Memory Assessment of Versatile Video Coding

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ViTech
VIDEO TECHNOLOGY RESEARCH GROUP

UNIVERSIDADE FEDERAL DE PELOTAS
RS-BRASIL
UFPEL

INSTITUTO FEDERAL
Rio Grande do Sul
Campus Farroupilha

Introduction

- Background
- The novel Versatile Video Coding (VVC)
- Goal of this work
- Main contributions
  - *Memory profiling*
  - *Inter-prediction memory analysis*

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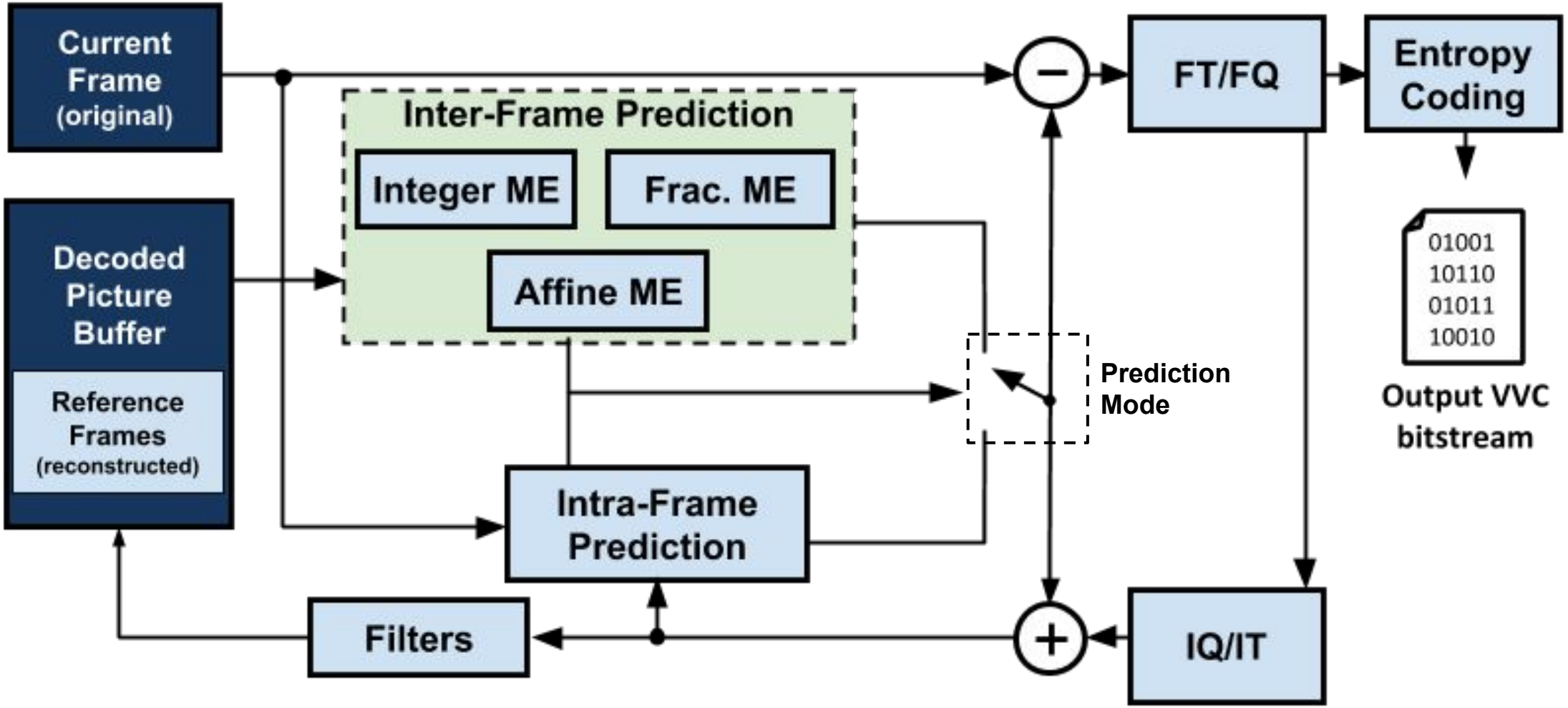
VVC Encoder


