

4K-UHD Real-time HEVC Encoder with GPU Accelerated Motion Estimation

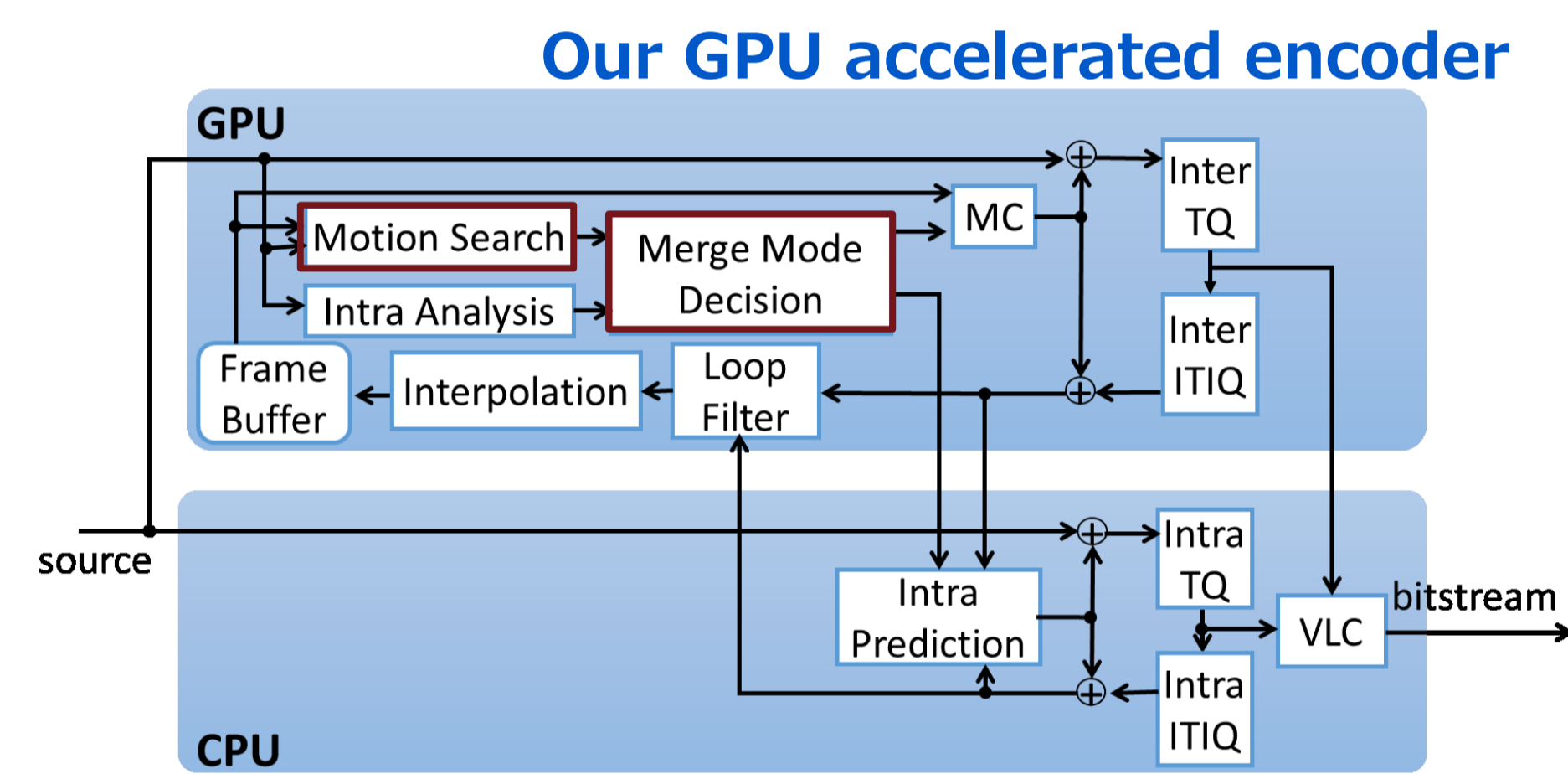
