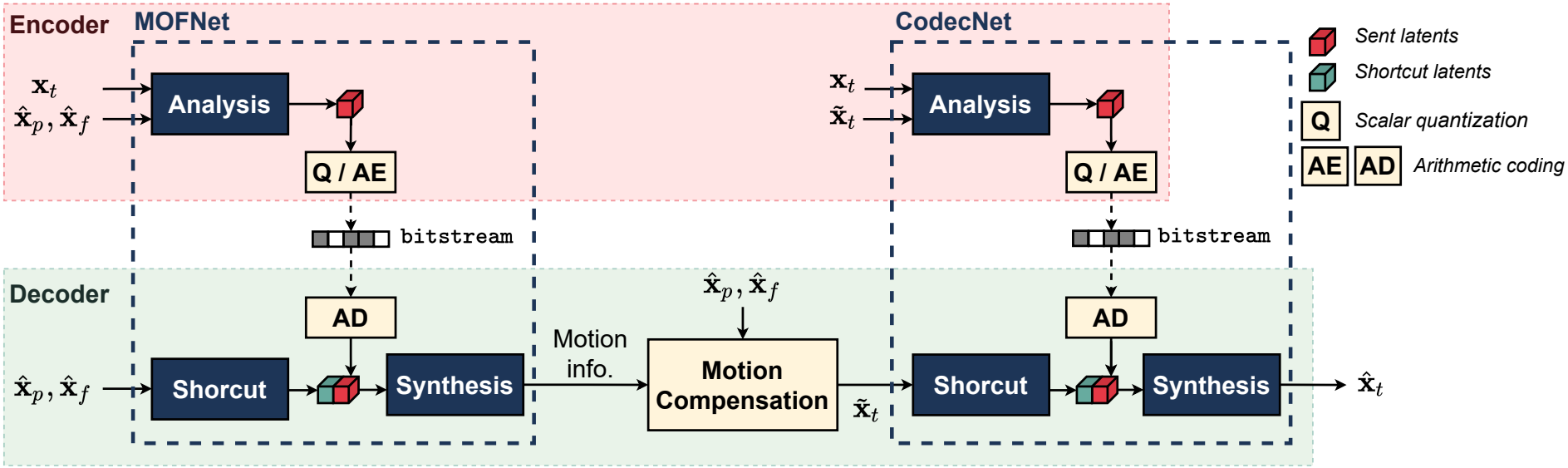
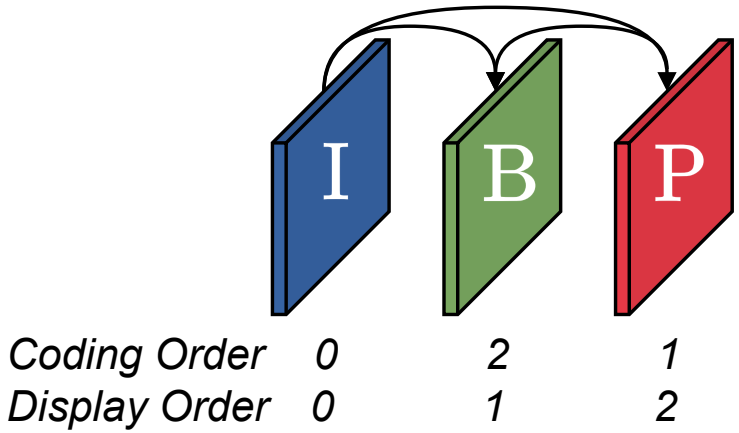


- Conditional Coding for CodecNet and MOFNet
  - **Retrieve motion information** from the references
  - The analysis transform sends only a **small** correction

Motion from the shortcut

Motion from the analysis

Training process



- The system is trained to code an **entire GOP** (+ the first I)
  - Our system learns to code I, P & B-frames

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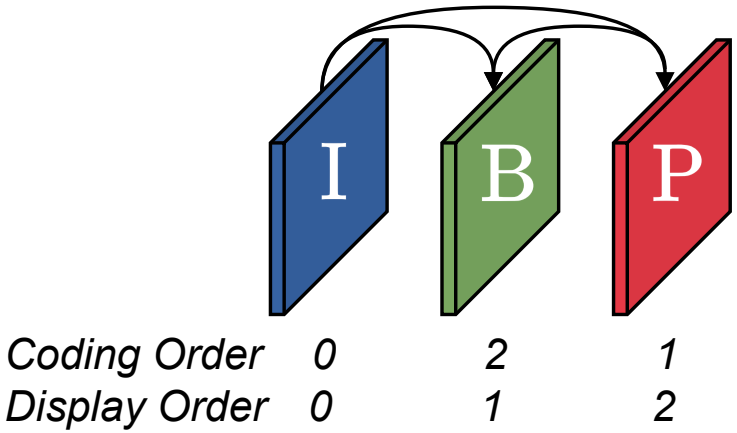