Current Frame (original)
Inter-Frame Prediction
Integer ME
Frac. ME
Affine ME
Decoded Picture Buffer
Reference Frames (reconstructed)
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FT/FQ
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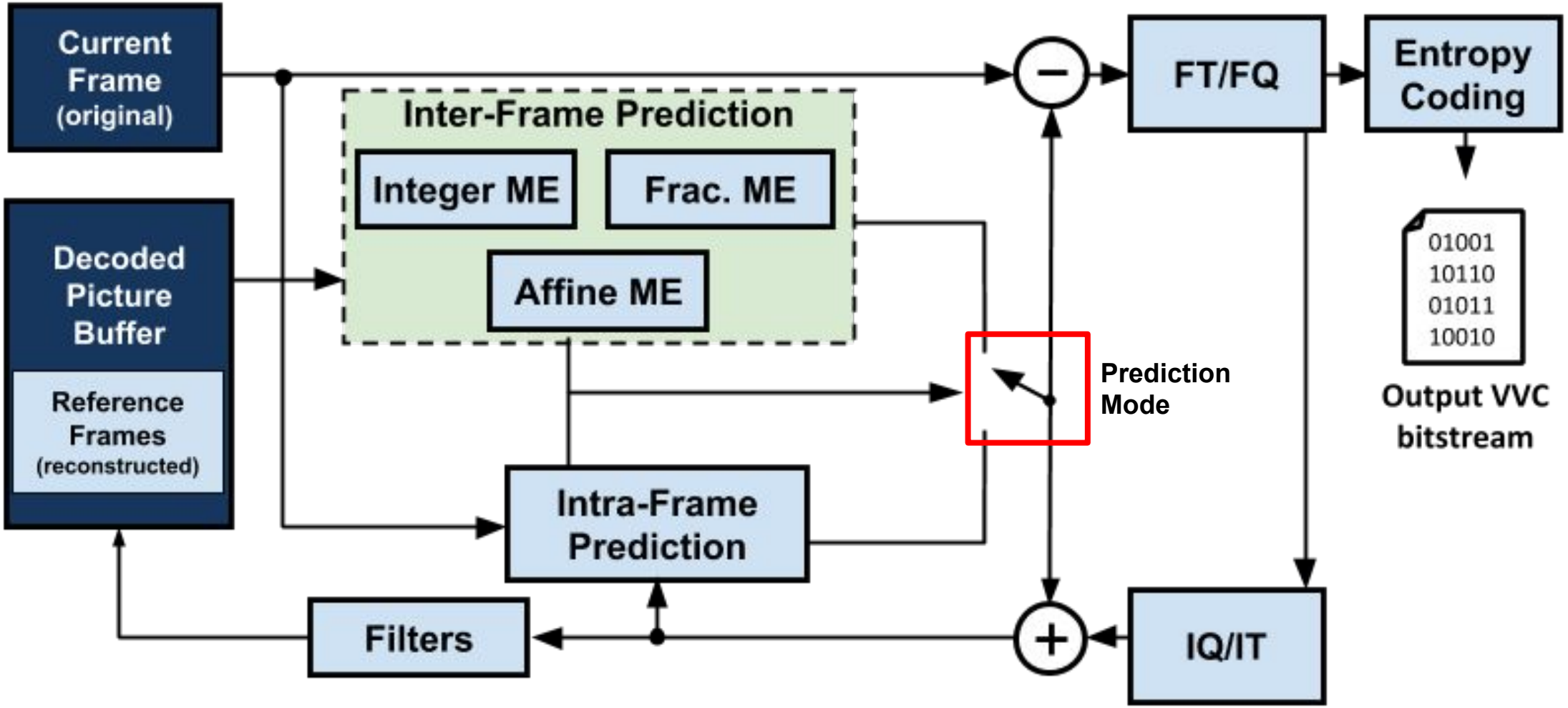
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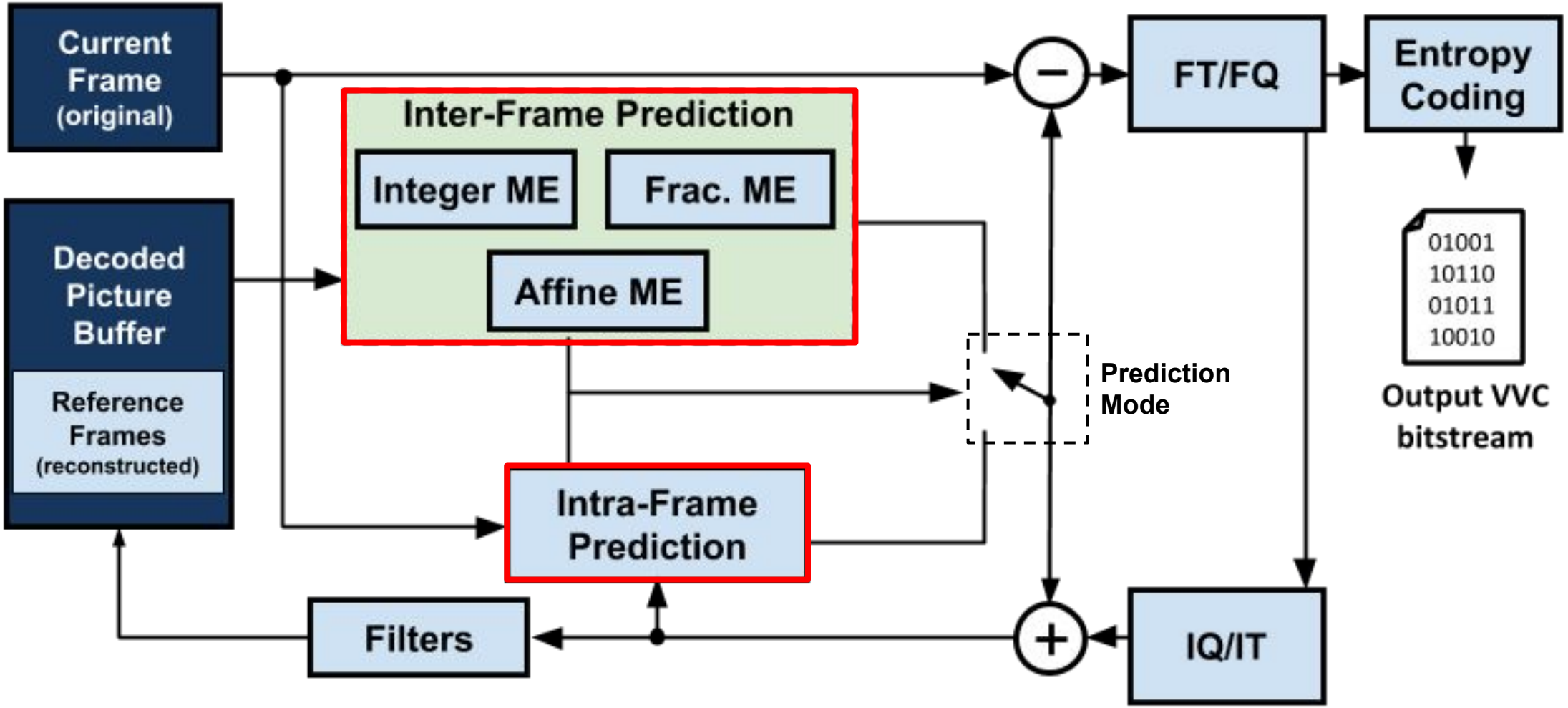
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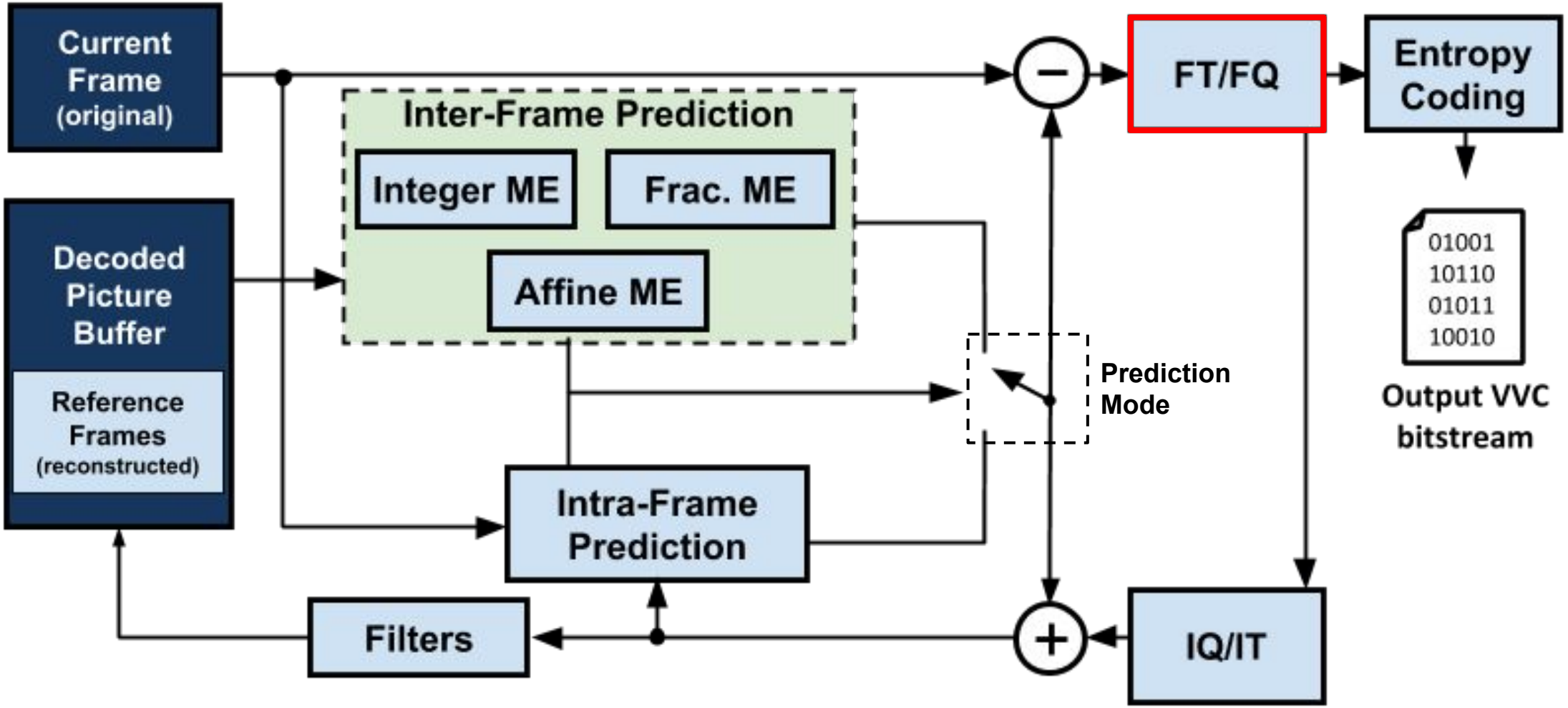
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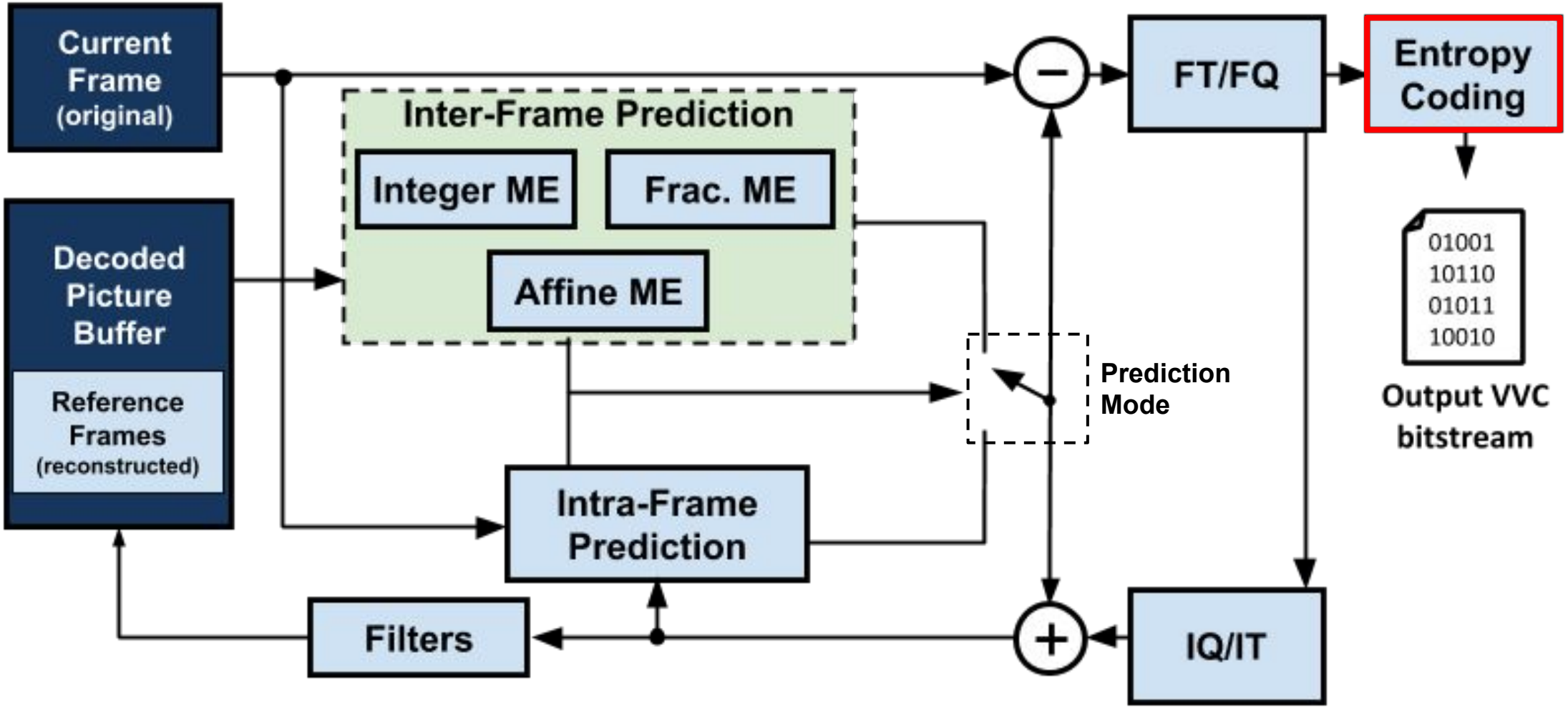
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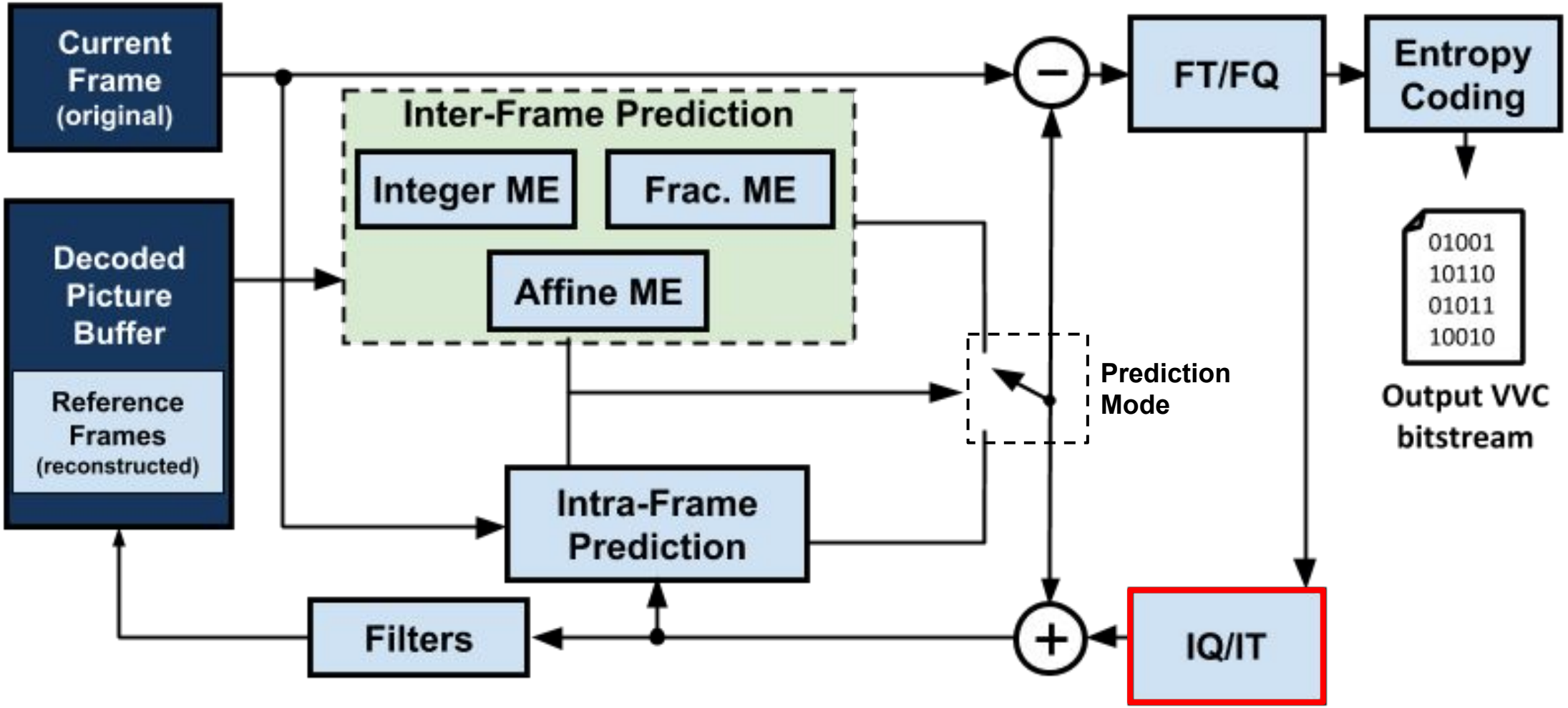
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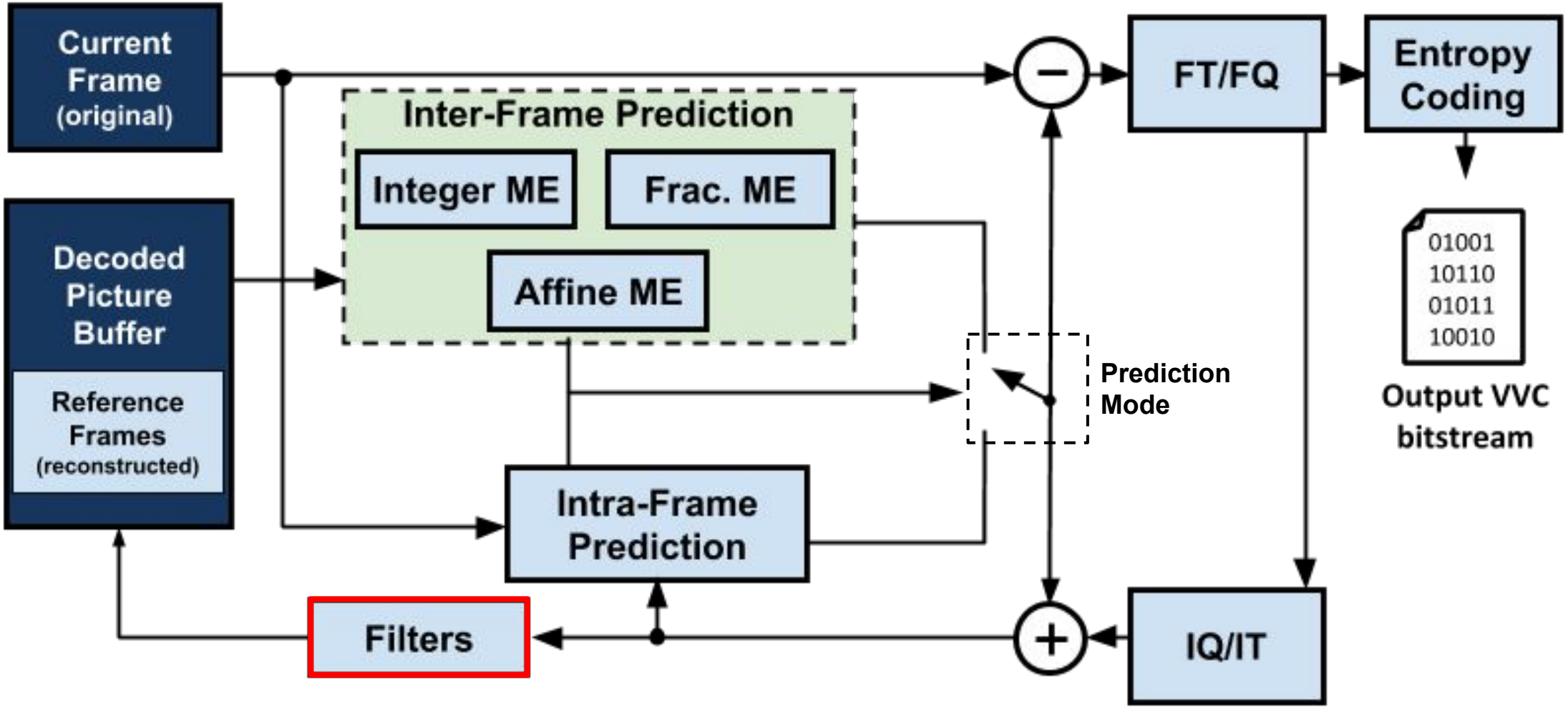
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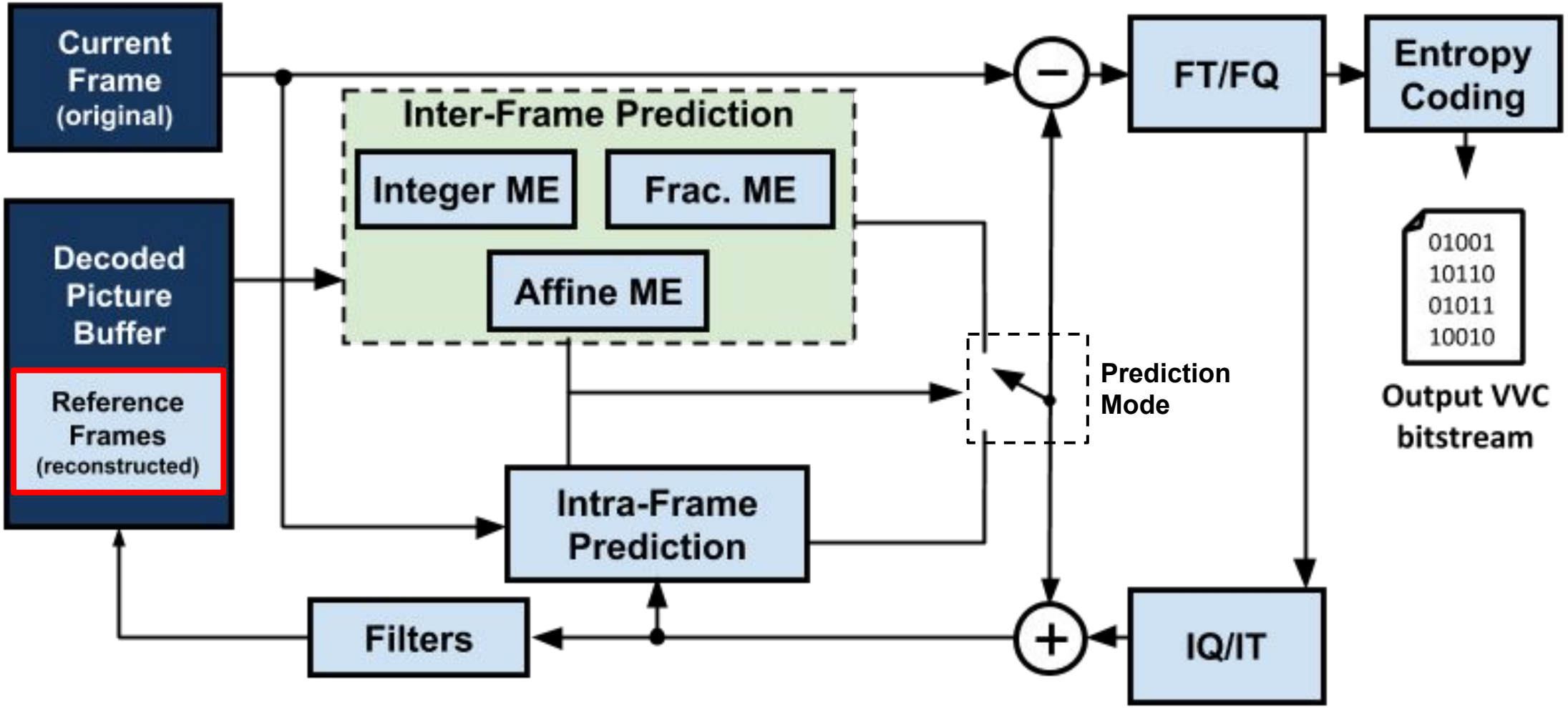
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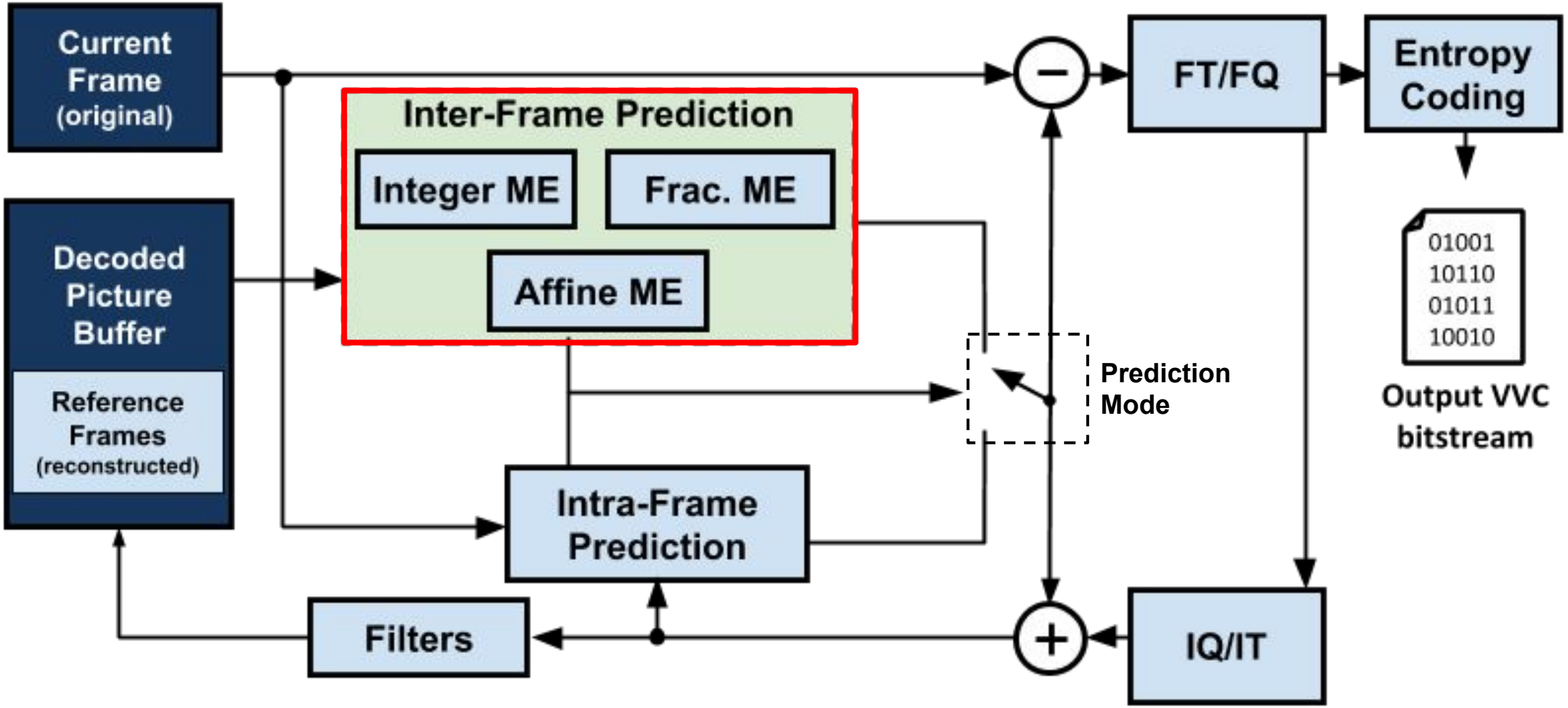
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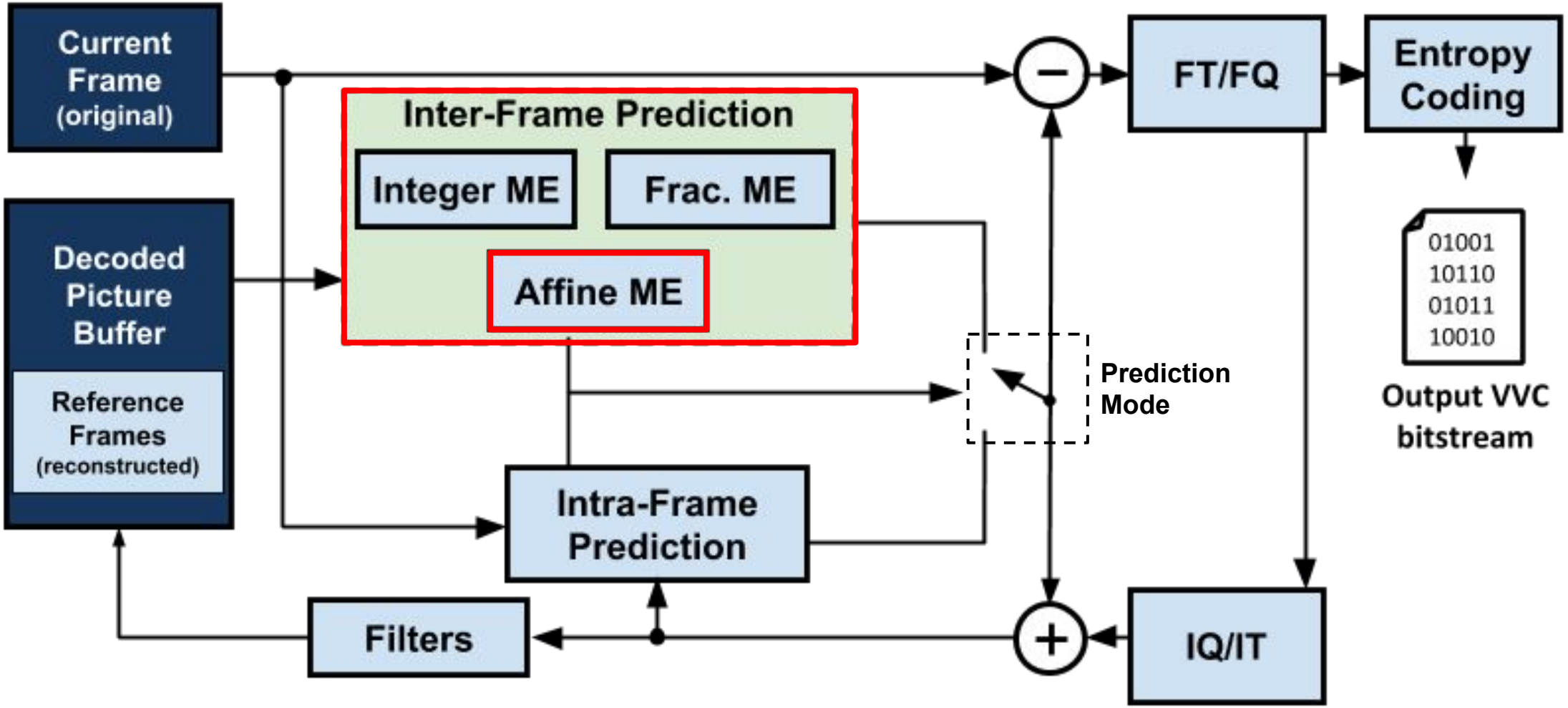
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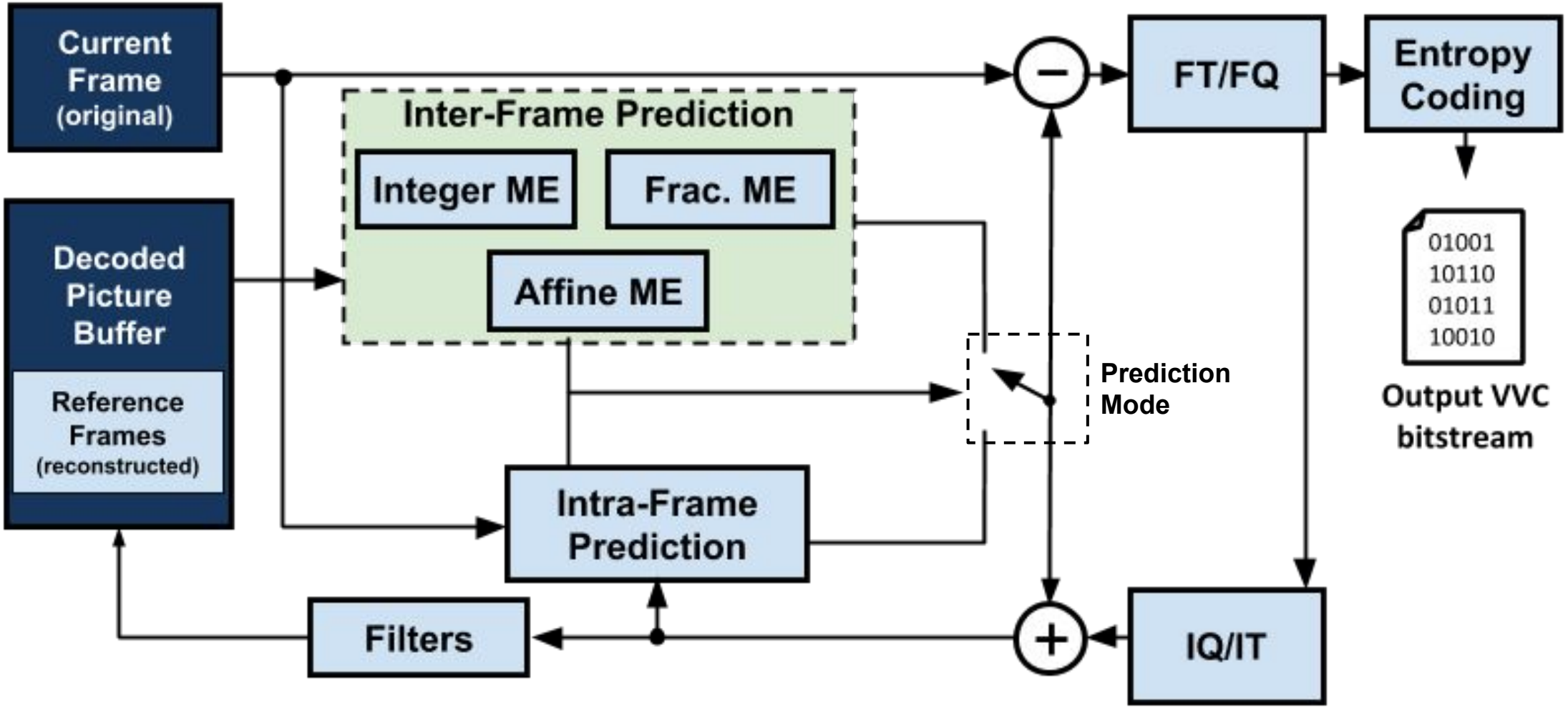
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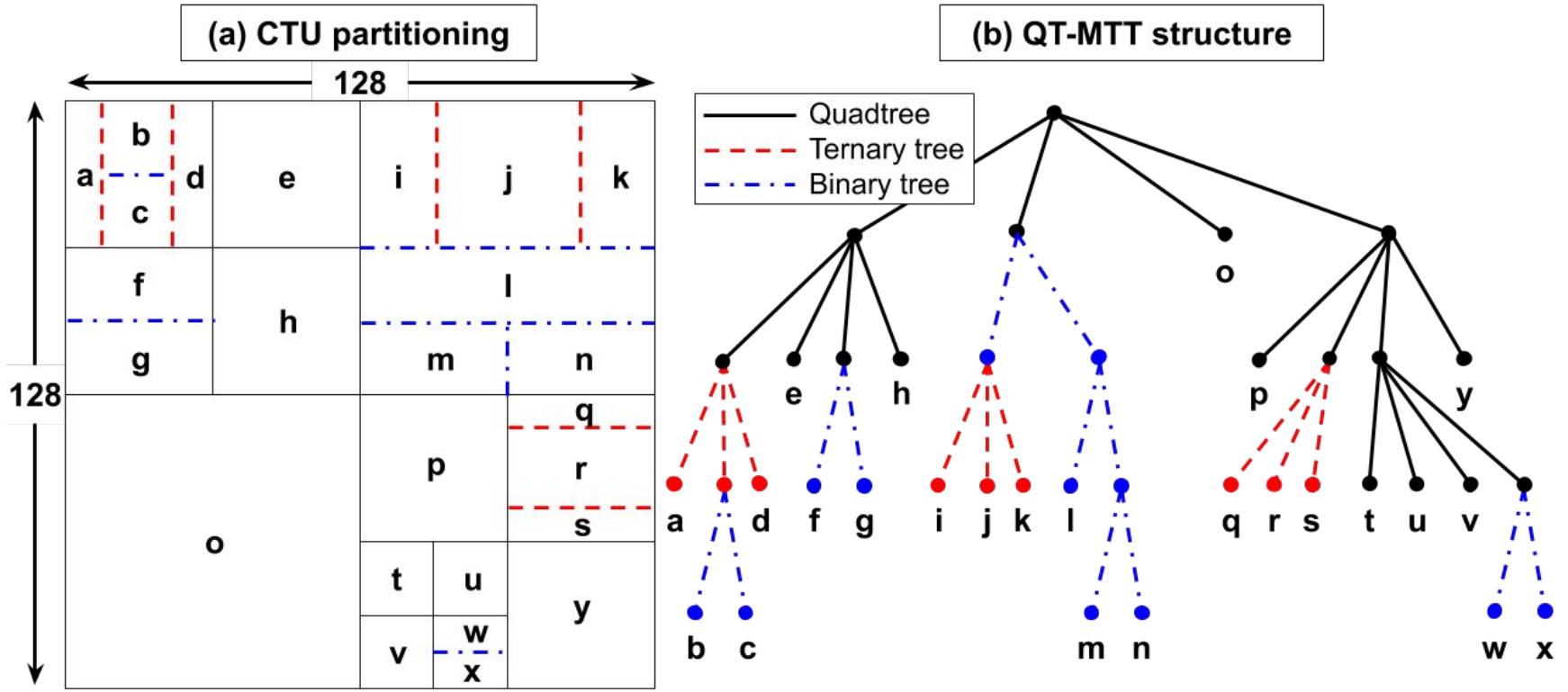
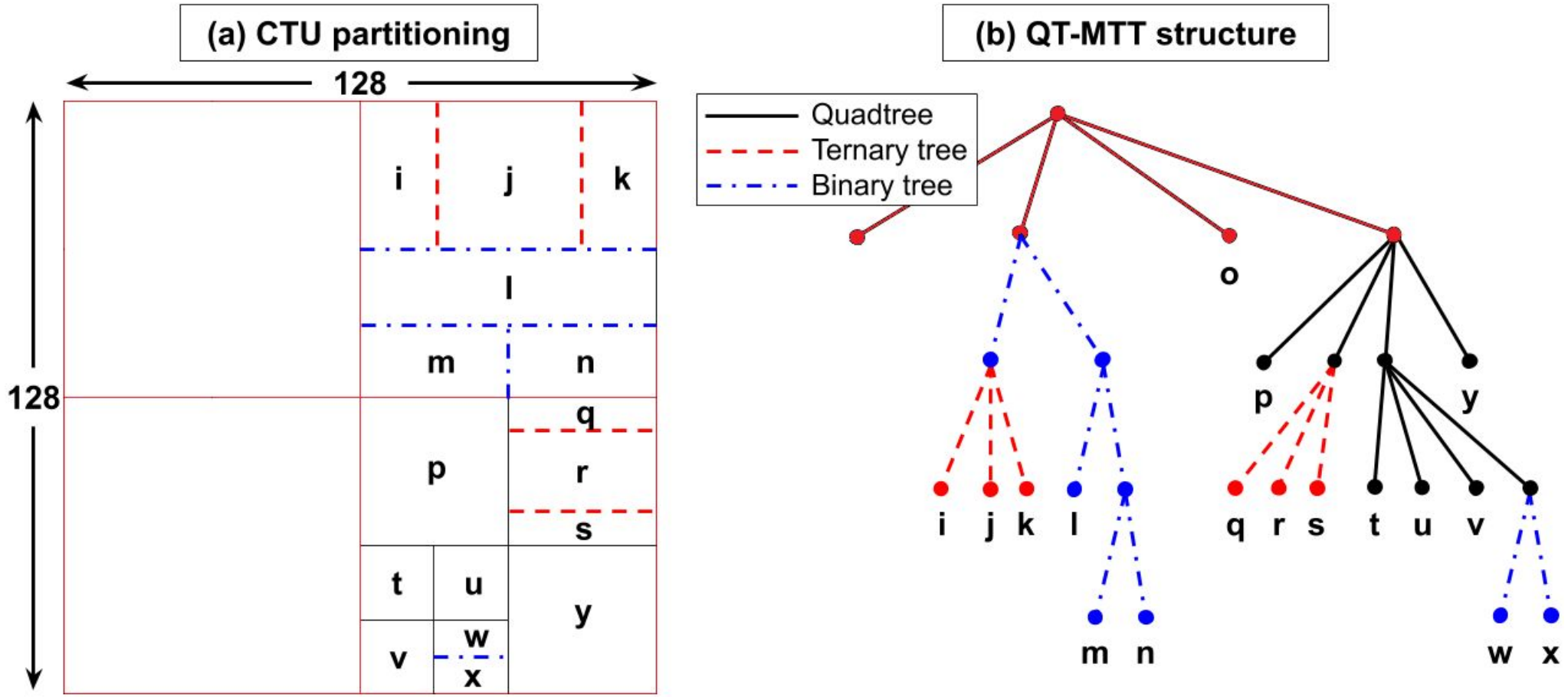
VVC Coding Structures

