Compression-Aware Video Super-Resolution

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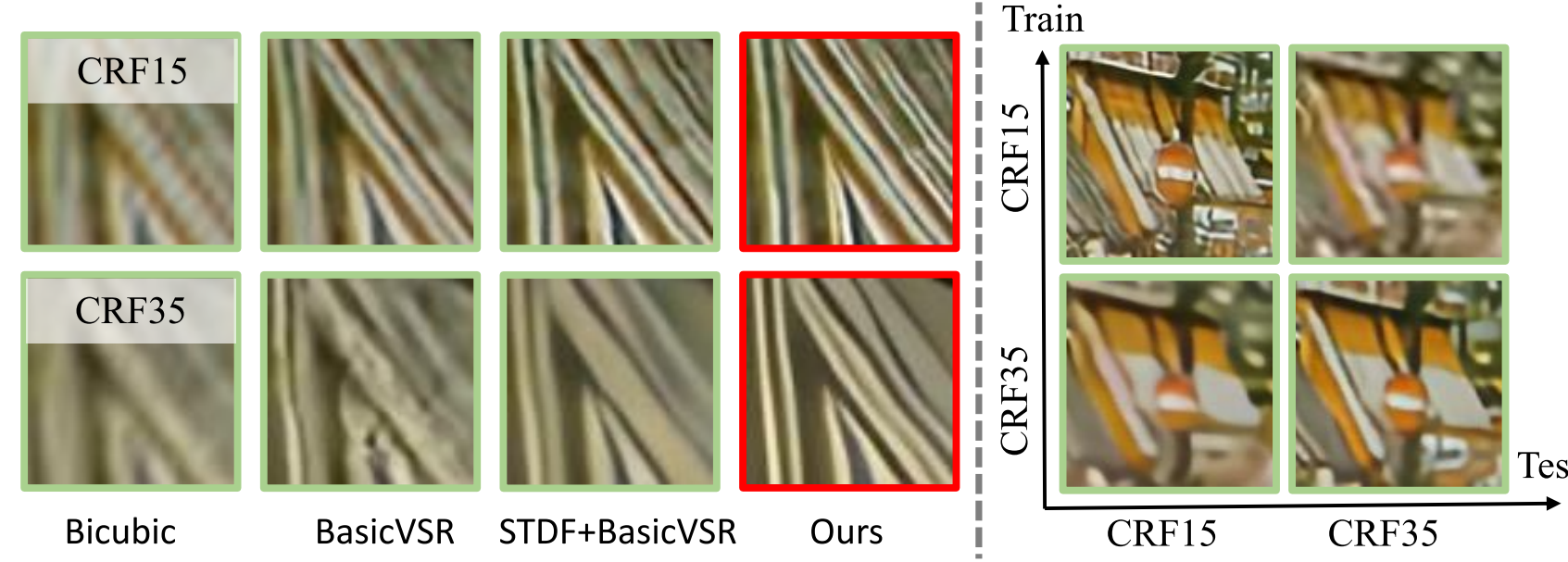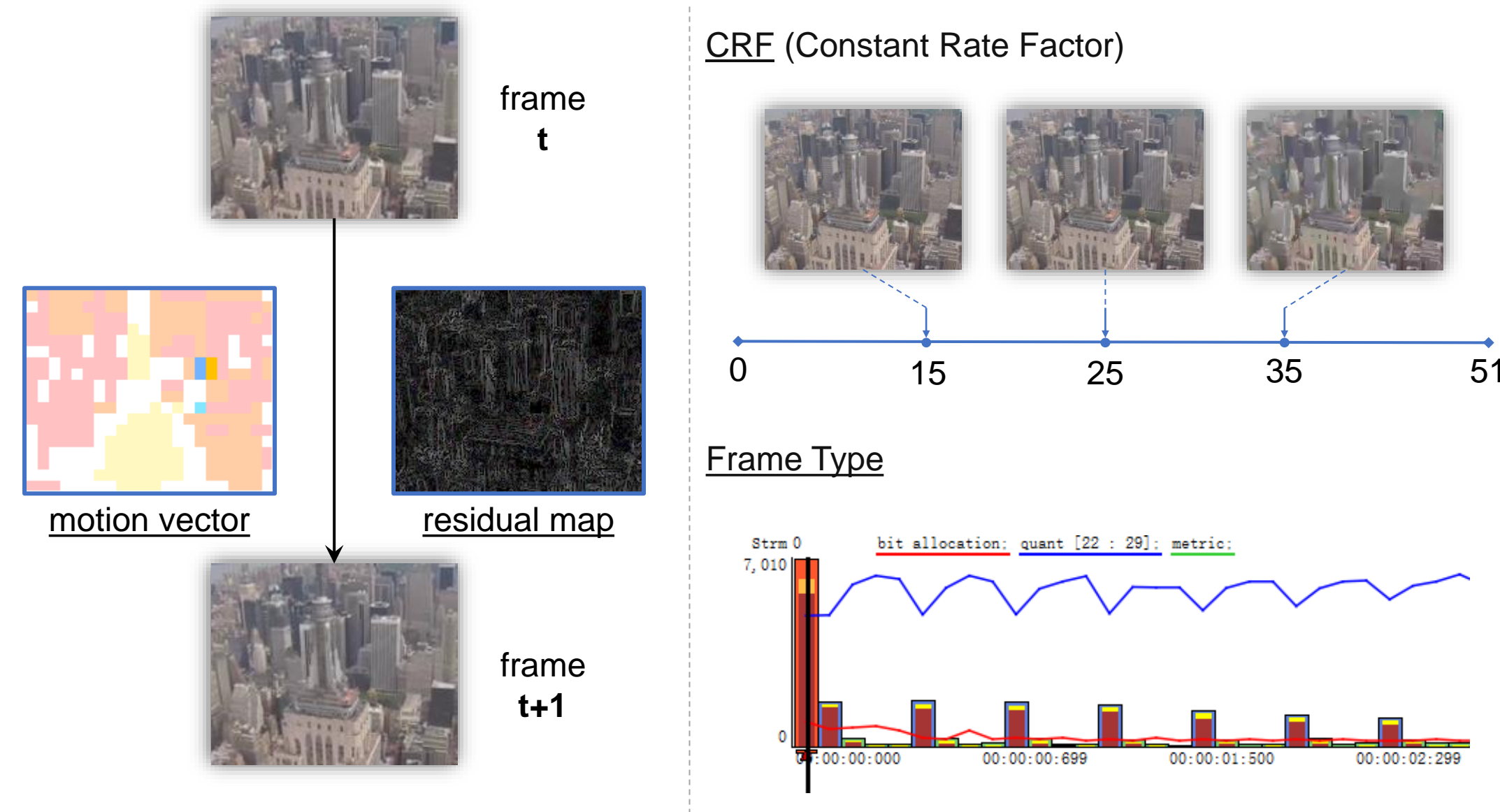
Motivation