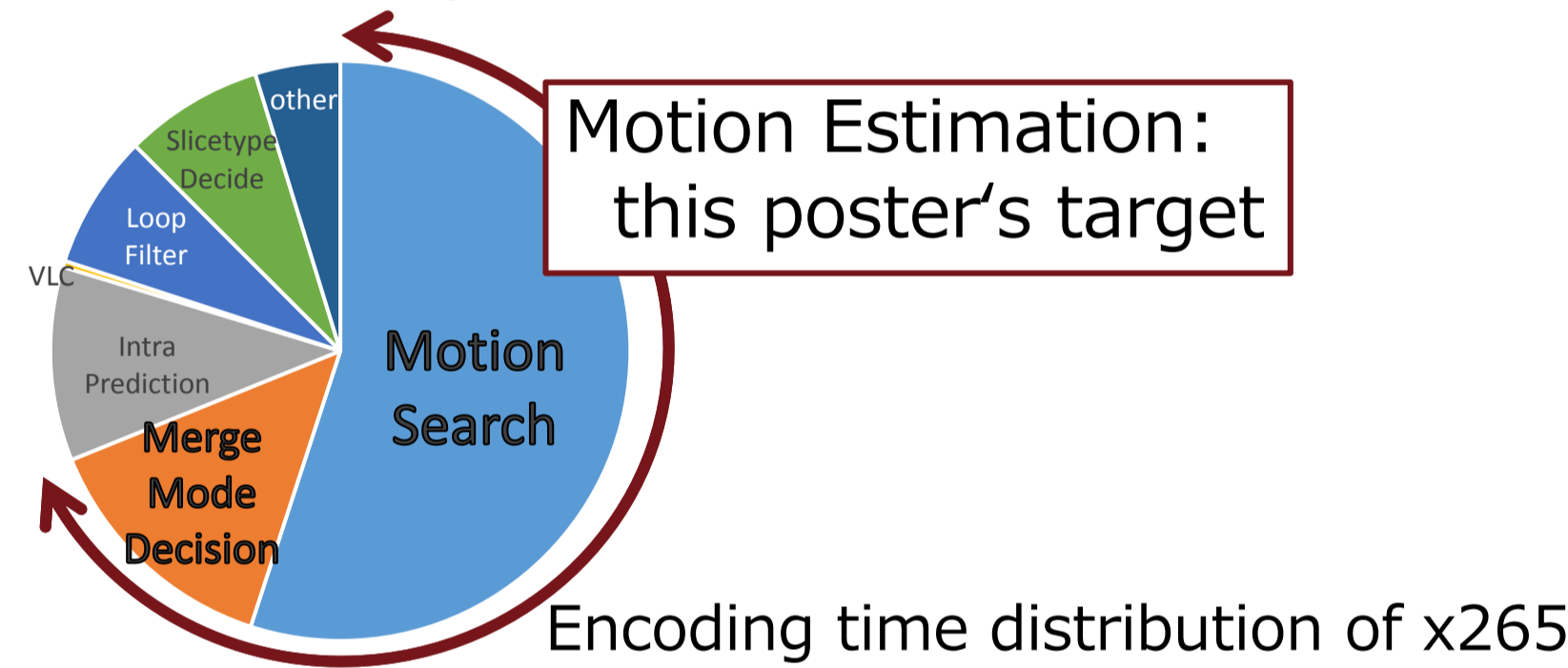
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1. HEVC: most recent video coding standard