- Main innovations of VVC
- QT-MTT structure



VVC Coding Structures

- QT-MTT example



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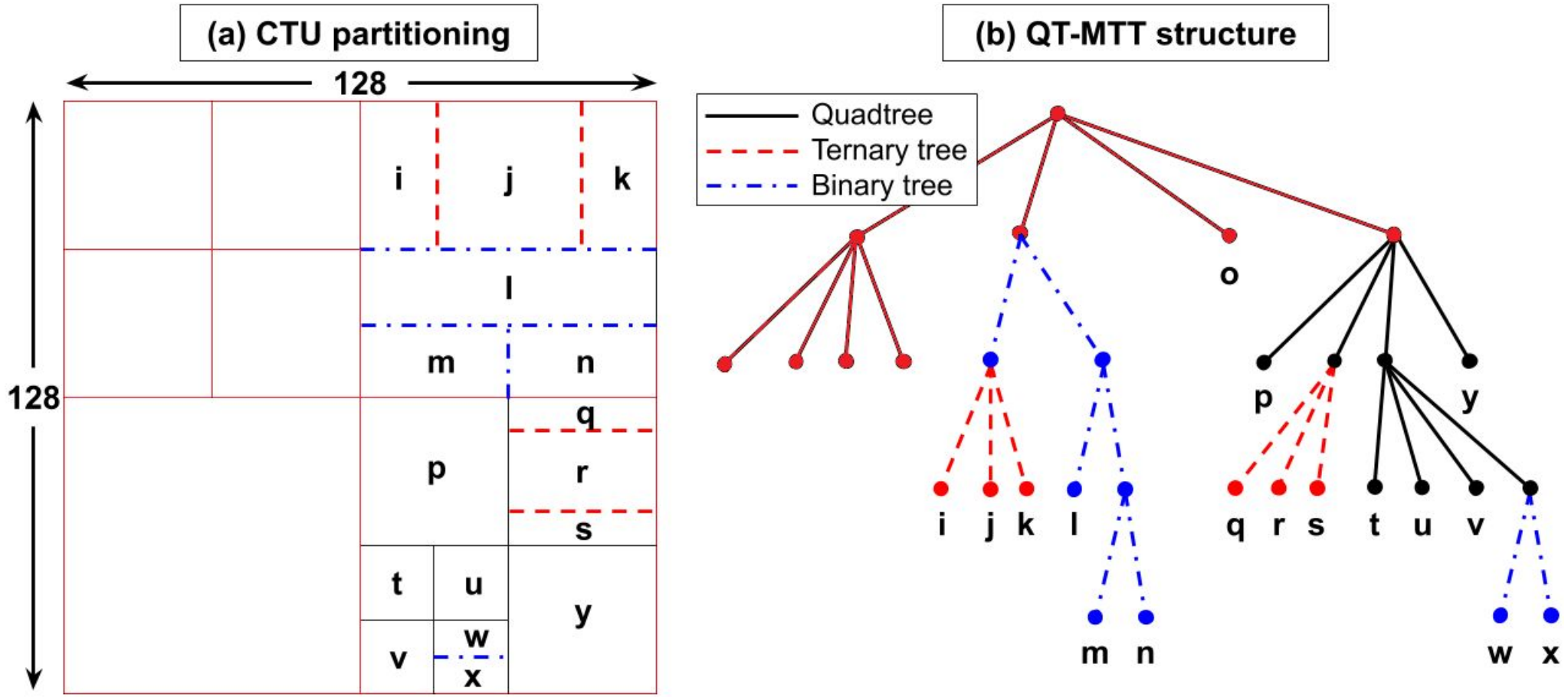

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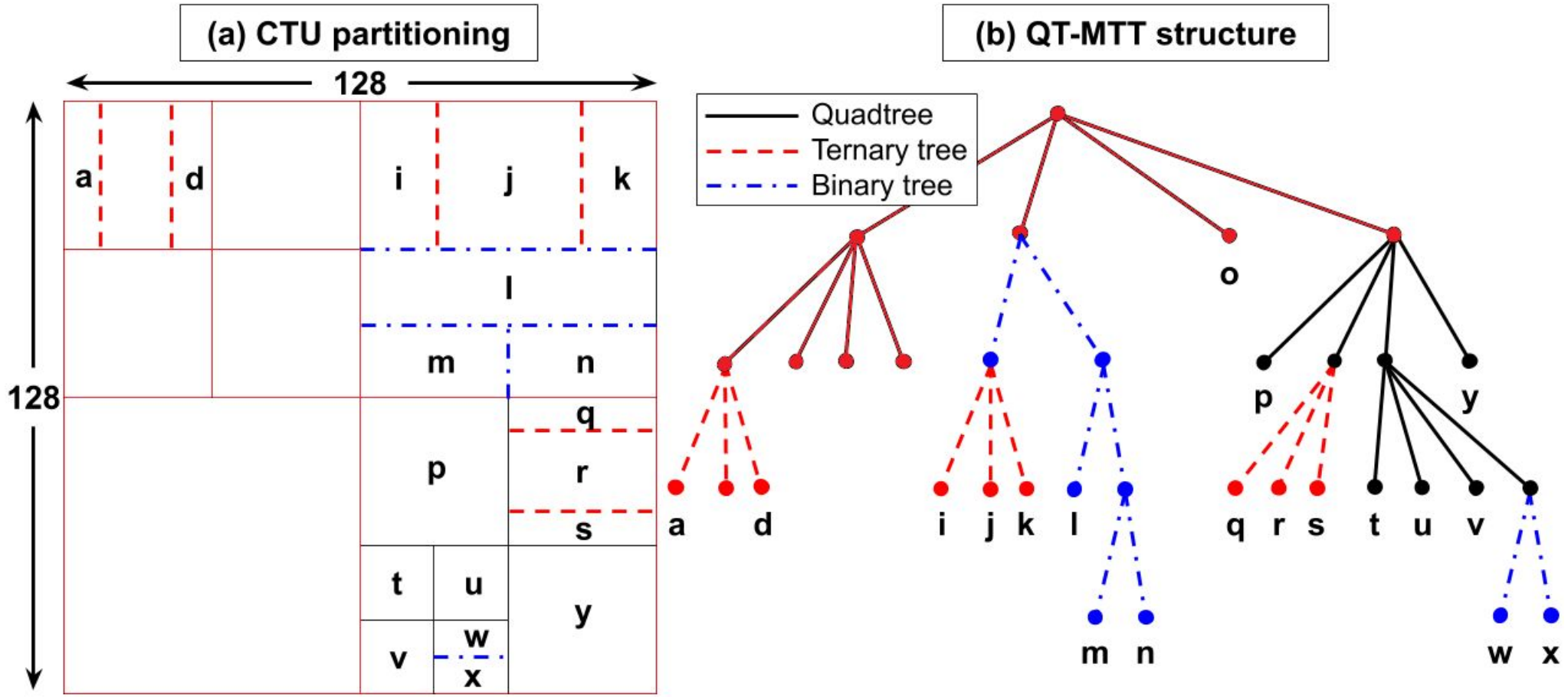

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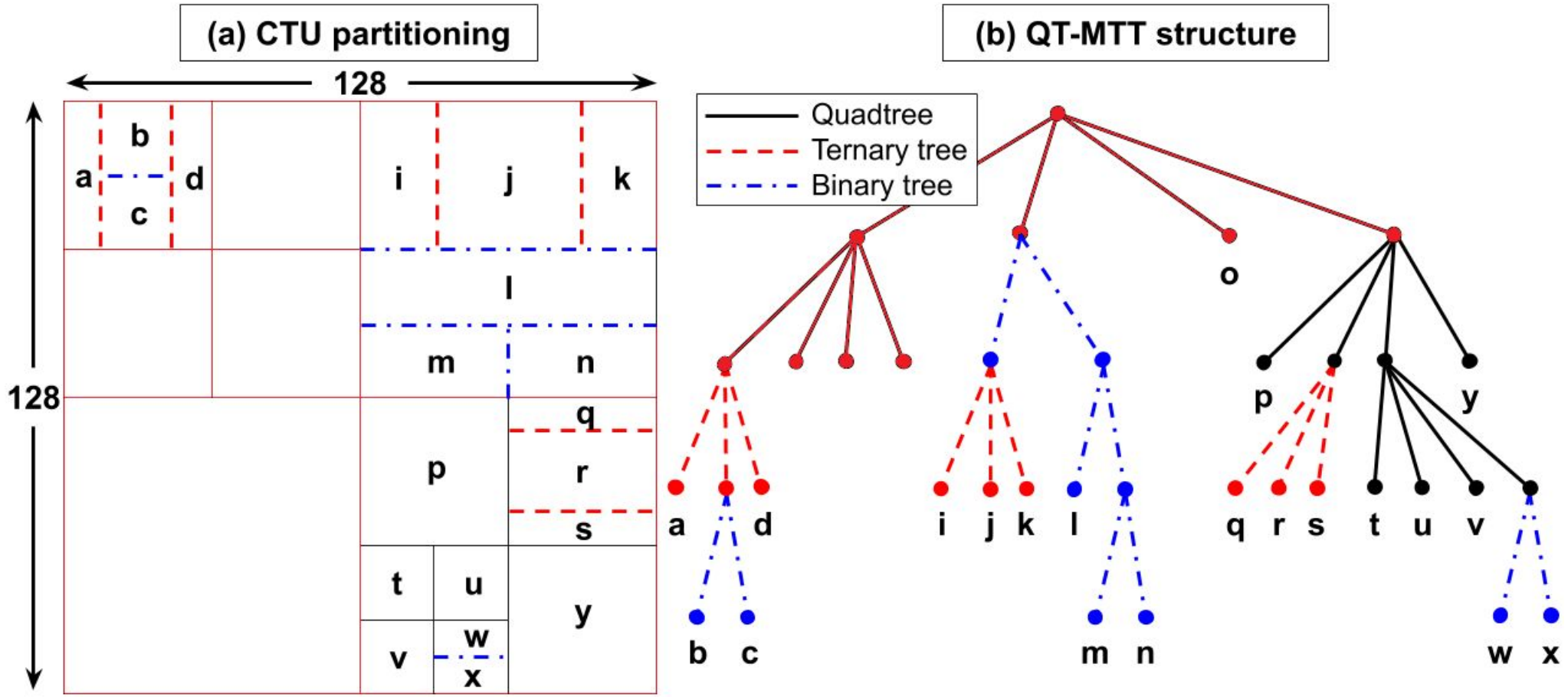
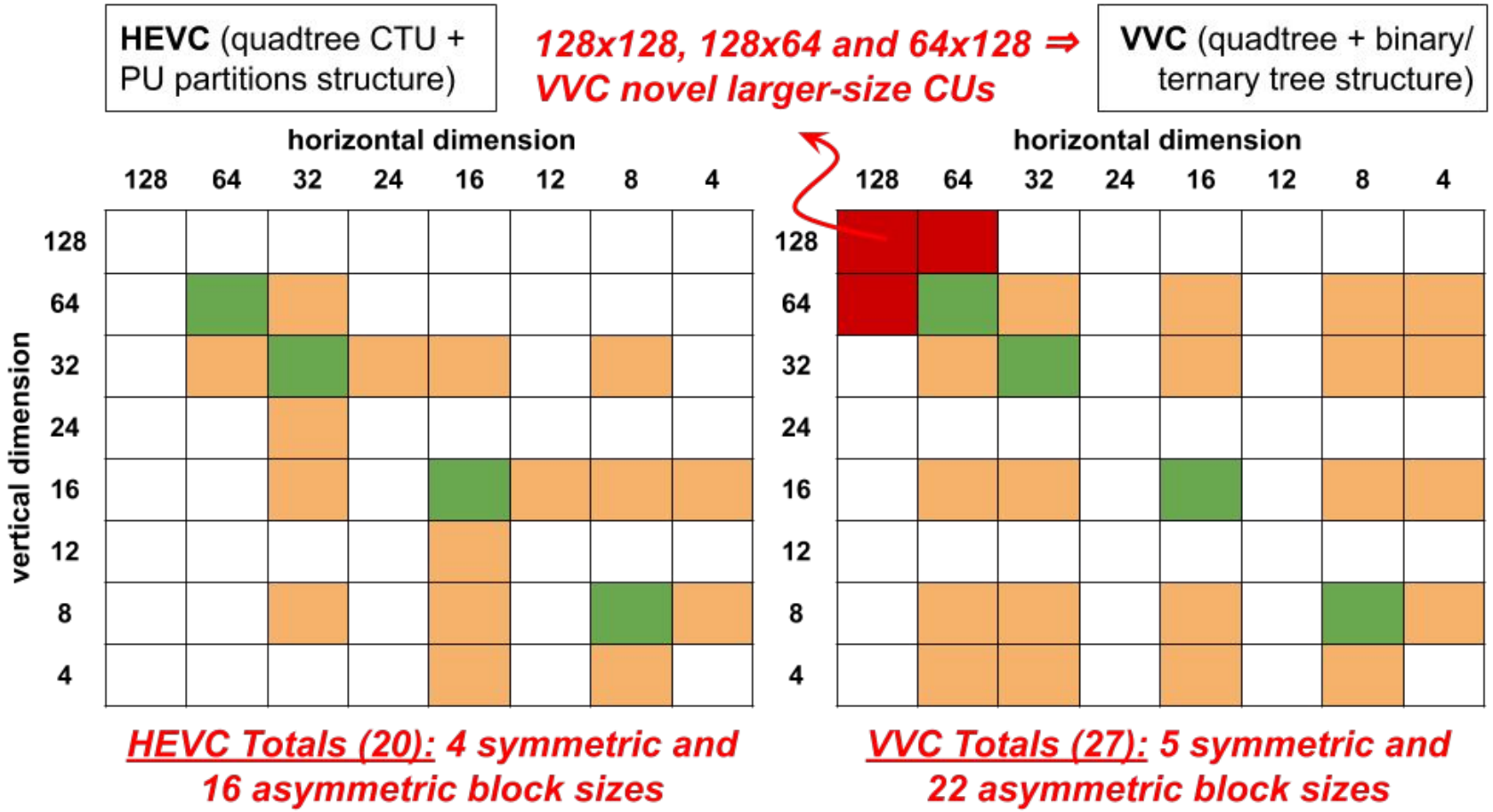


VVC Coding Structures

- VVC-novel block sizes



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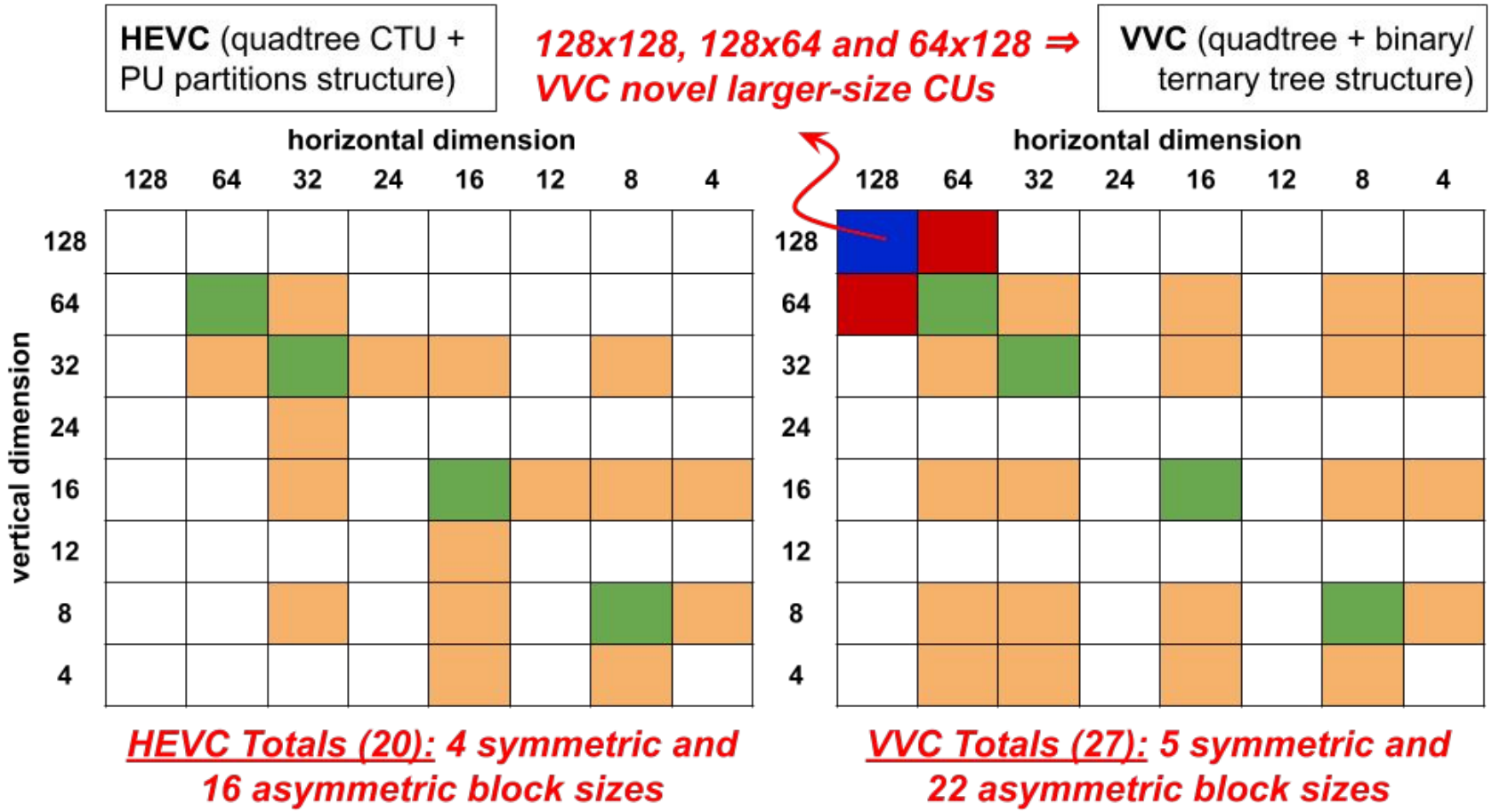

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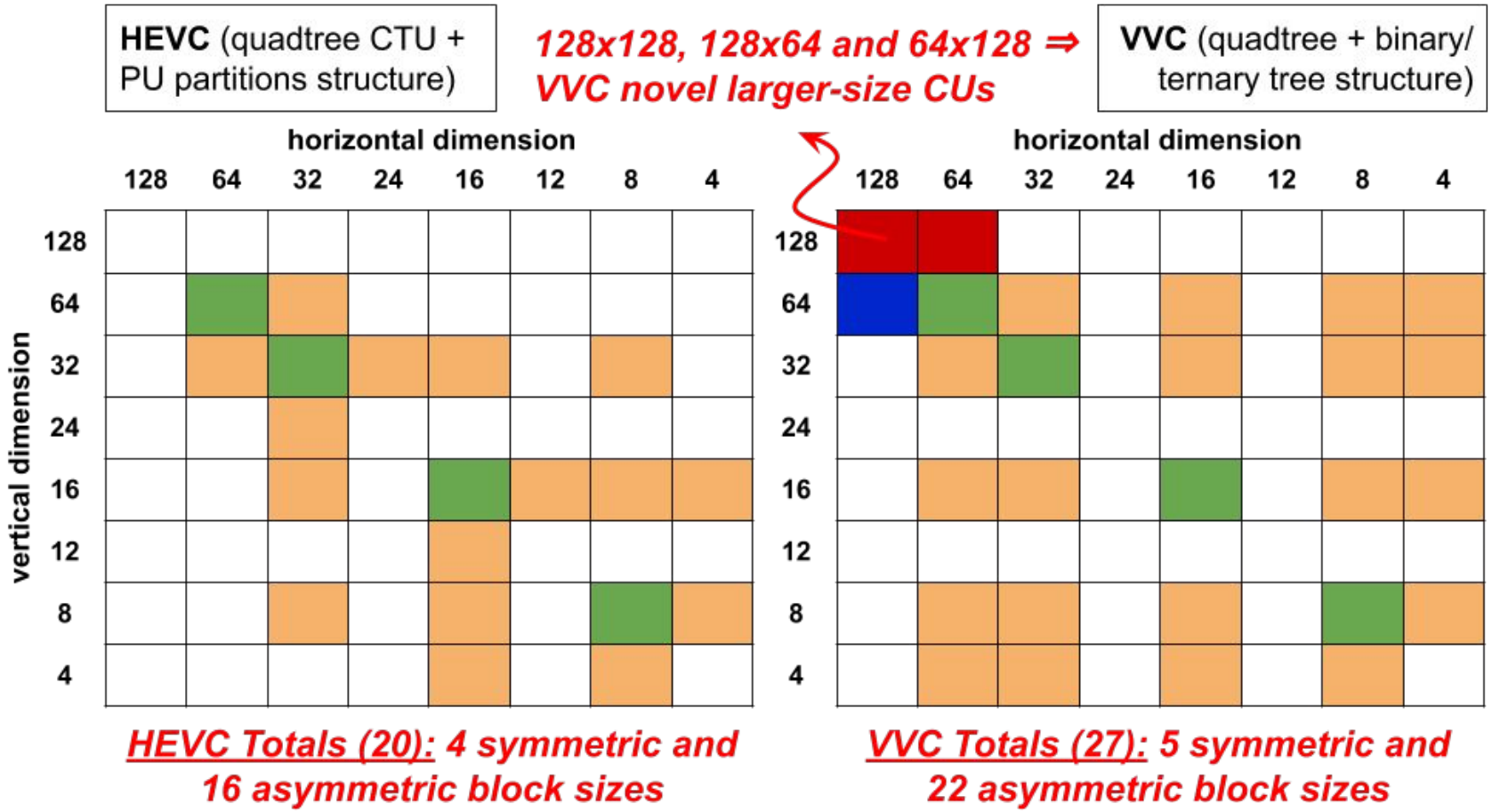