- Problems:
  - ❑ unaware of compression level   ❑ disregard of meta data
    - ▪ artifacts   ▪ detail loss


Meta Data of Compressed Videos


Contribution

- A compression encoder to perceive compression levels of input frames.

- A compression-aware modulation module to encourage the base model to perform adaptively under various compression.

- Alignment and propagation process assisted by metadata.
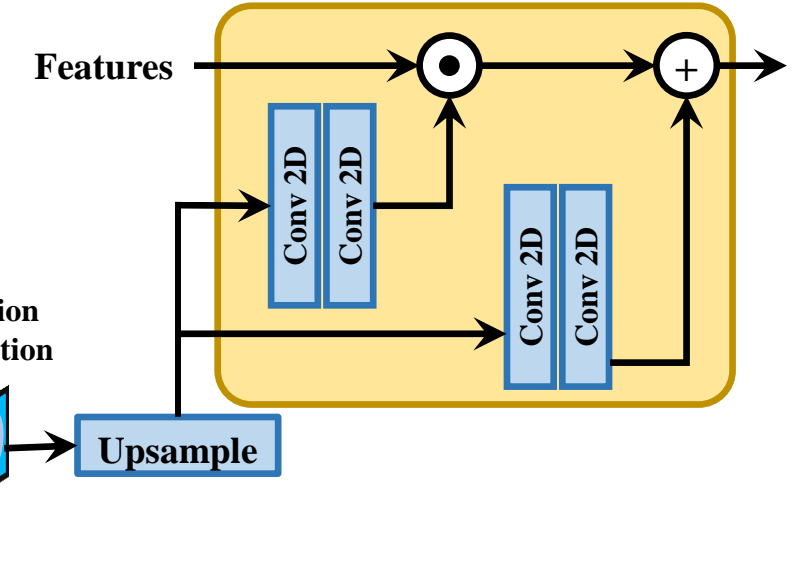
Approach