- HEVC is key technology for 4K-UHD services
 - Demand on 4K broadcasting or streaming services has been increasing despite of larger data size
 - HEVC achieves double compression ratio than H.264
- HEVC's problem: huge computation complexity to encode**
 - Even x265, highly optimized practical encoder, takes 10 times longer than real-time

2. GPU accelerated HEVC encoder

- GPU is promising technology to accelerate HEVC encoding
 - Thousands of cores bring high peak performance
- To achieve high performance on GPU, massive parallelism is essential**
- This poster's target: motion estimation which is most time-consuming and difficult to parallelize



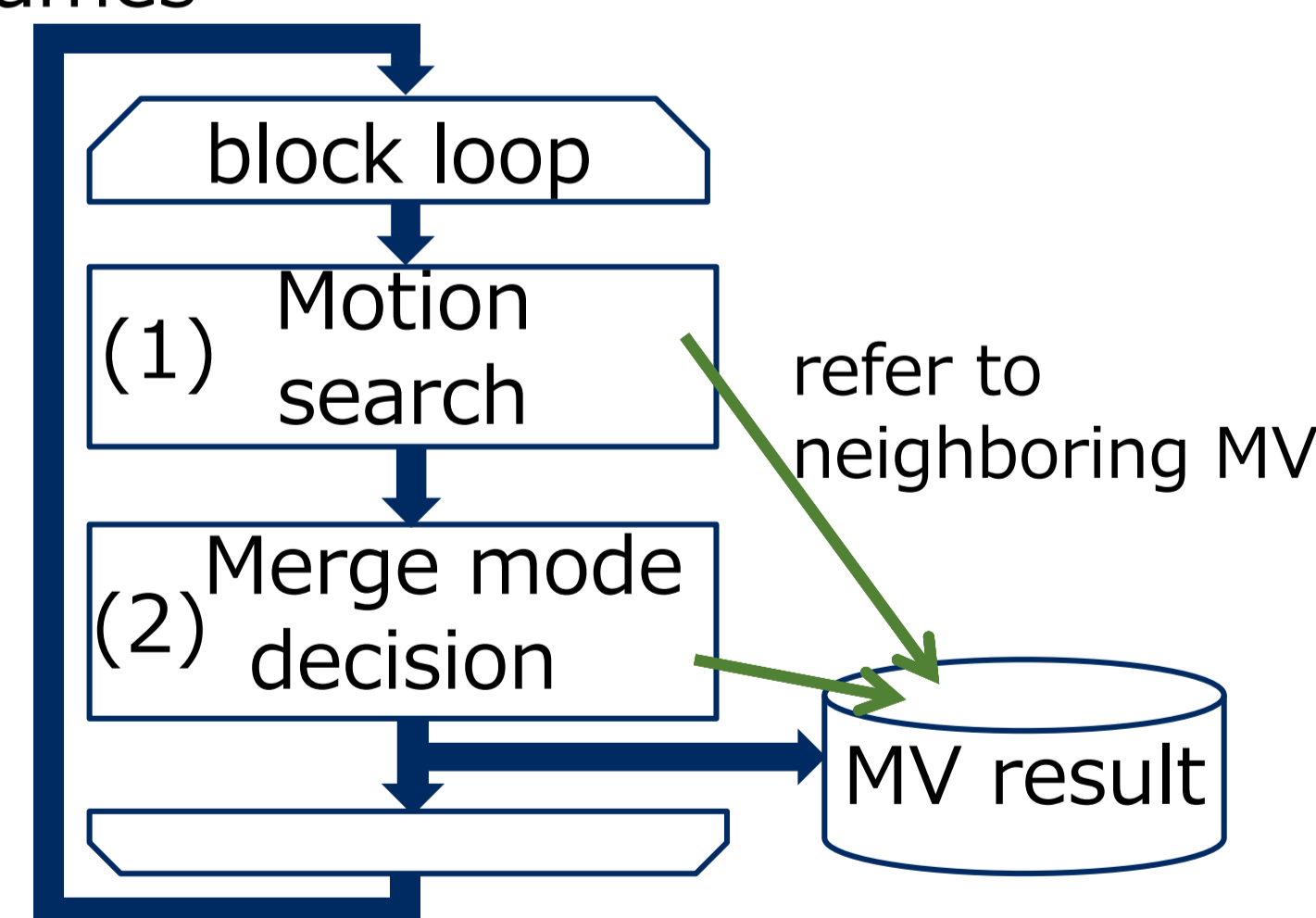
3. Data dependence on motion estimation

- Data compression by redundancy elimination on HEVC
 - Coding only motion vector(MV) and difference image between frames
 - Coding only difference MV between blocks, or "Merge index" in case of having same MV with neighboring block's
 - Merge Index on "Merge mode" identifies position of block which has same MV (new coding tool for HEVC)