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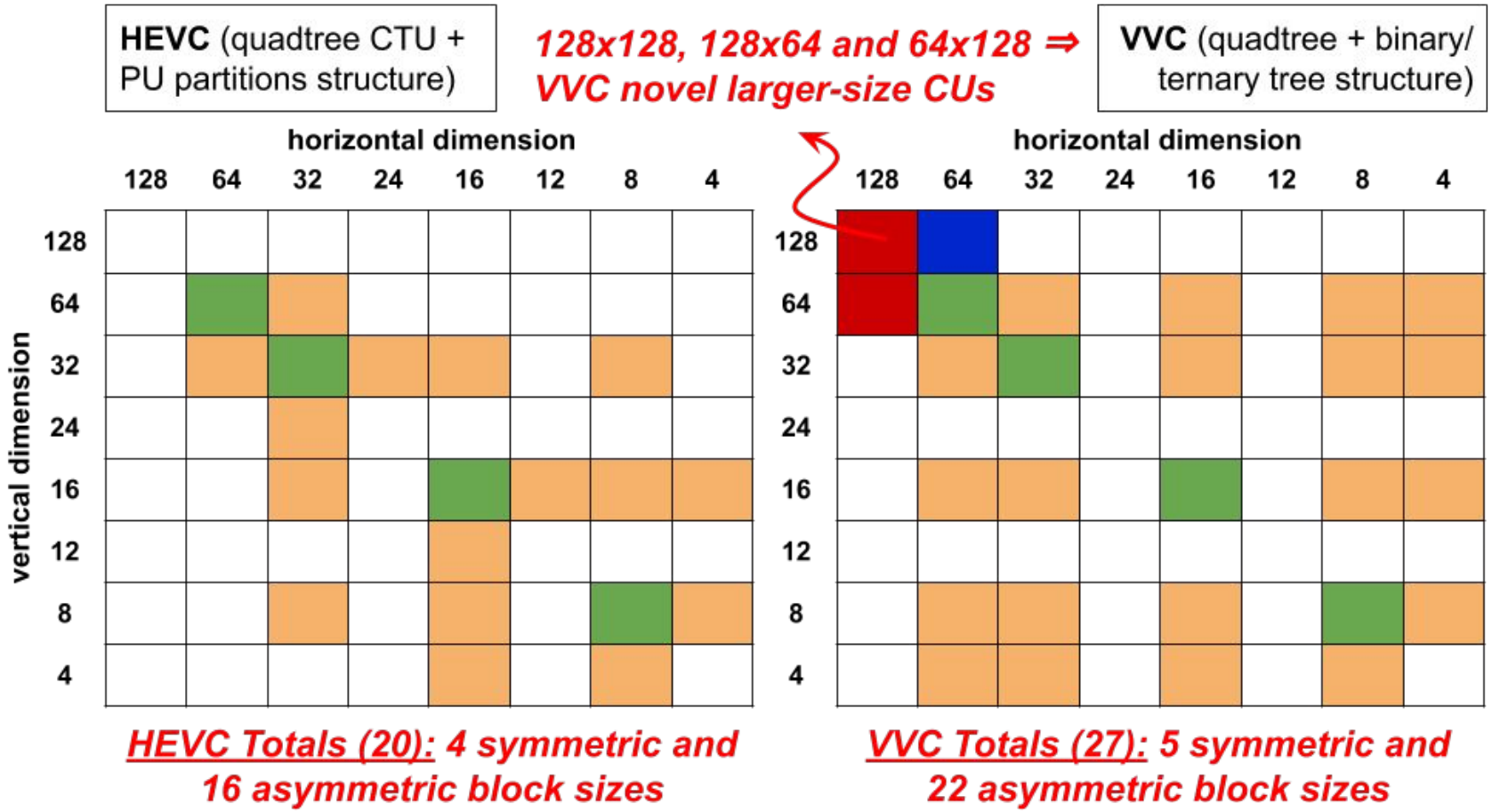
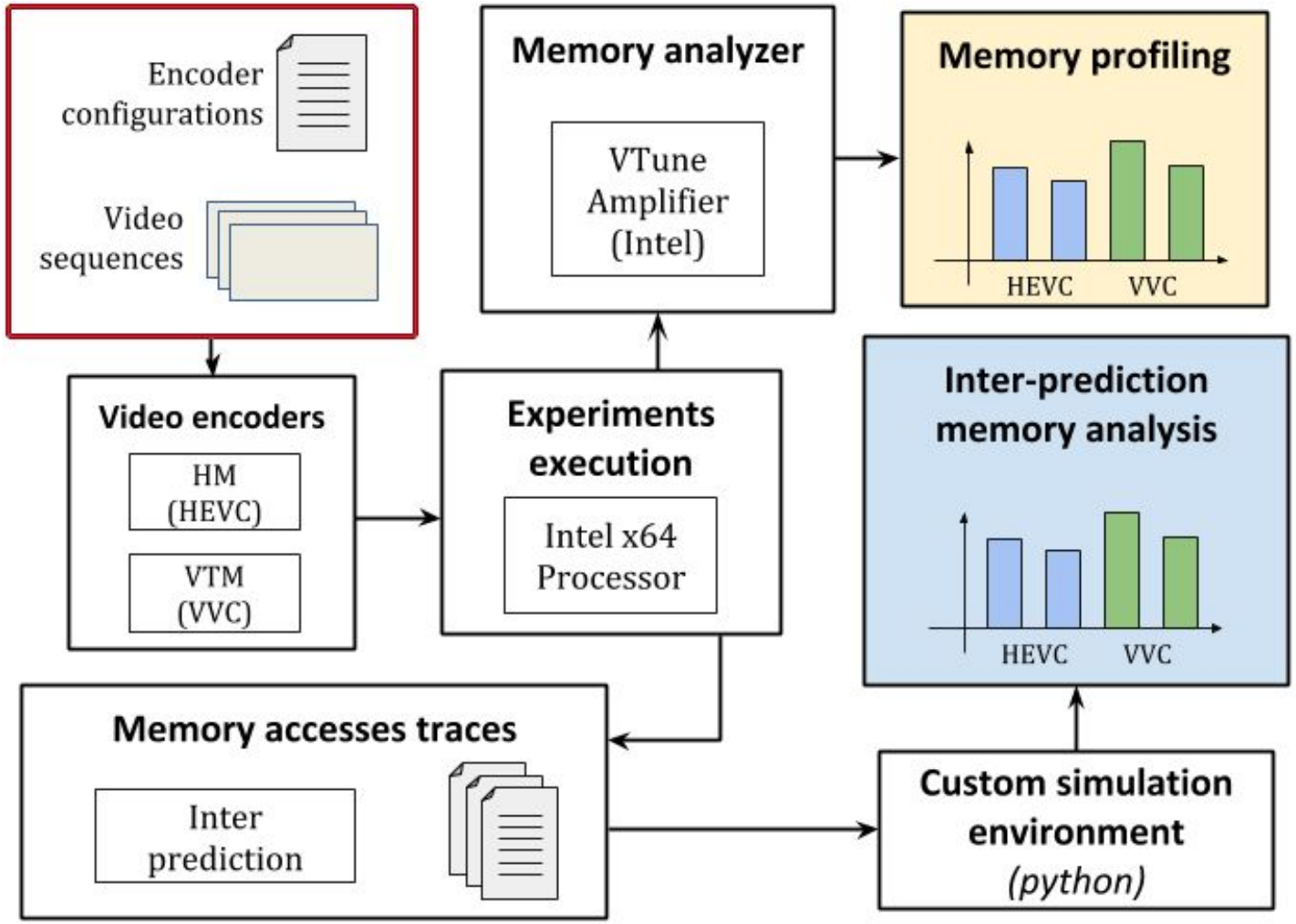


VVC Coding Structures

- VVC-novel block sizes
  - *The use of these large CU sizes enables better compression efficiency;*
  - *However, they also increases the encoder computational complexity.*

Experimental Setup



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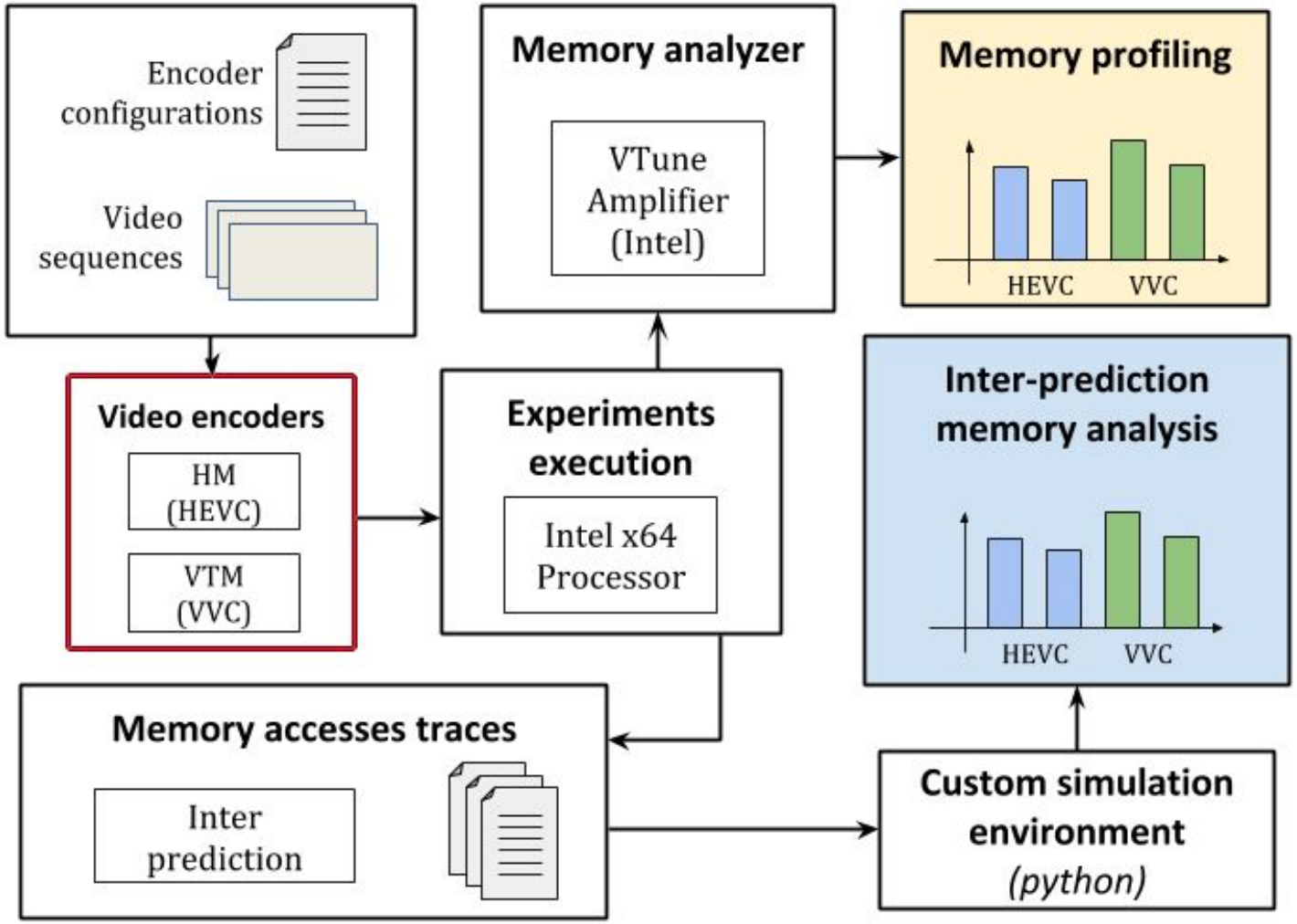

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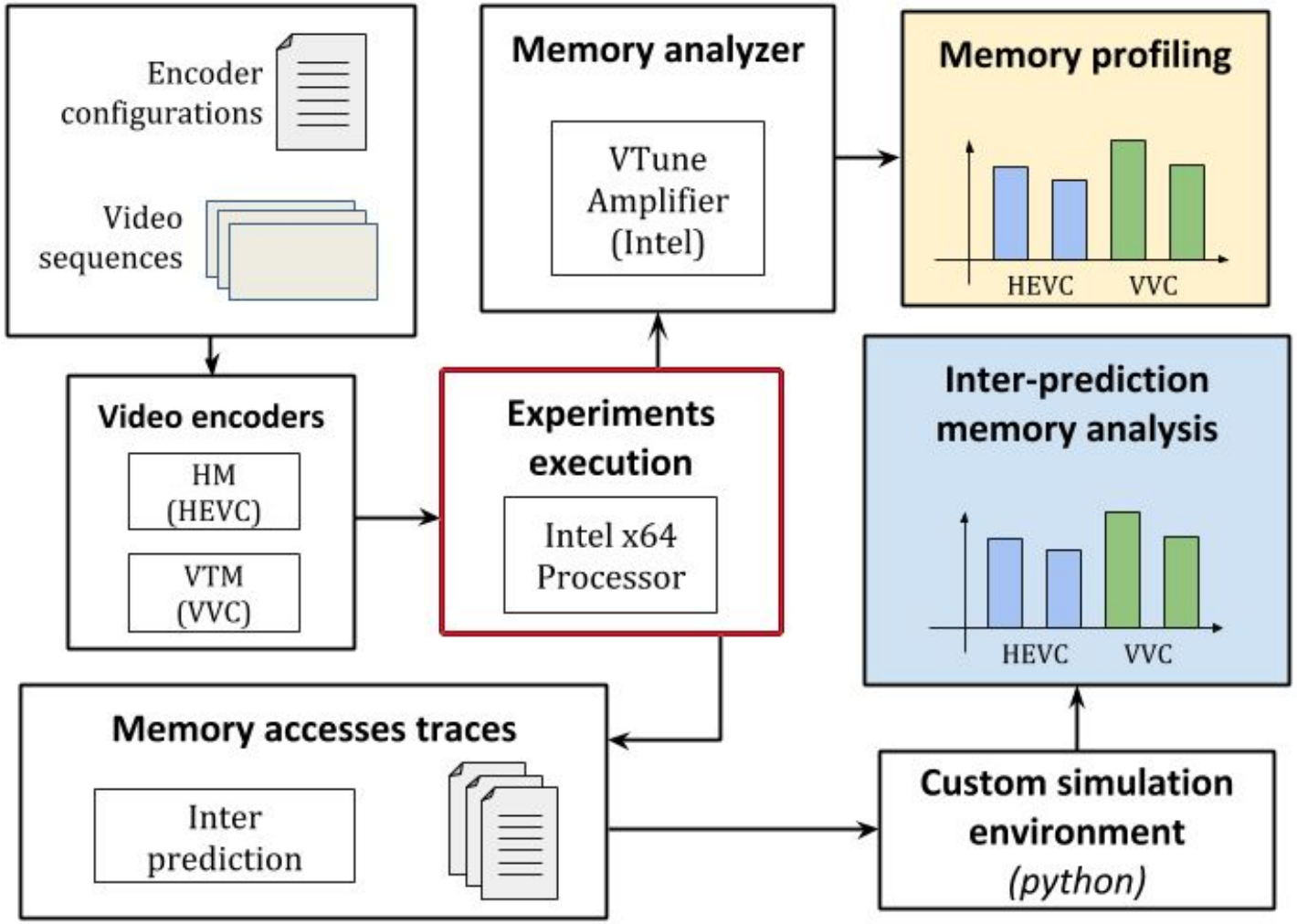

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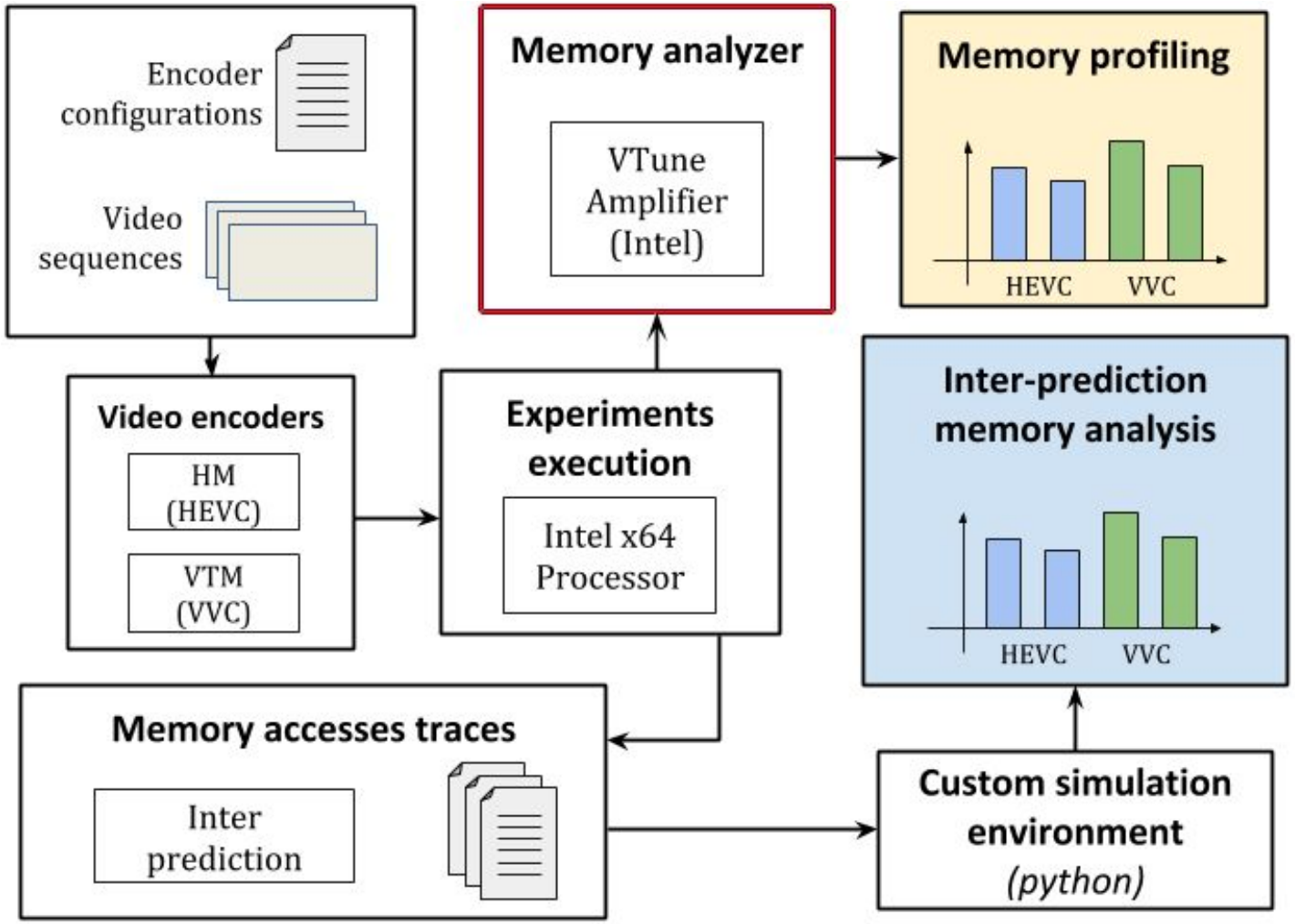

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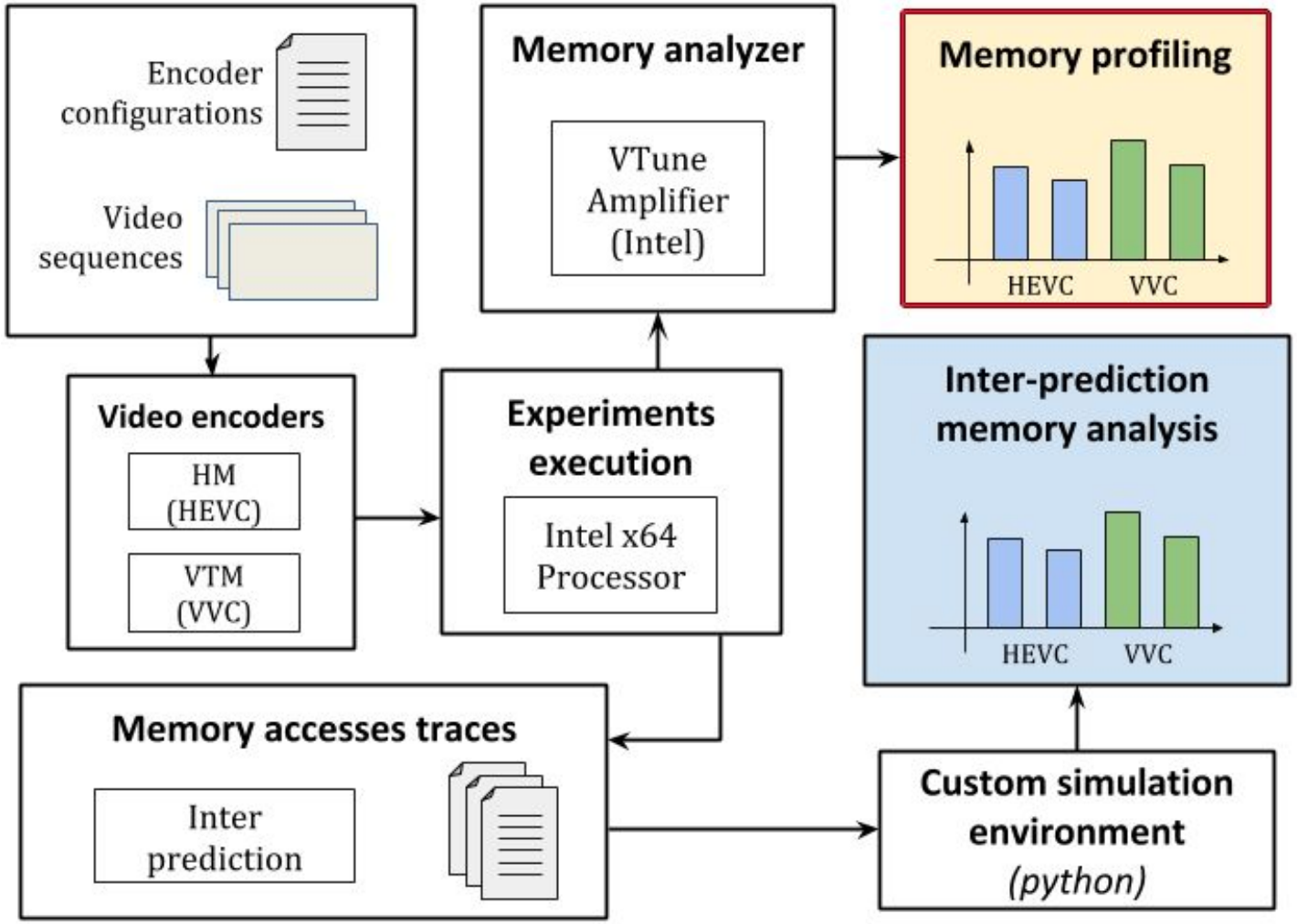