A novel bi-directional recurrent compression-aware video super-resolution approach is proposed to deal with various compression.
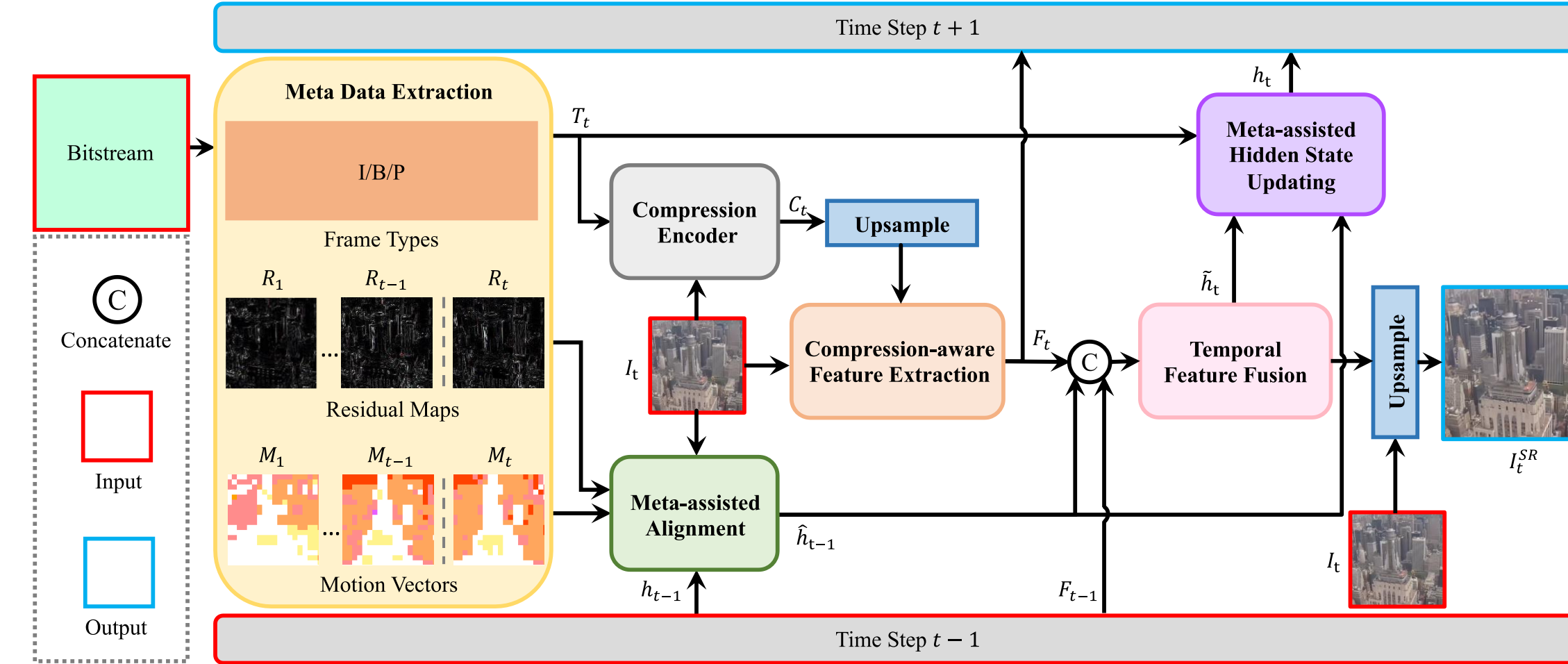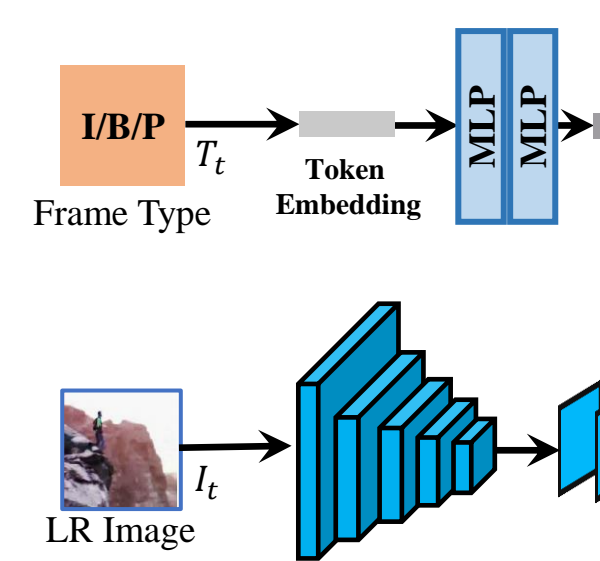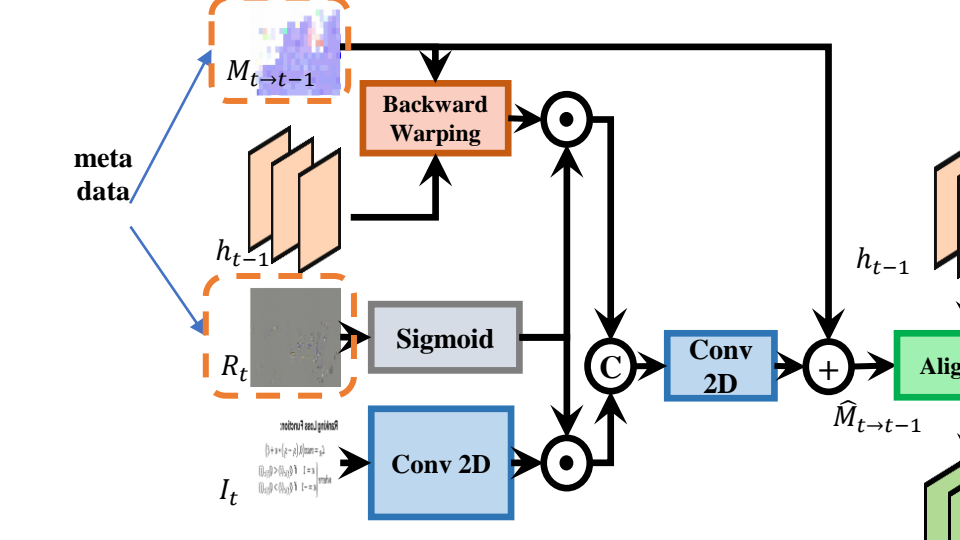

- Compression Encoder
- Compression-Aware Modulation
- Meta-Assisted Alignment and Propagation
  - ➢ Hidden-State Alignment