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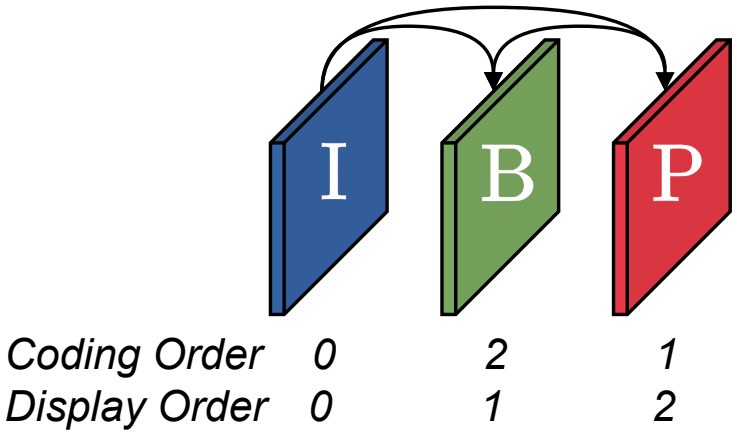

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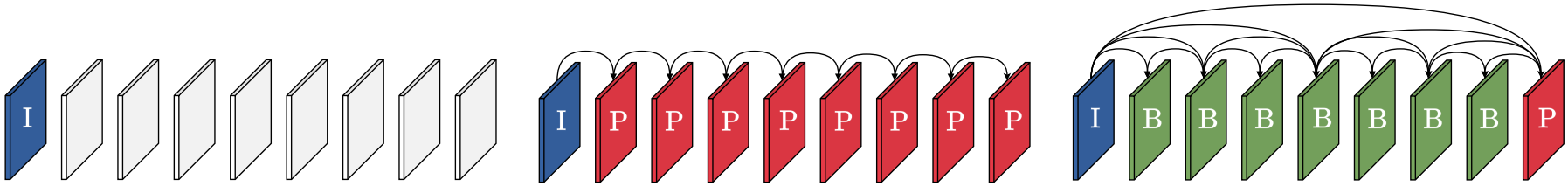
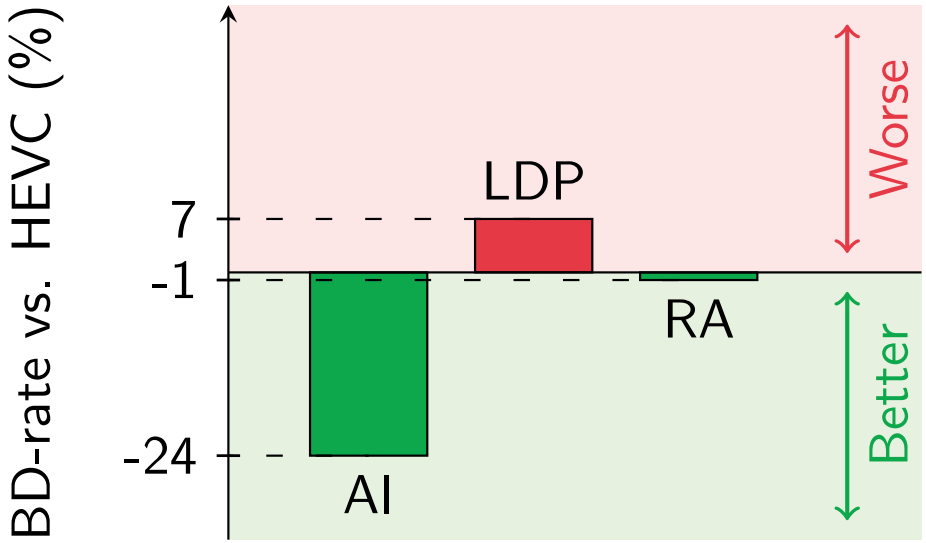
- **Single** backward for all the frames: model compression **noise propagation**

Experimental Results



All Intra (AI) *Low-delay P (LDP)* *Random Access (RA)*

- Evaluation on 3 coding configurations against HEVC



- Our **single-coder** system is **on par** with HEVC for the 3 coding config.

Thanks for your attention