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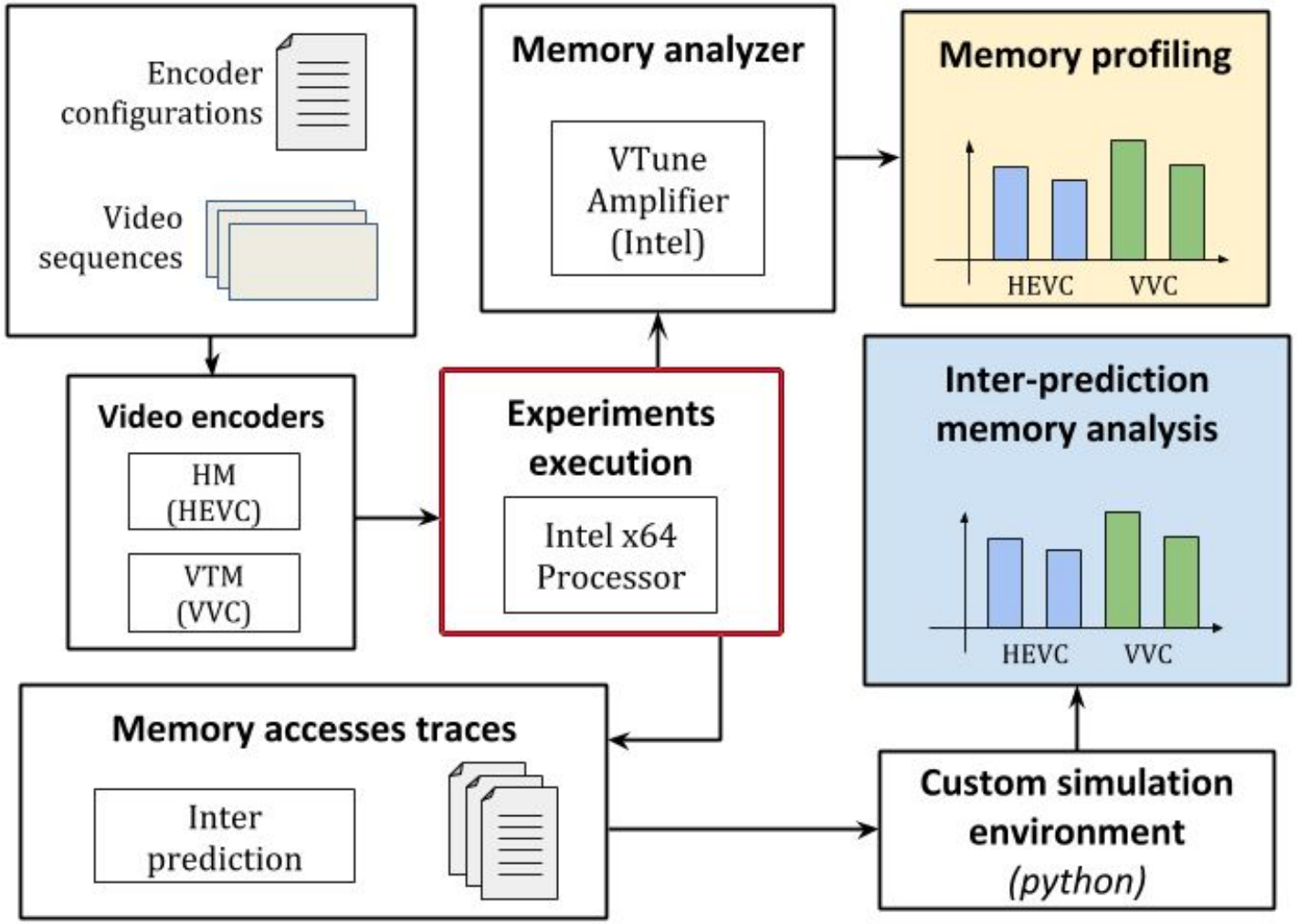

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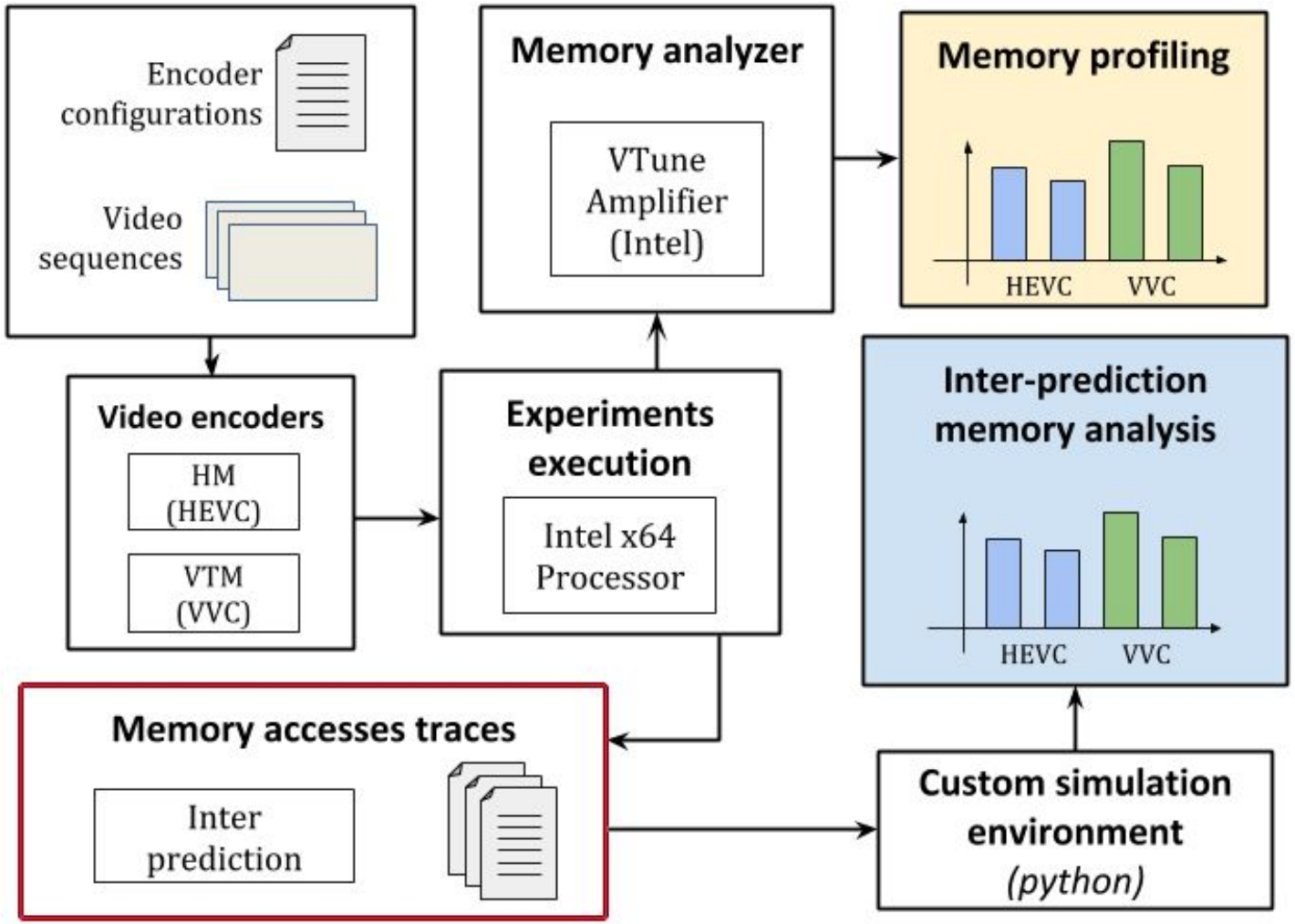

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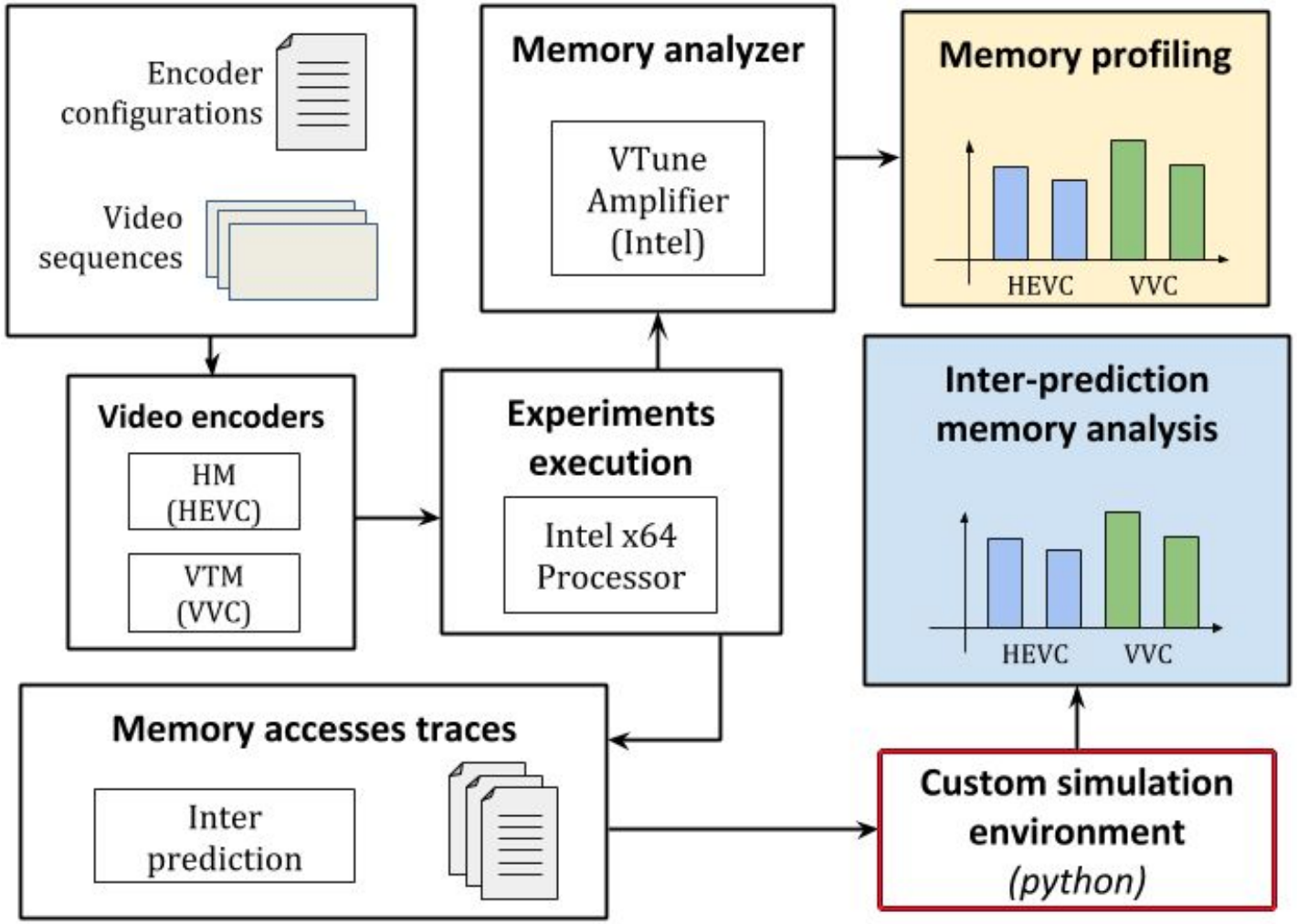

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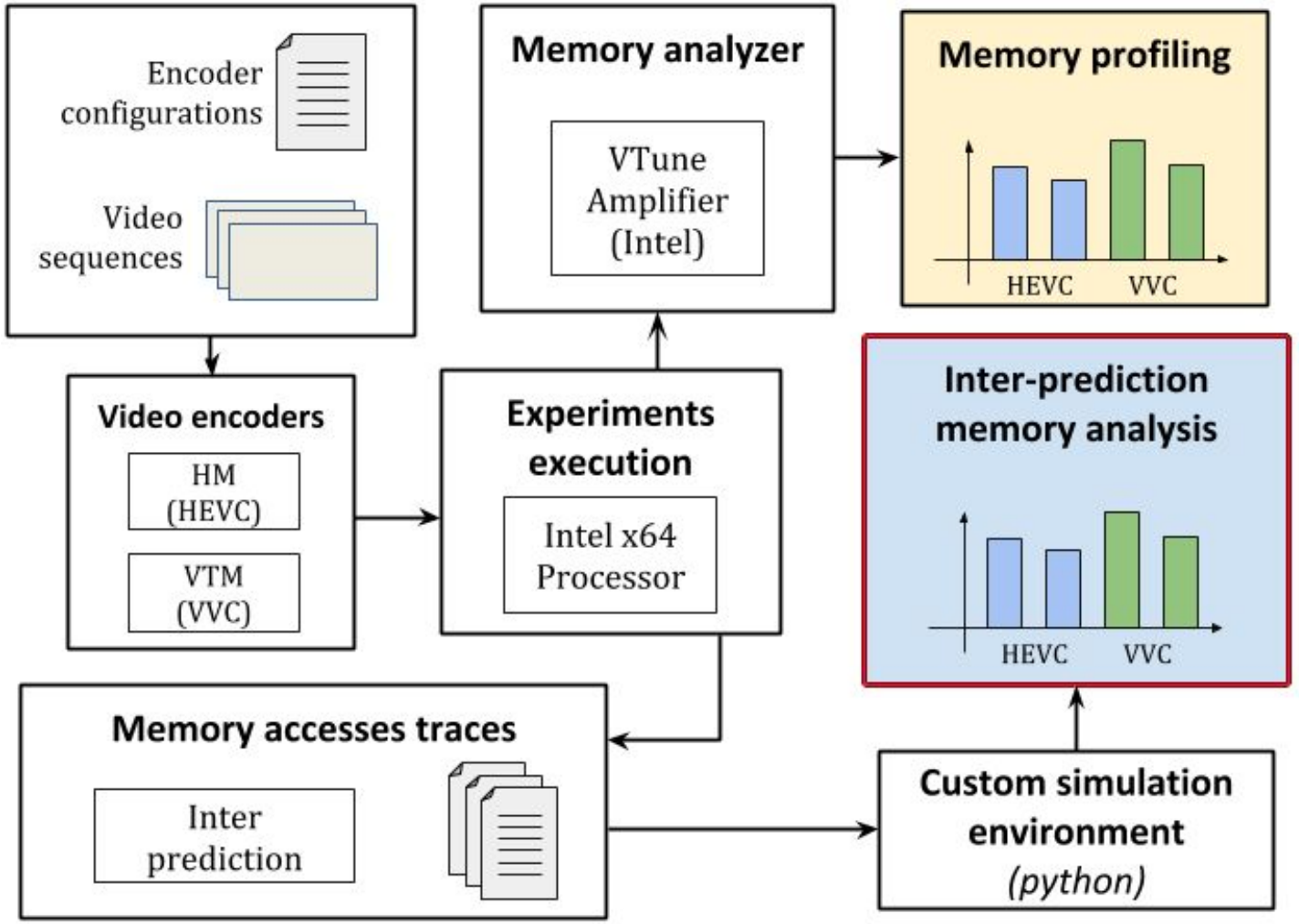

Memory Profiling

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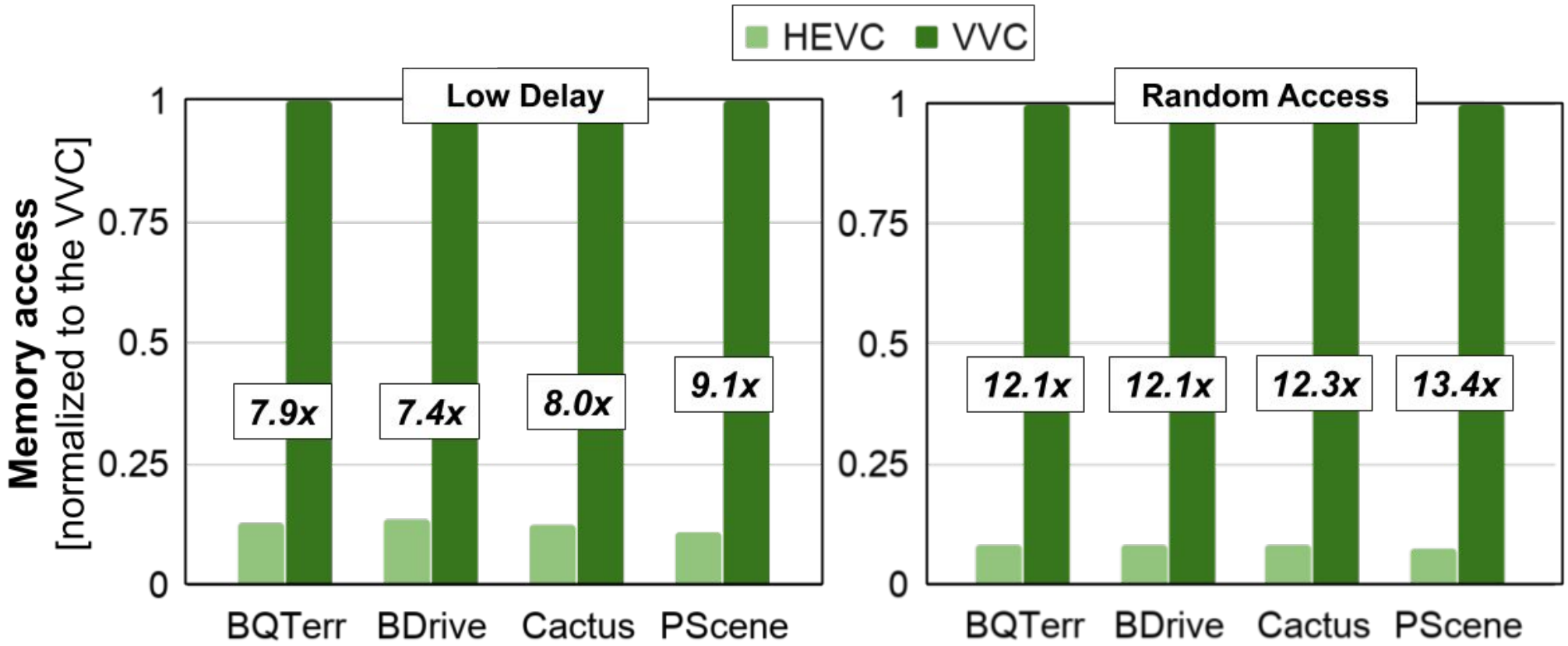

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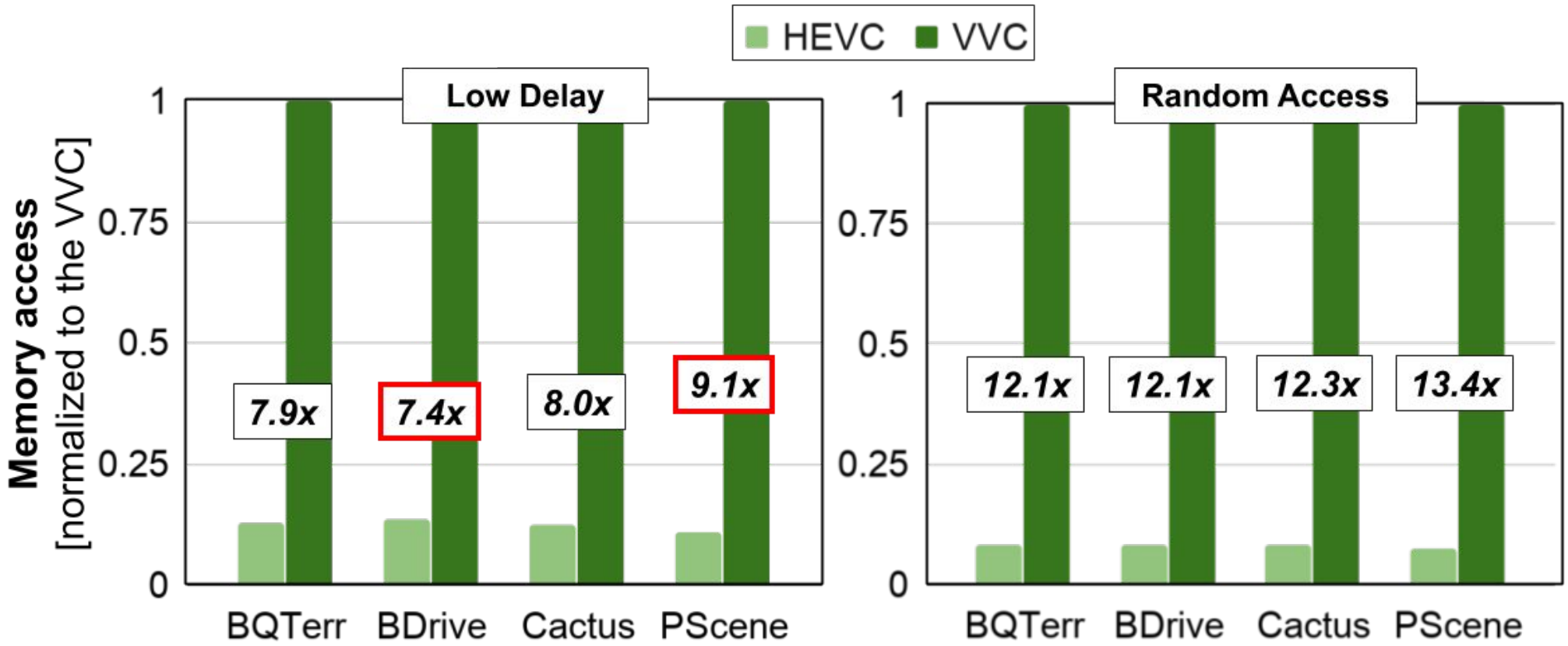