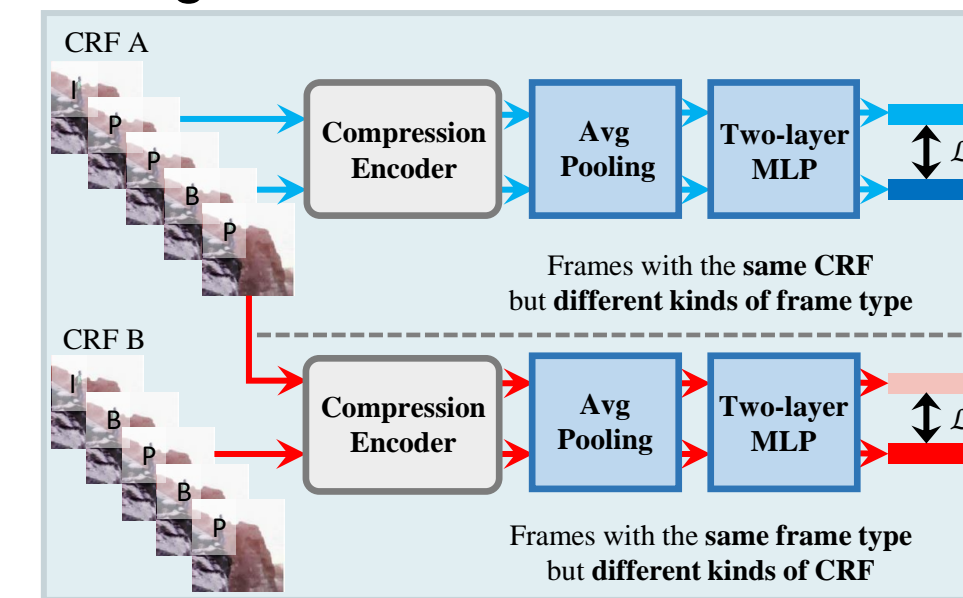$$CAM(\mathbf{F}|\gamma_i, \beta_i) = \gamma_i \odot \mathbf{F} + \beta_i$$

- ➢ Hidden-State Updating

$$\begin{cases} h_t = \alpha * \tilde{h}_t + (1-\alpha) * \hat{h}_{t-1} & if\ T_t = B \\ h_t = \tilde{h}_t & otherwise, \end{cases}$$