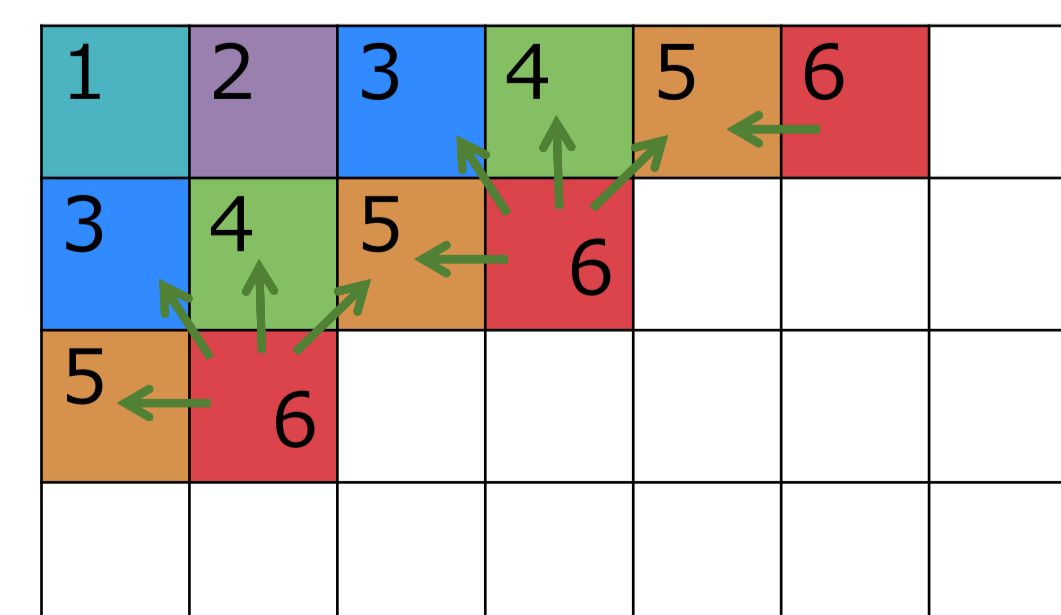
- Redundancy elimination is obstacle to parallelize
 - Motion search: searches MV which has smaller image difference and smaller MV difference
 - Merge mode decision: refers to neighboring MV for judging whether to use Merge mode
- ➔ Block process depends on results of neighboring blocks