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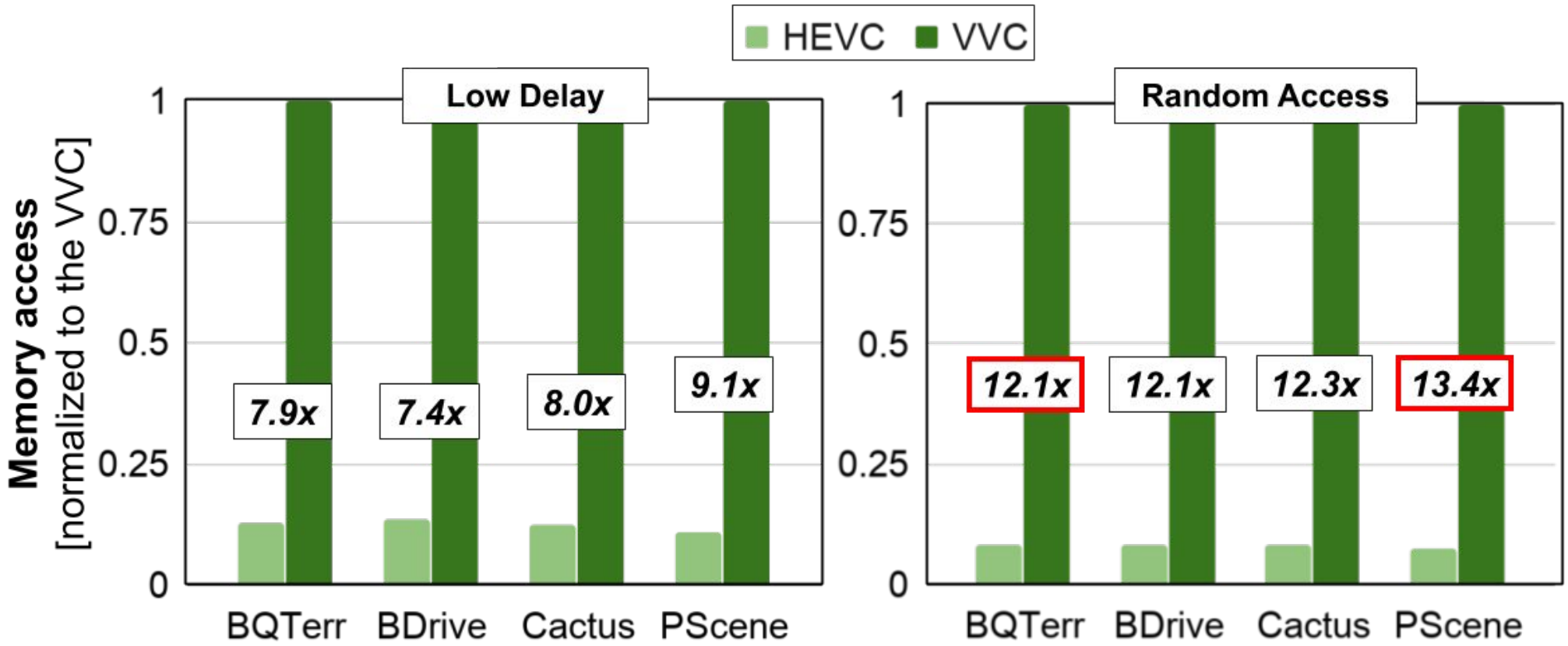

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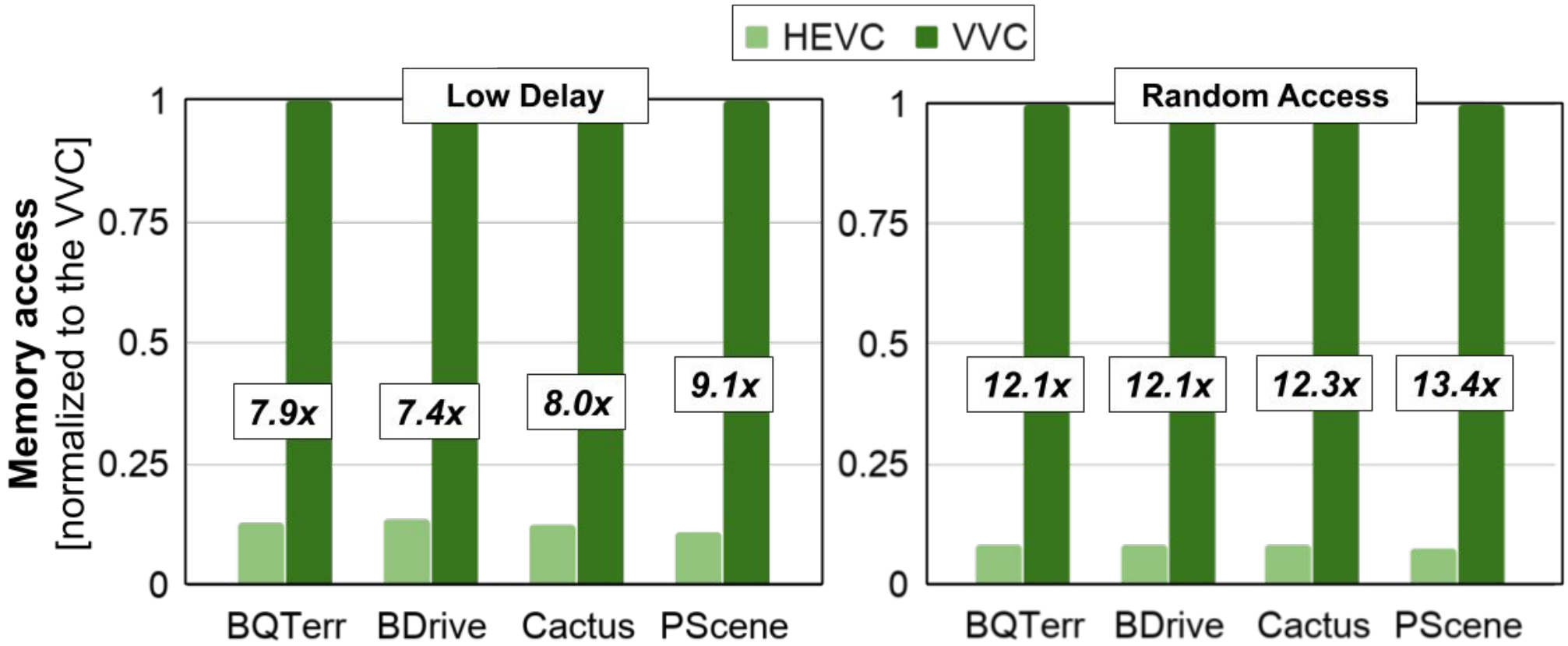
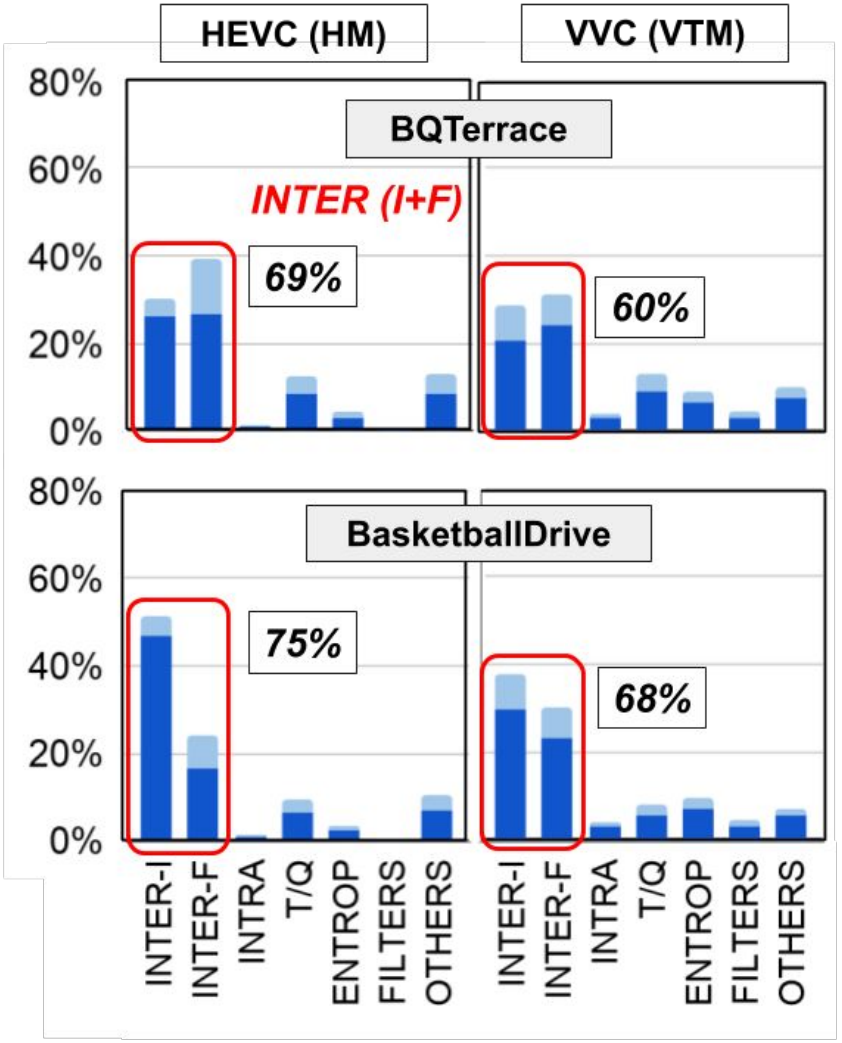


Memory Profiling

- Insights from Analysis-1
  - *The memory access increase of VTM shows the importance of evaluations in memory-related topics of VVC.*

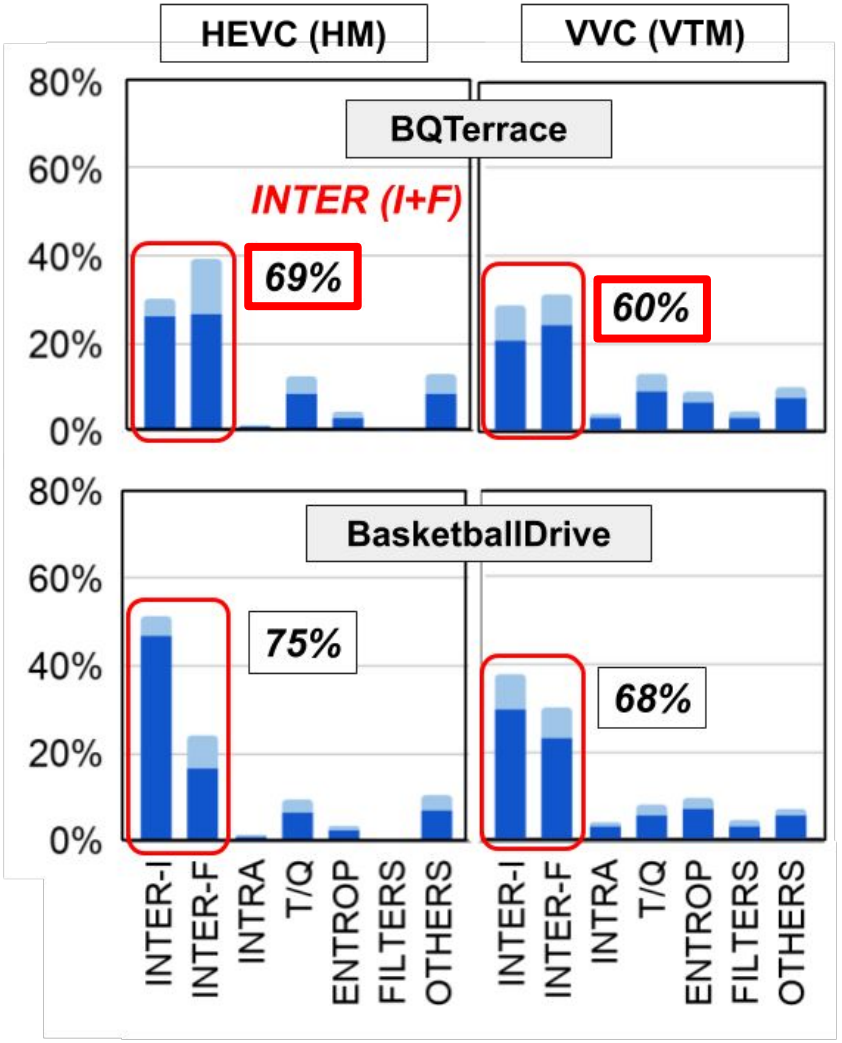
Memory Profiling

- Analysis-2



Memory Profiling

- Analysis-2



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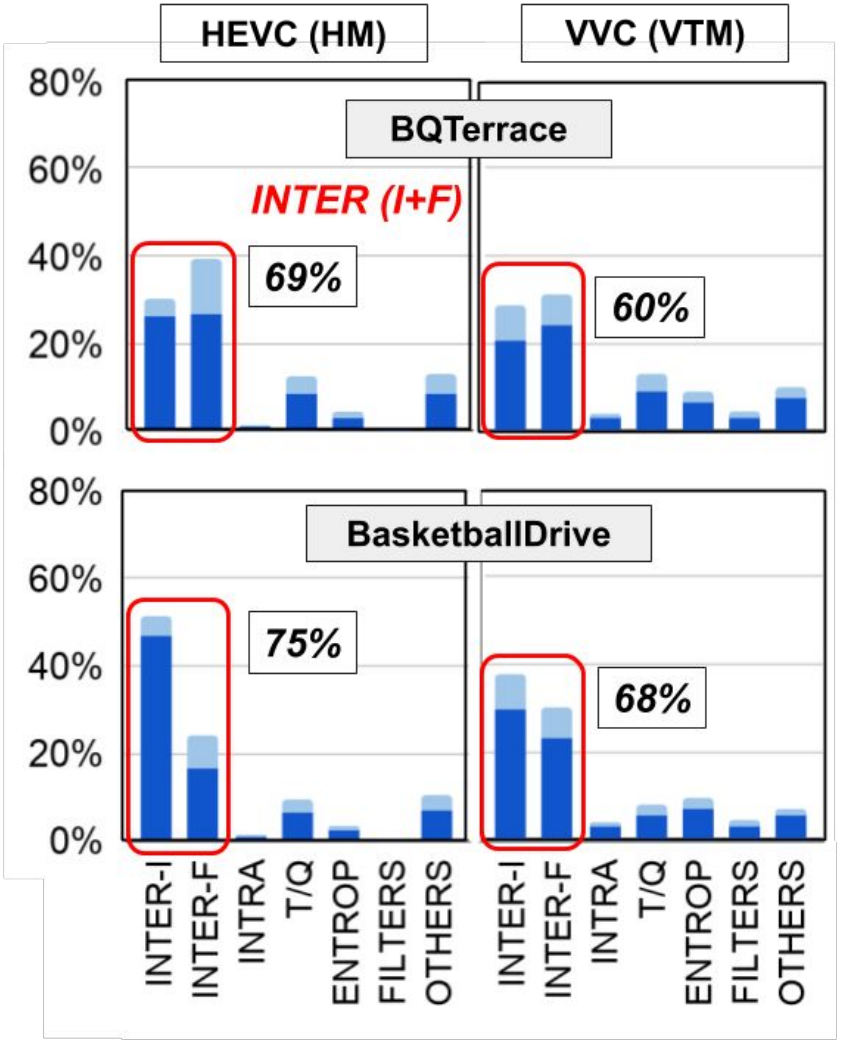

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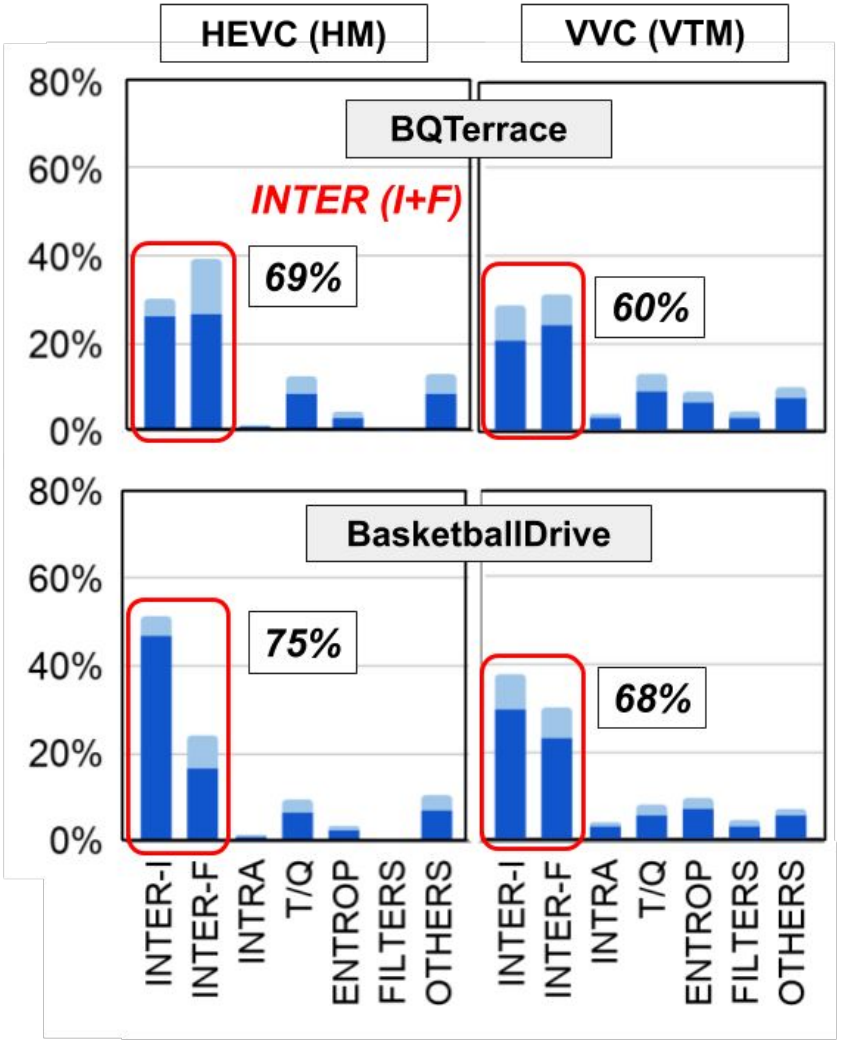
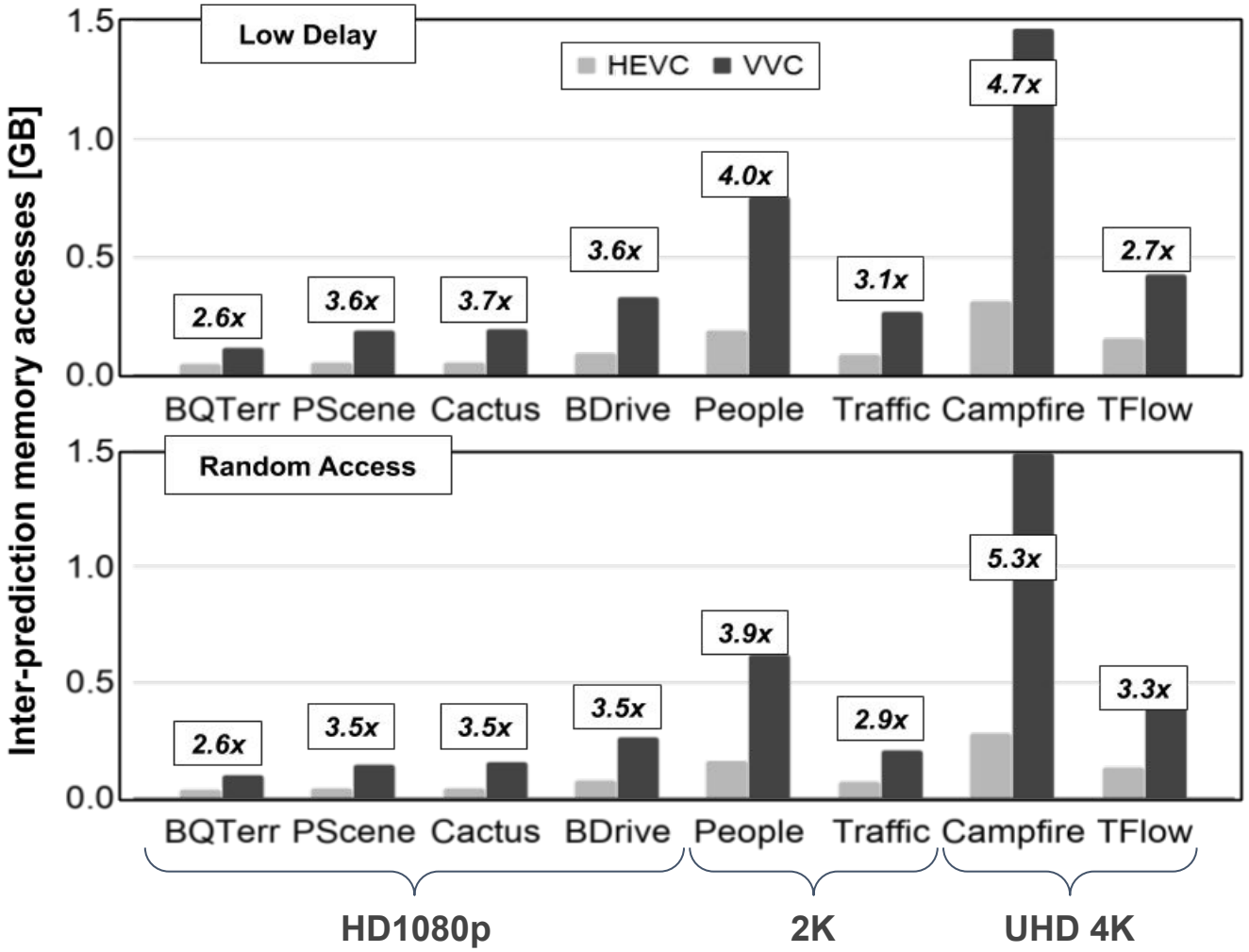


Memory Profiling

- Insights from Analysis-2
  - *Inter-frame prediction remains the most critical bottleneck at VVC;*
  - *Specific optimizations of this module are needed to enable memory-efficient VVC encoding.*