- Encoder Pretraining
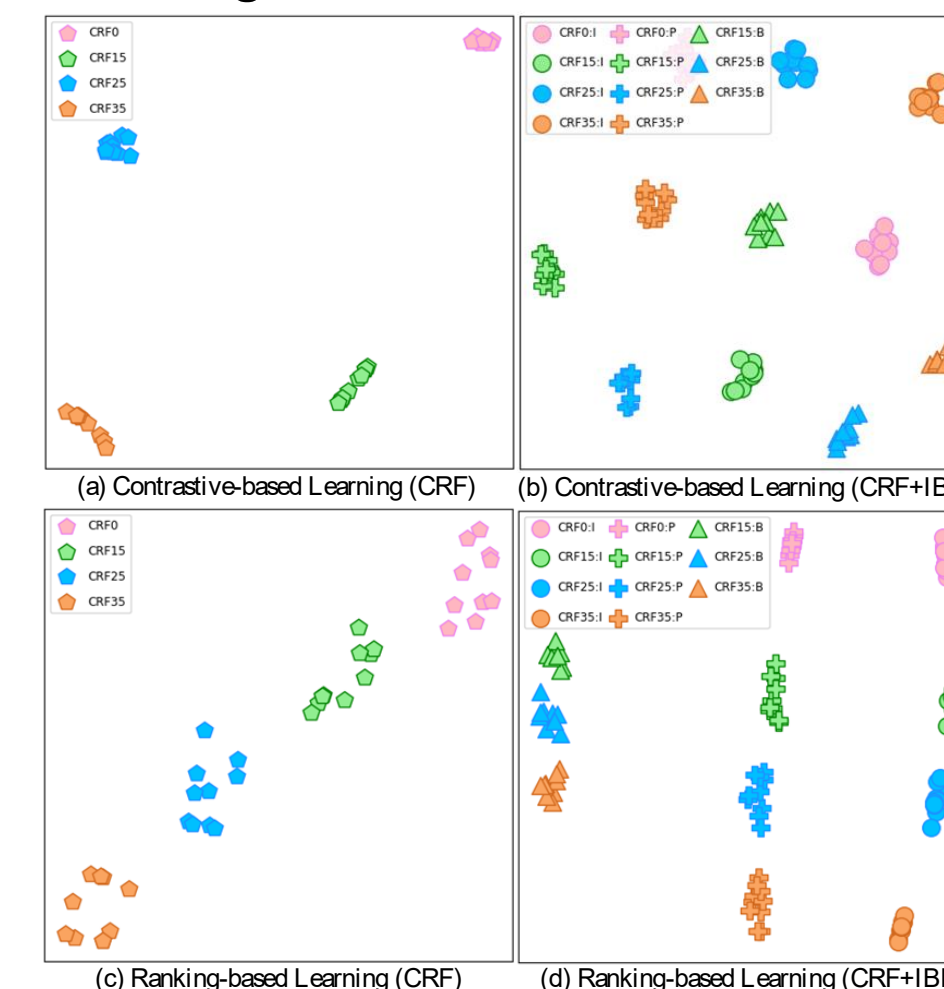 - ➢ Learning to **rank**
- ➢ Ranking v.s. Contrastive loss

Ranking Loss Function:

$$\mathcal{L}_R = max(0, (s_i - s_j) * \kappa + \xi)$$

$$where \begin{cases} \kappa = 1 & if\ Q_{f/c}(i) < Q_{f/c}(j) \\ \kappa = -1 & if\ Q_{f/c}(i) > Q_{f/c}(j) \end{cases}$$