Inter Prediction Specific Memory Analysis

- Analysis-3



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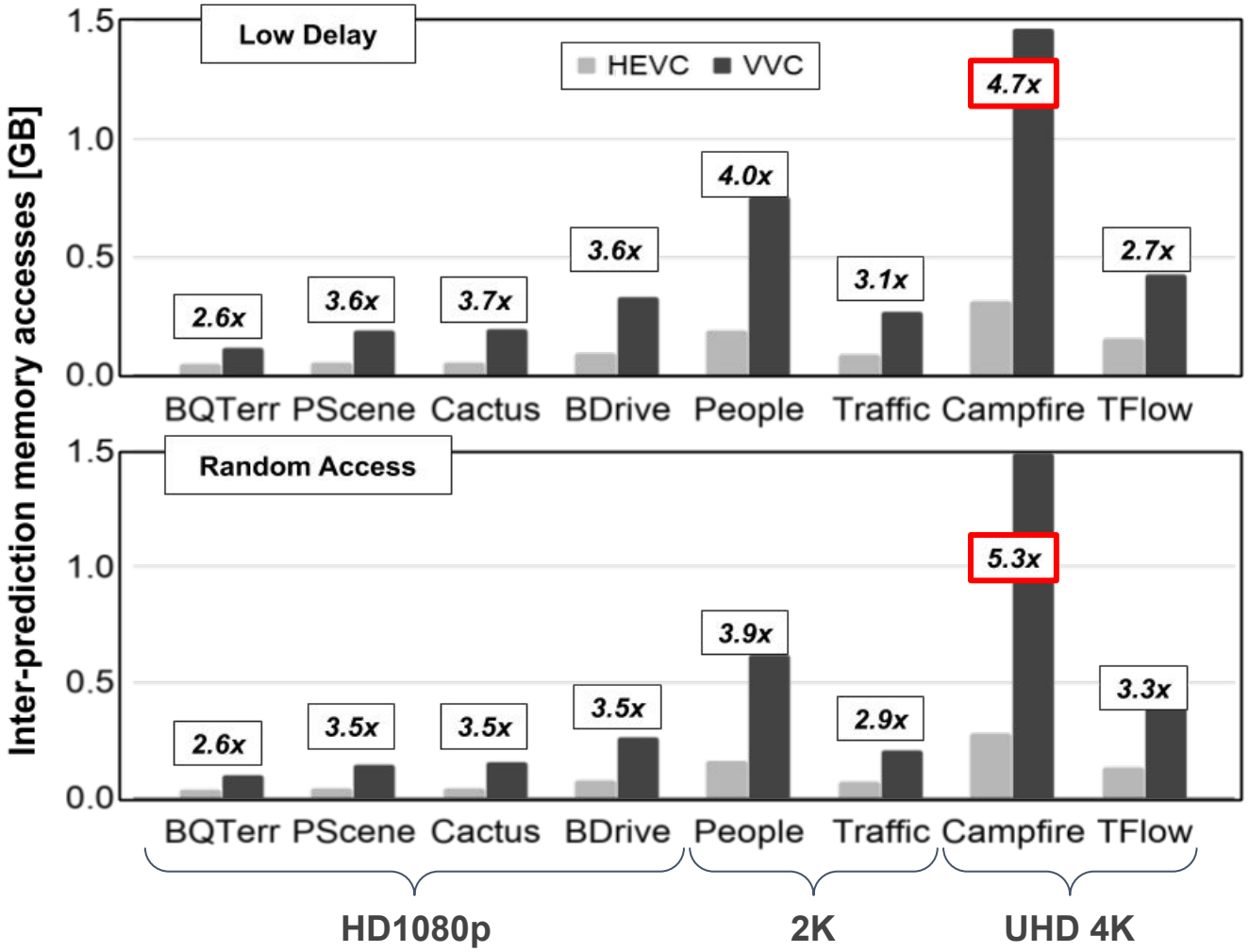

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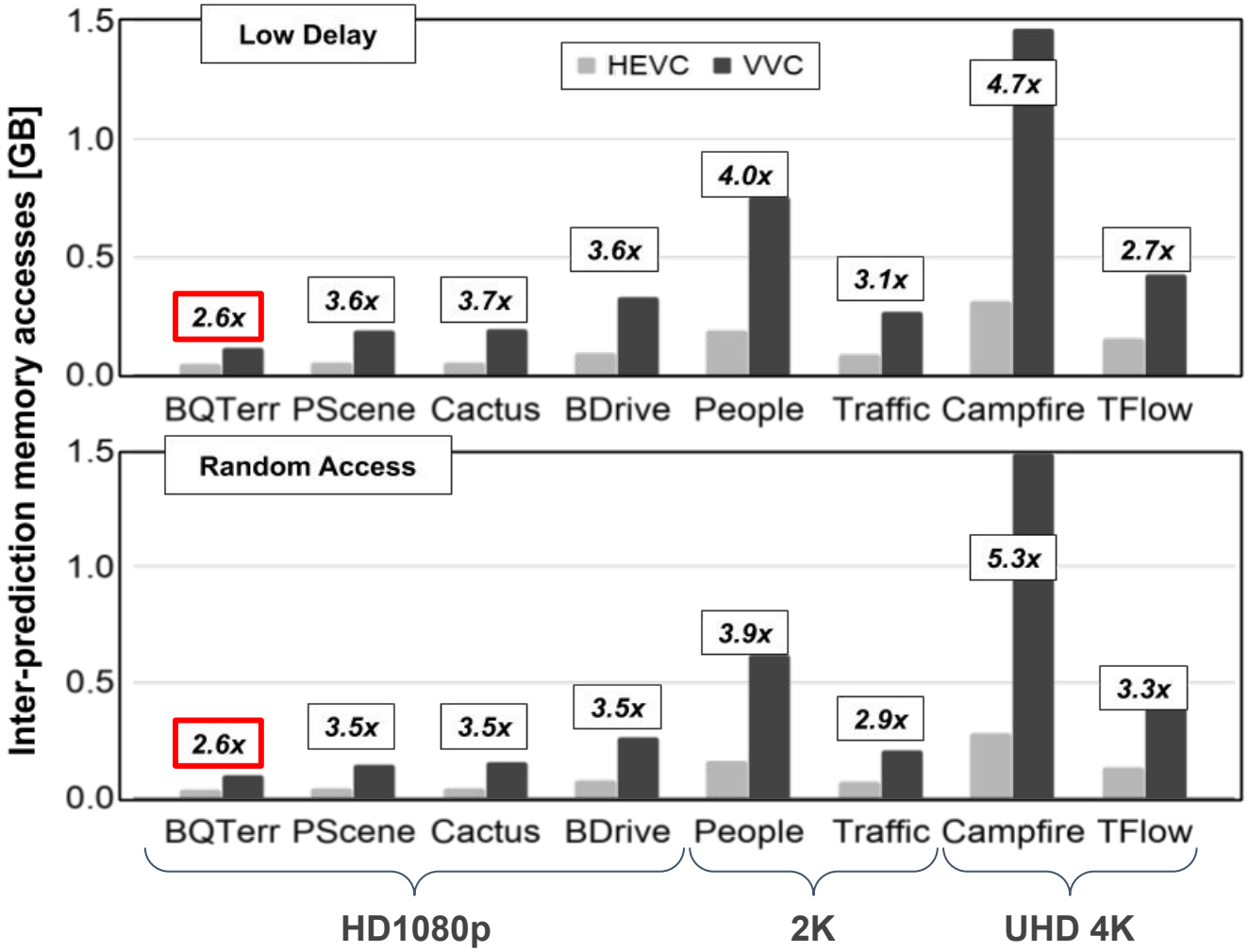

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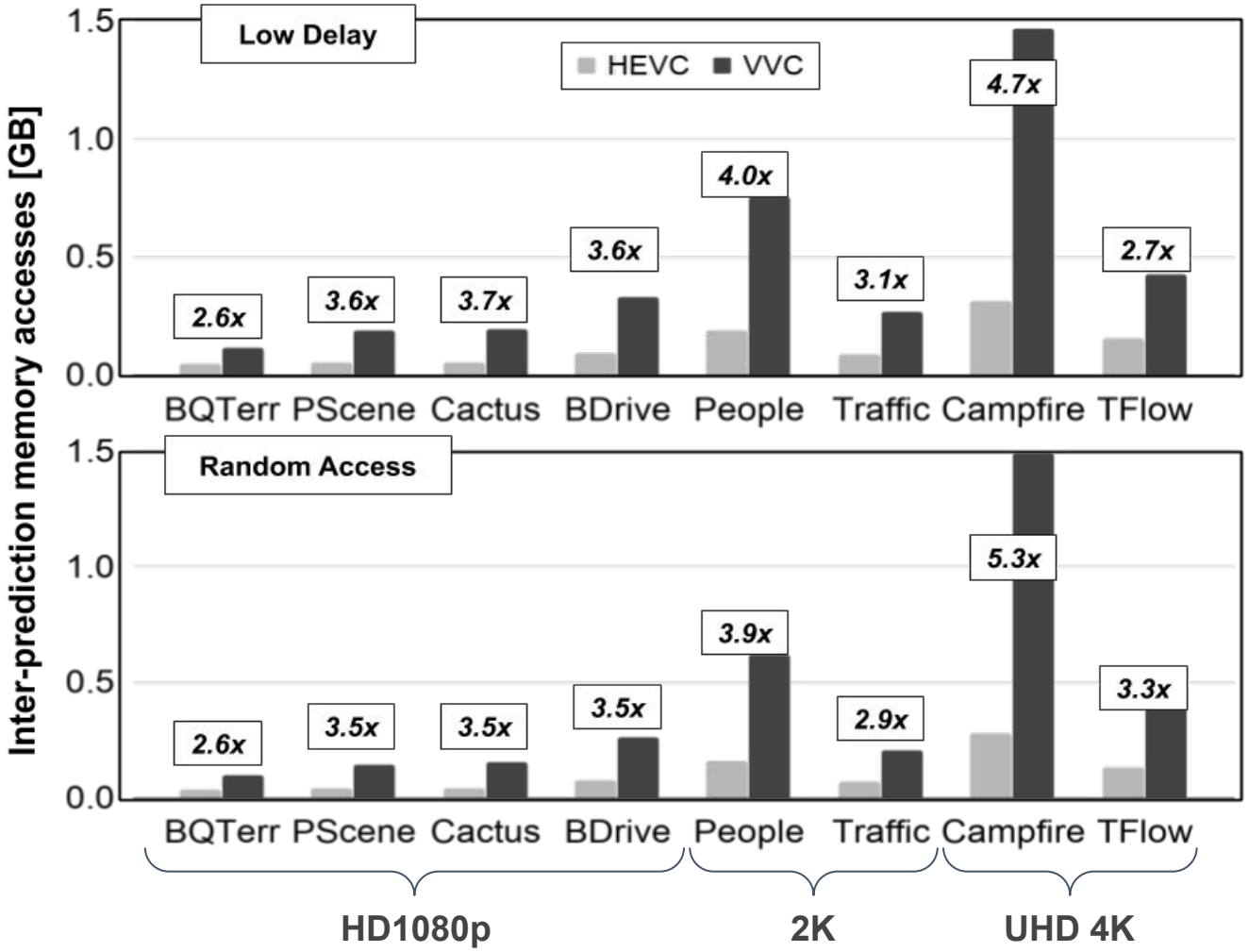

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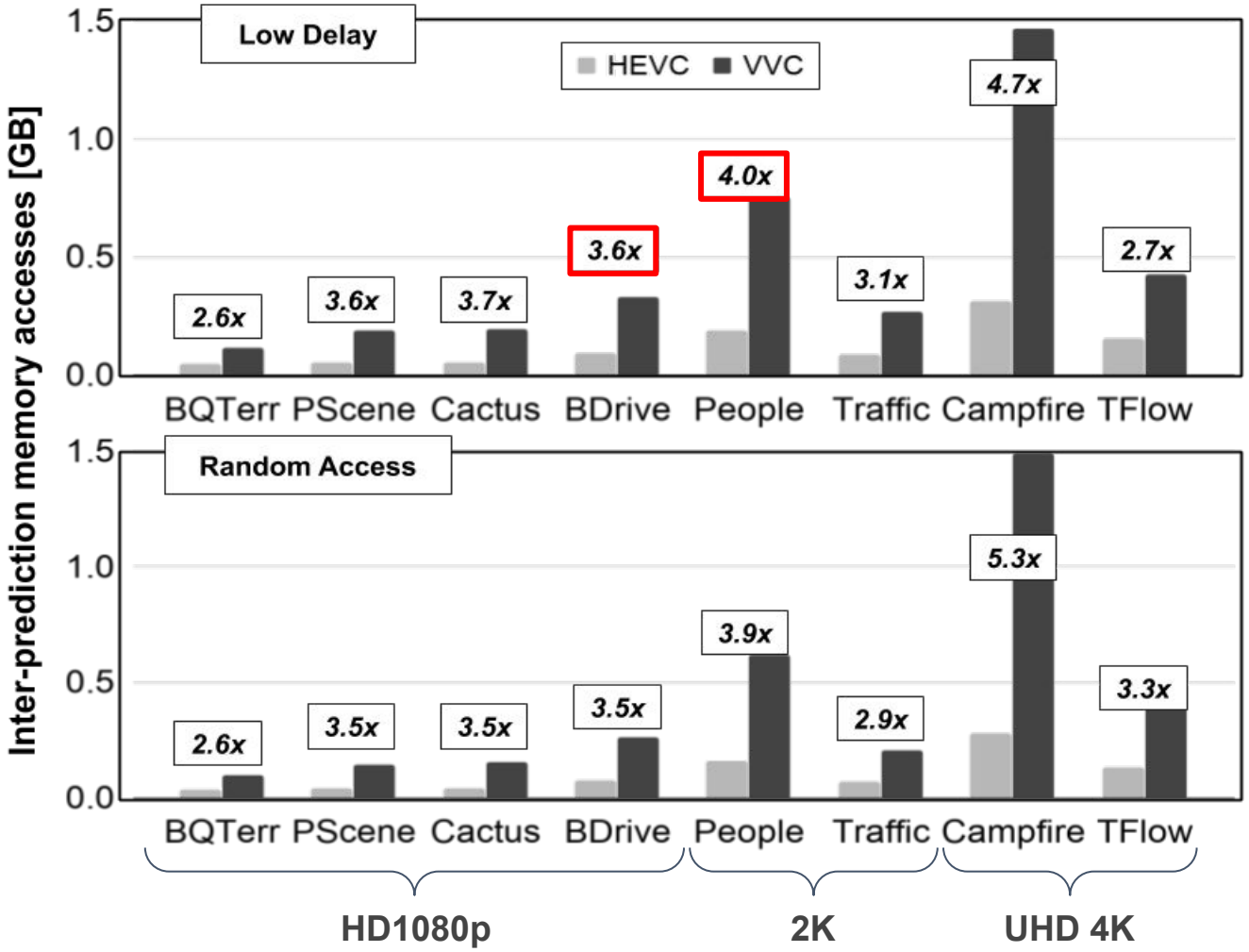

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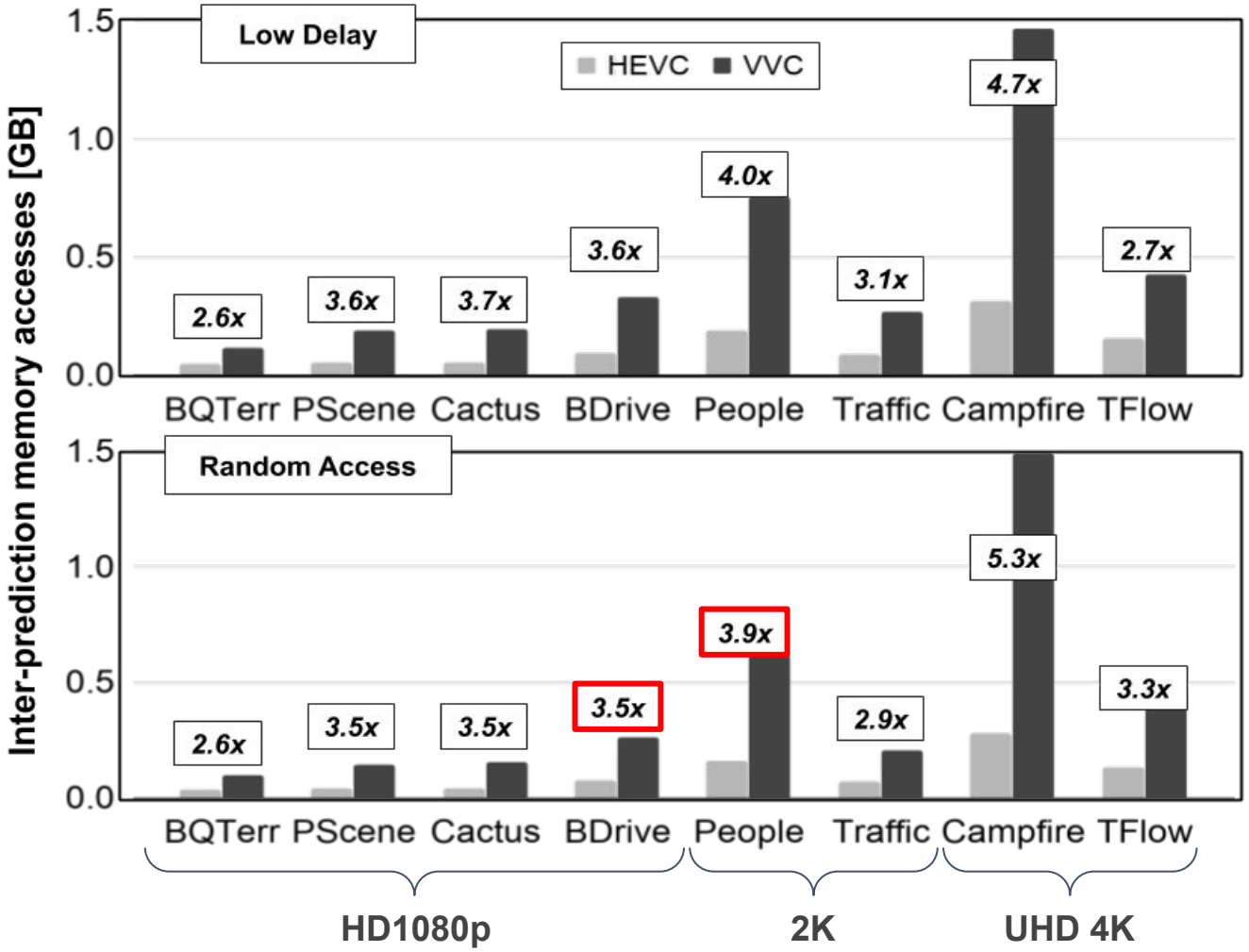

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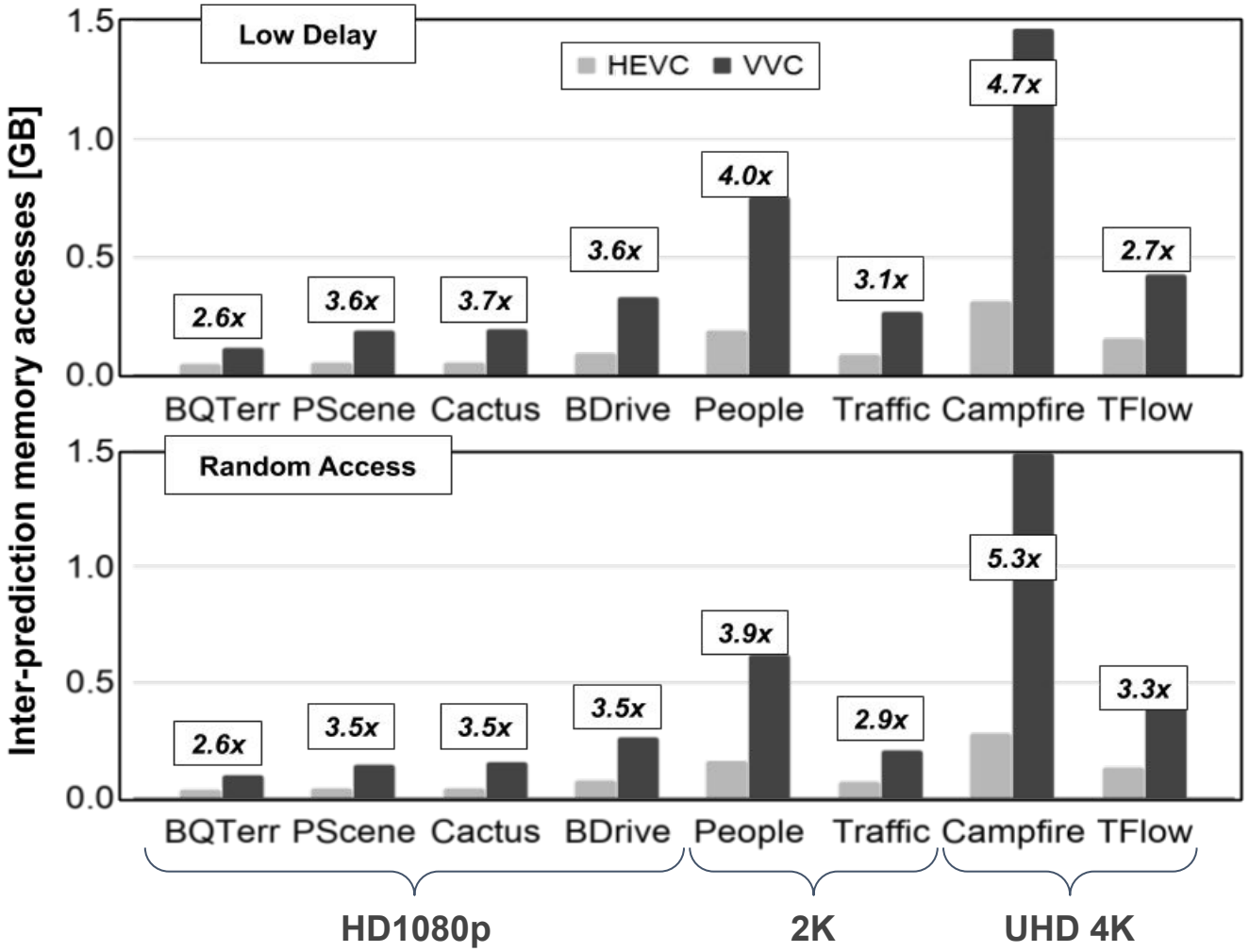
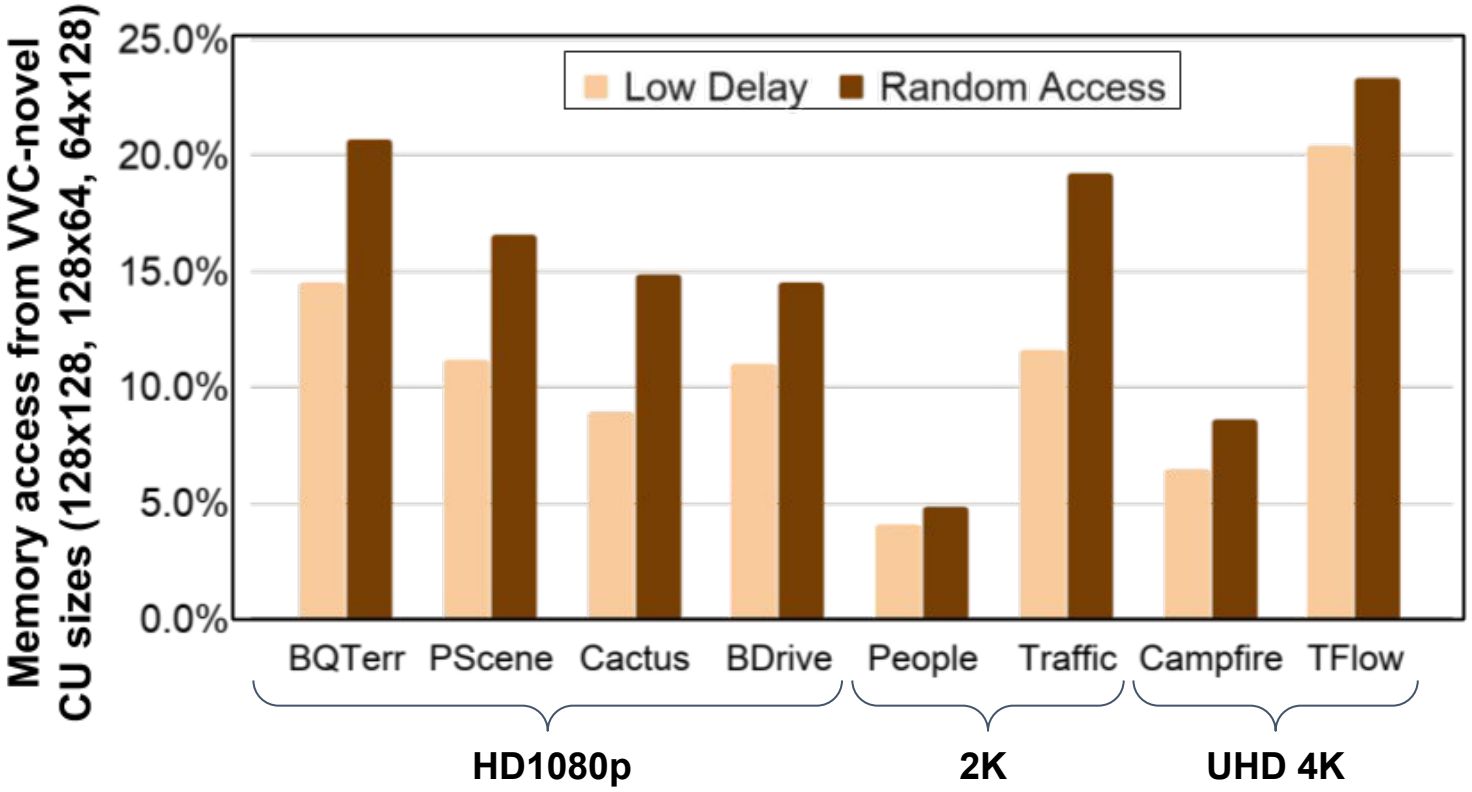