Evaluation

	Params (M)	Runtime (ms)	Vid4 (Y)			REDS4 (RGB)		
			CRF 15	CRF 25	CRF 35	CRF 15	CRF 25	CRF 35
EDVR	20.6	378	26.53/0.794	24.76/0.694	22.39/0.544	29.31/0.836	26.27/0.742	23.78/0.625
RealBasic VSR	6.3	63	26.94/0.813	24.87/0.701	2239/0.531	29.76/0.849	26.49/0.746	23.63/0.626
COMISR	6.2	73	26.66/0.801	25.14/0.713	22.62/0.546	29.76/0.832	26.96/0.749	23.87/0.629
FTVSR	10.8	850	27.50/0.826	25.51/0.732	22.79/0.561	30.89/0.864	28.10/0.786	24.83/0.674
Ours	8.9	93	27.42/0.833	25.65/0.742	22.84/0.574	30.76/0.873	28.15/0.798	24.93/0.682
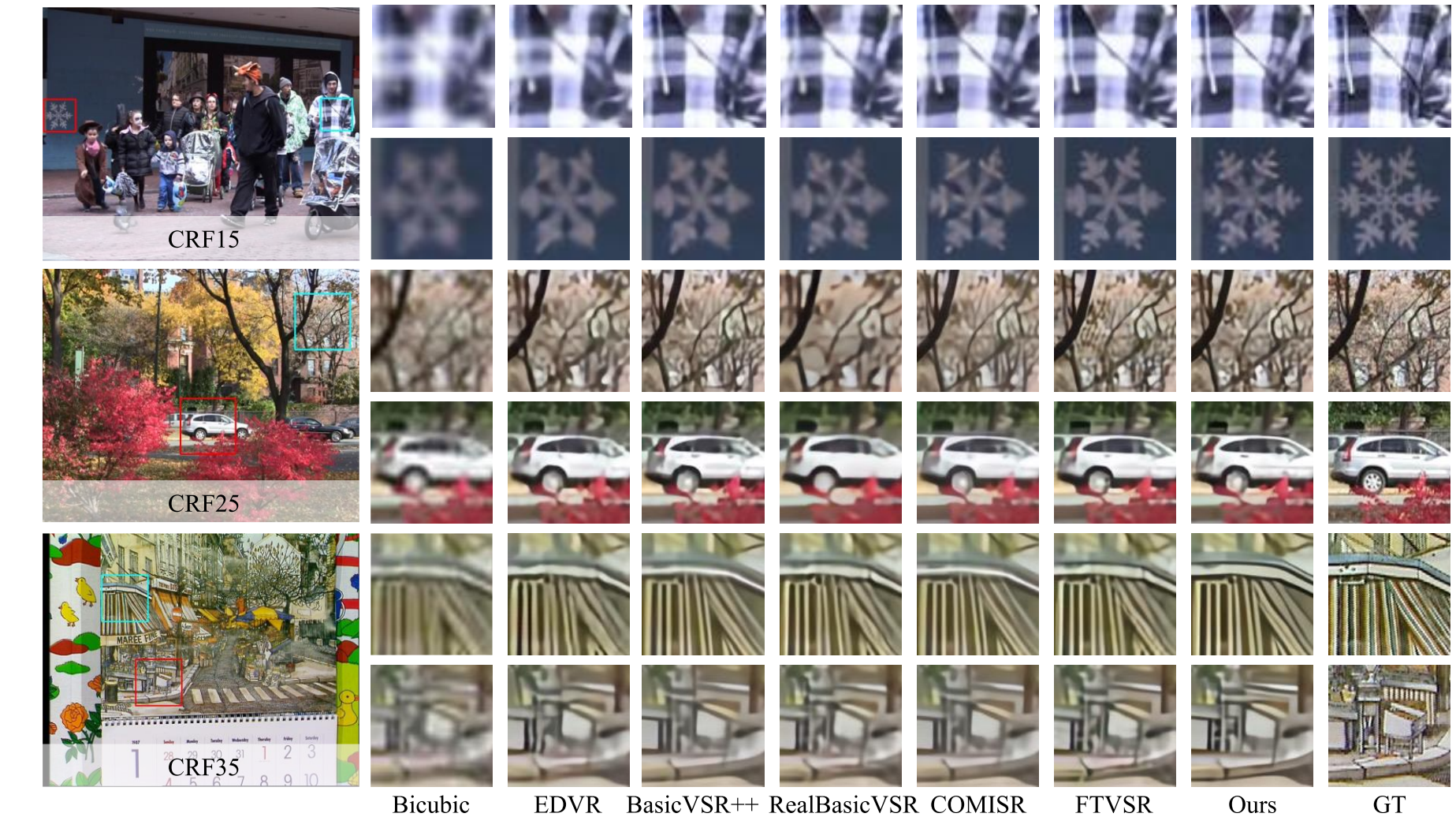
Ablation Studies

CAM	OA	MA	MH	CRF 15	CRF 25	CRF 35
	✓			26.76	24.54	22.06
✓	✓			27.25	25.41	22.74
✓		✓		27.40	25.60	22.80
✓		✓	✓	27.42	25.65	22.84

- CAM: Compression-Aware Modulation
- OA/ MA : Optical Flow/Meta-assisted Alignment
- MH: Meta-assisted Hidden State Updating

Conclusion

- A compression encoder and a compression-aware modulation
  - Perceiving compression level using rank-based pretrained encoder
  - Modulating feature extraction stage based on compression representation
- A meta-assisted alignment
  - Leveraging the information from bitstream to enhance motion and temporal consistency modeling
- A meta-assisted propagation strategy
  - The propagation process is more stable, resulting in fewer artifacts
  - Reducing the computational cost and parameters of the optical flow network