Memory Profiling

- Insights from Analysis-3
  - *The novelties of VVC lead to increased memory requirements for inter-prediction, which can reach 5.3x of overhead.*

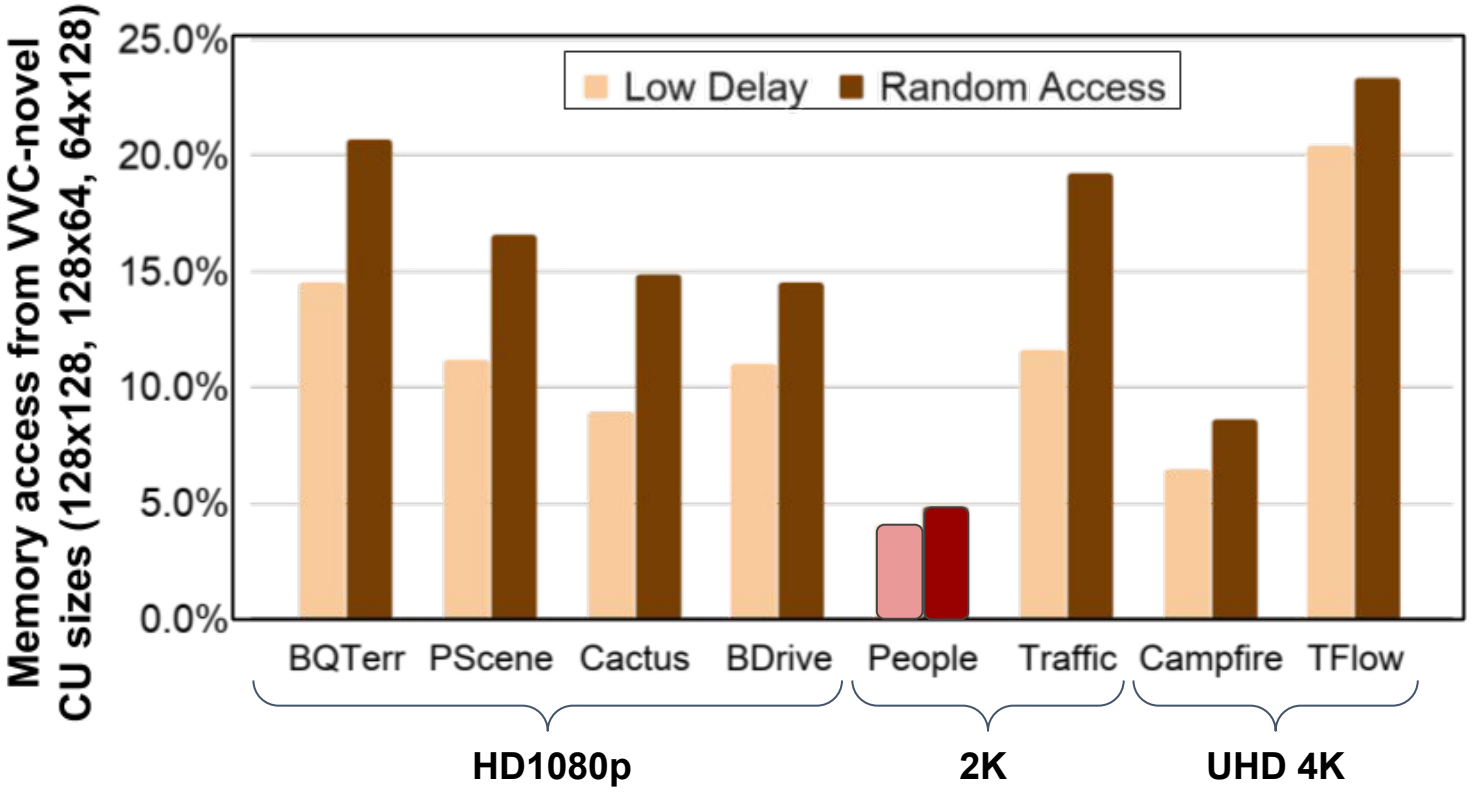
Inter Prediction Specific Memory Analysis

- Analysis-4



Inter Prediction Specific Memory Analysis

- Analysis-4



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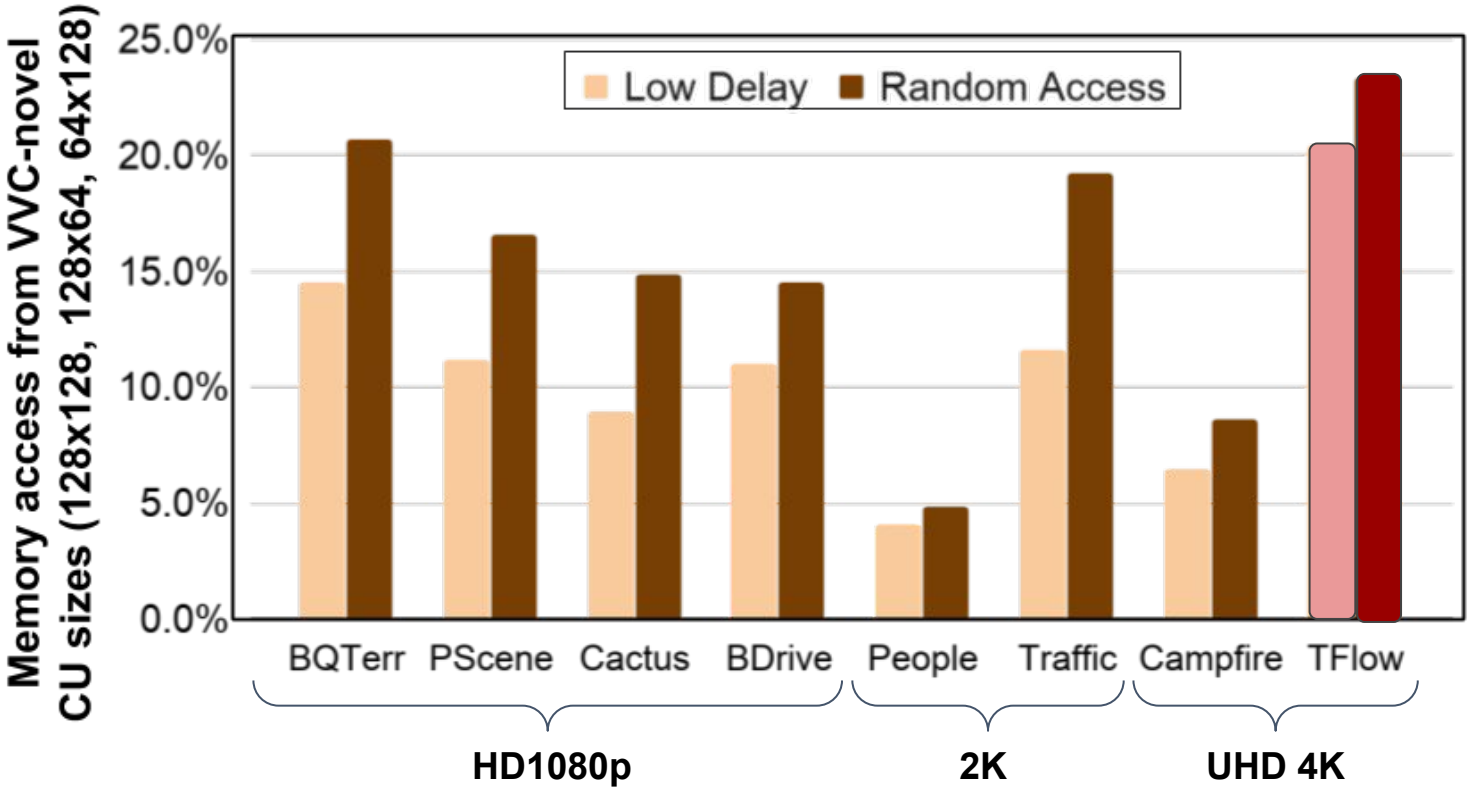

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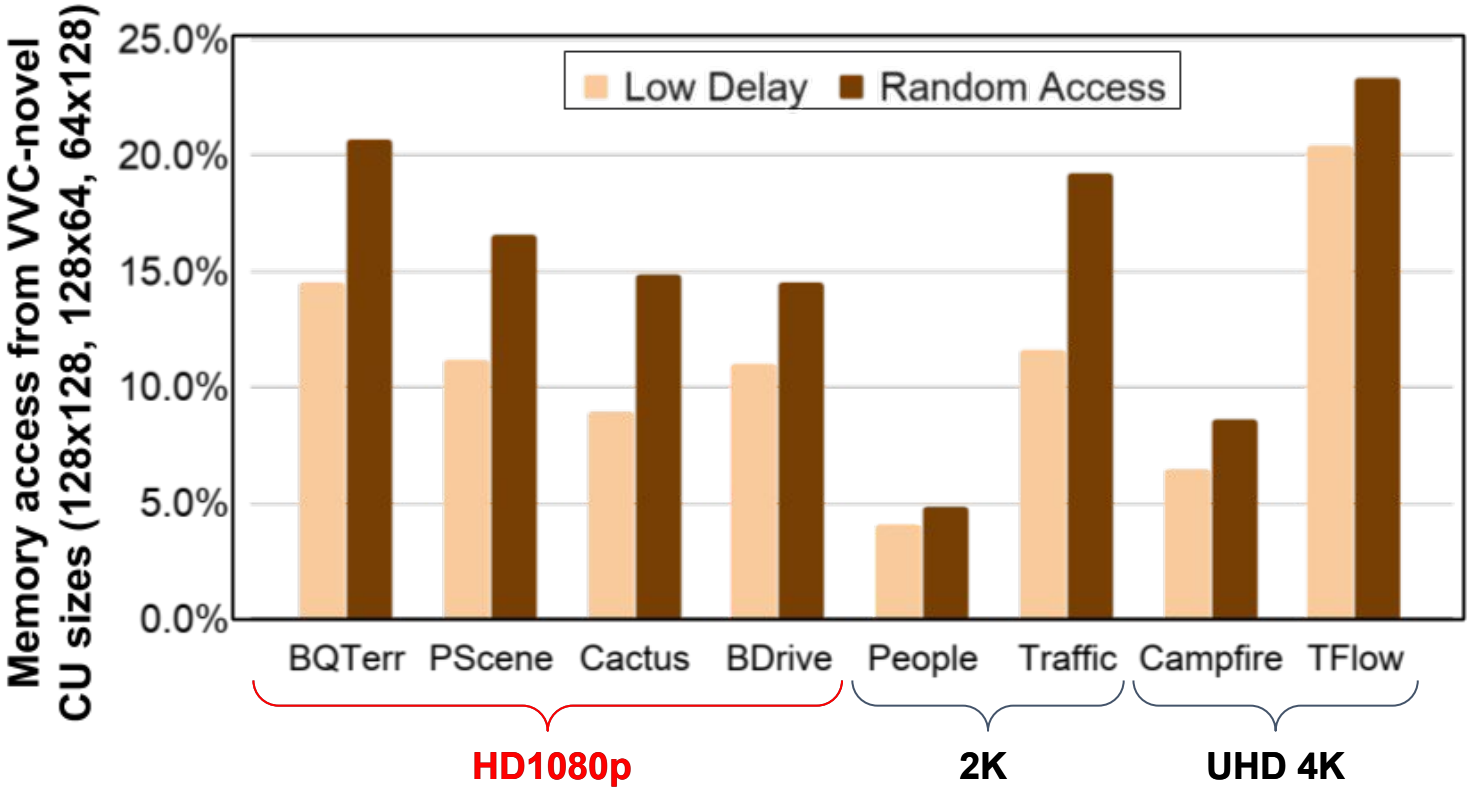

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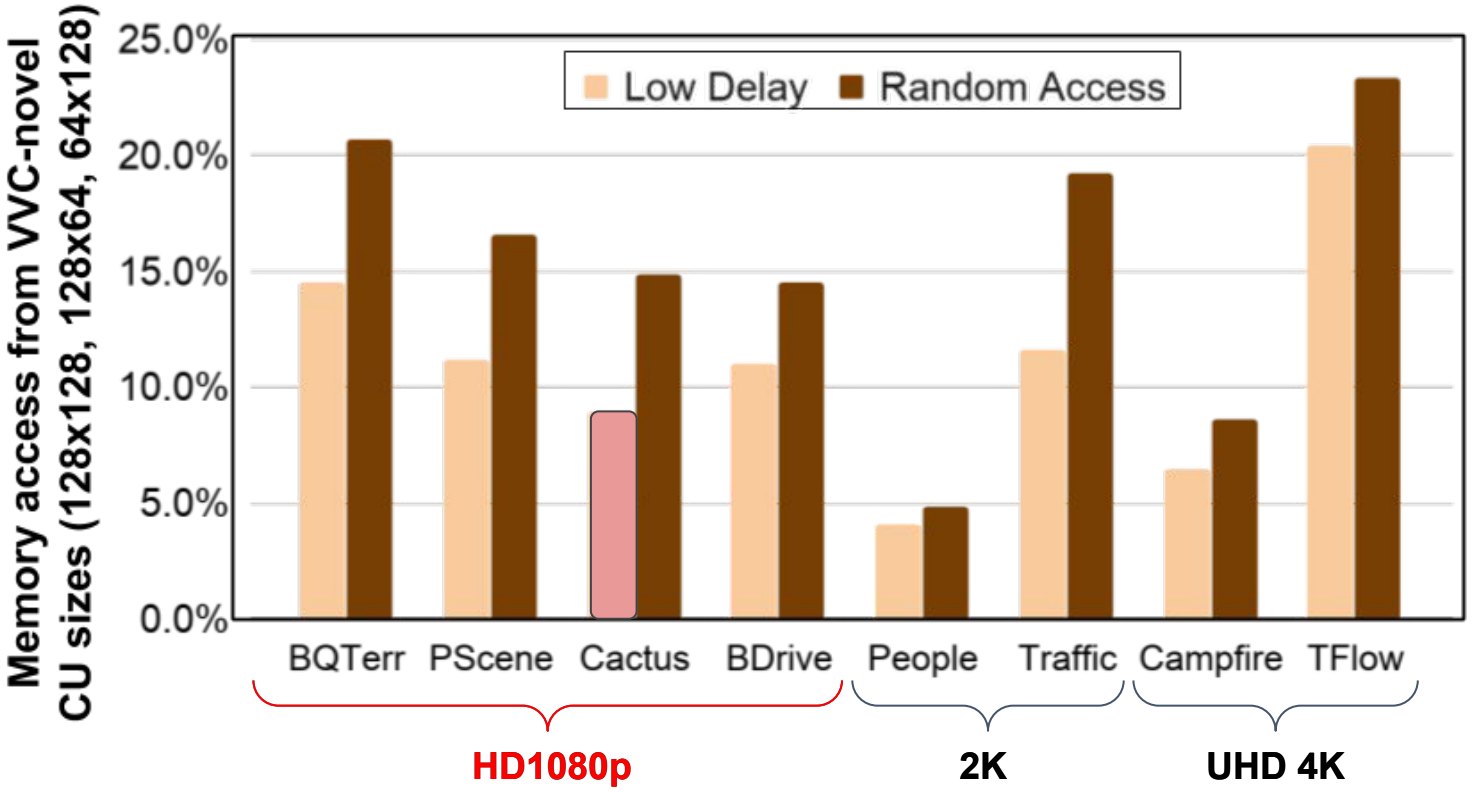

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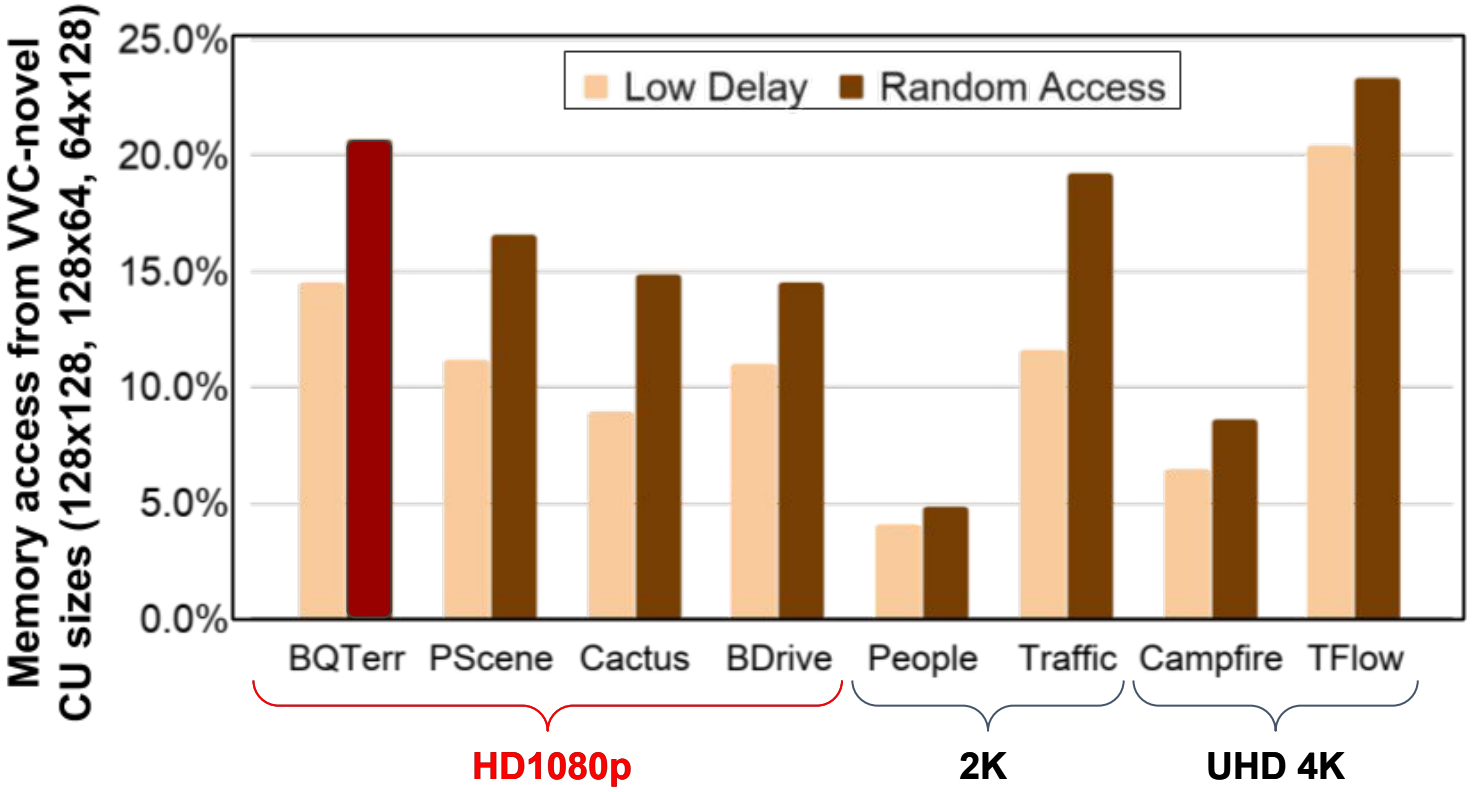
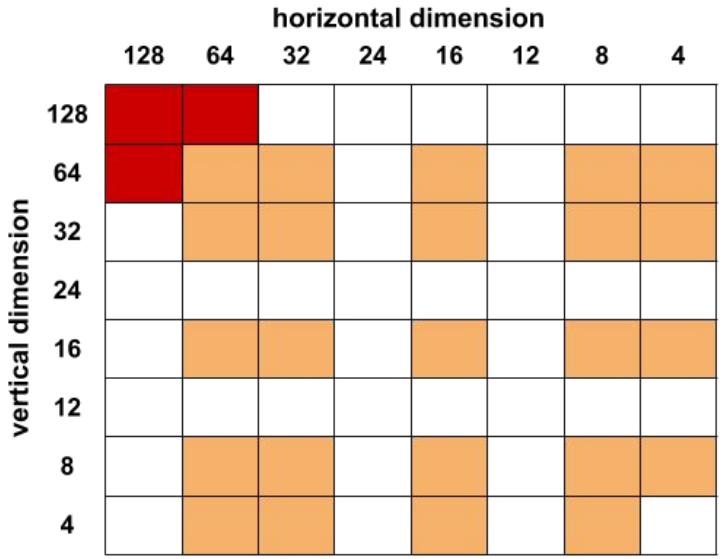


Memory Profiling

- Insights from Analysis-4
  - *CUs larger than 64x64 represent up to 23% memory overhead;*
  - *Large CUs memory overhead varies according to video characteristics.*



Conclusions

- Main insights
  - Significant memory accesses increase in VVC;
  - Inter-frame prediction step remains the biggest bottleneck in the encoding process;
  - Novelties introduced in VVC are responsible for most of the memory overhead.
- *There is an open research gap on minimizing the VVC memory bottleneck in order to enable energy-efficient video encoding.*

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Memory Assessment of Versatile Video Coding

Thank you!

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