Parallel processing on only independent blocks is insufficient for GPU

- Degree of parallelism = half of width in block= 30@4K

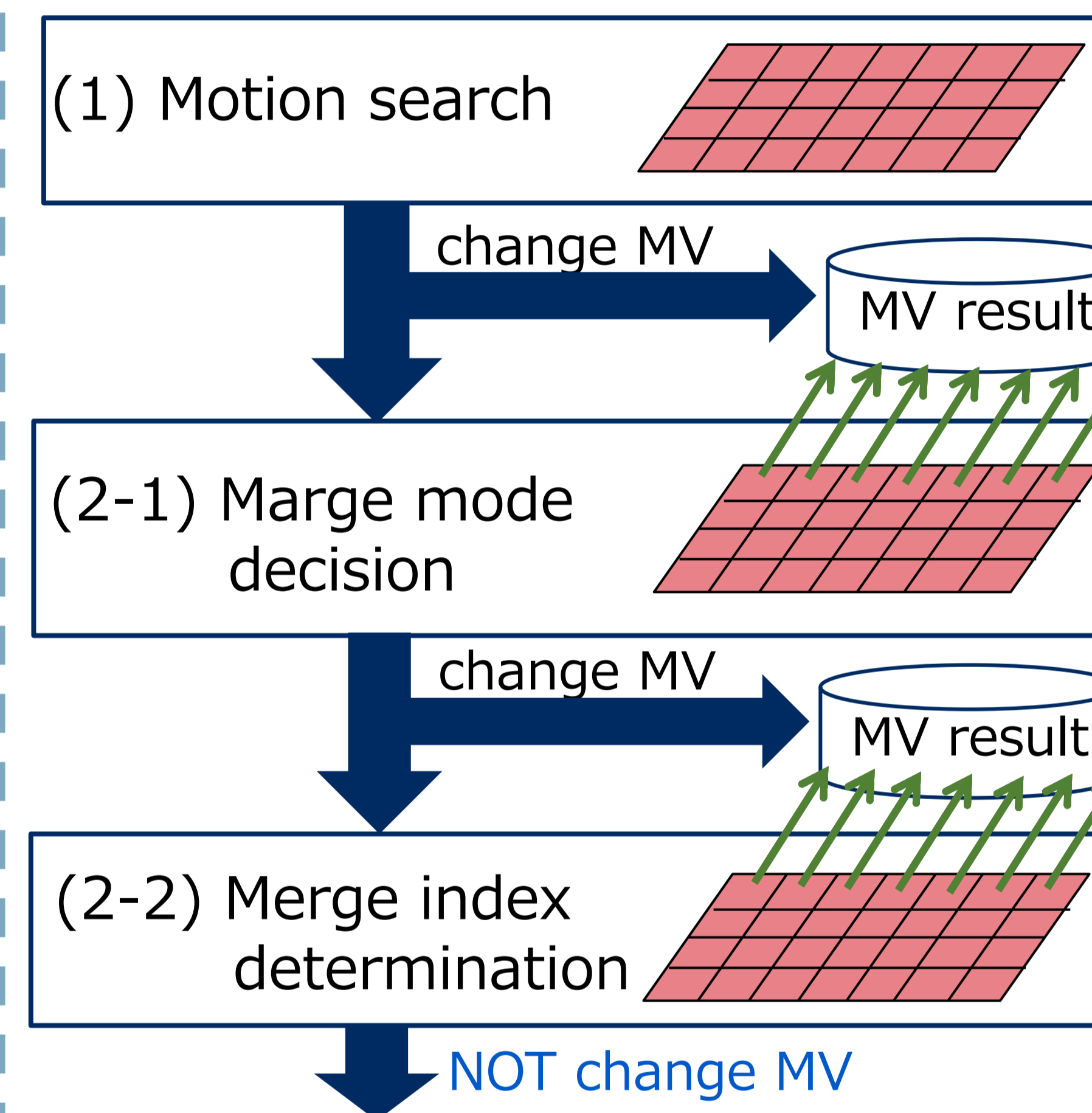


each block refers to left, above, above-left, above-right block

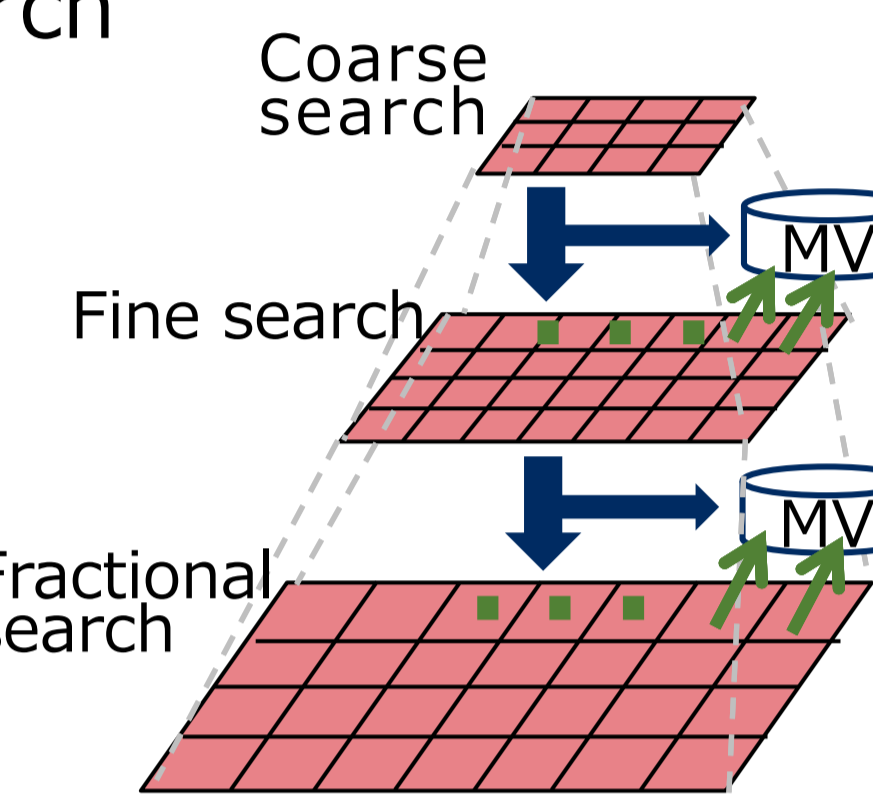


4. Parallelization of Motion estimation for GPU

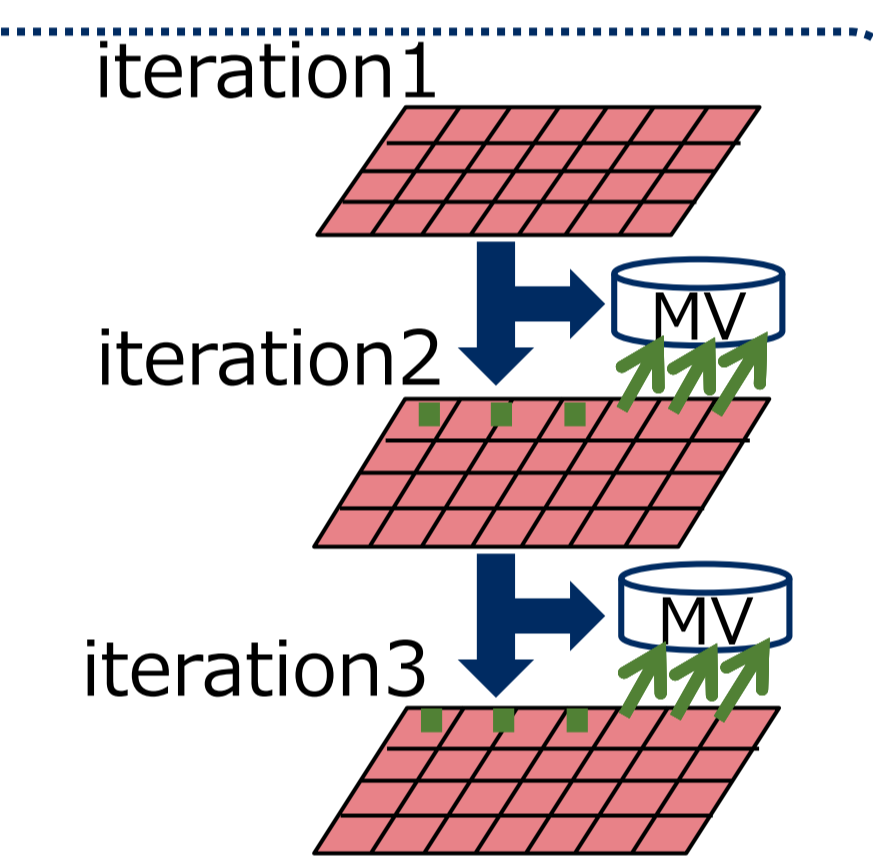
- Processing all blocks in parallel** to take advantage of GPU with numerous cores
 - Relaxing data dependence by **using neighboring MV in results of previous process**
 - Block process doesn't depend on results of other blocks in each process
- Separating Merge index determination** from Merge Mode Decision for HEVC conformance
 - Degree of parallelism = all blocks = 2040@4K



- Proposed hierarchical motion search
 - Large search range which is suitable for 4K in coarse search layer
 - Refining MV through each layer
 - Reference neighbor MV on result of previous layer**



- Proposed iterative Merge mode decision
 - Refining MV iteratively
 - Reference to neighbor MV on result of previous iteration**

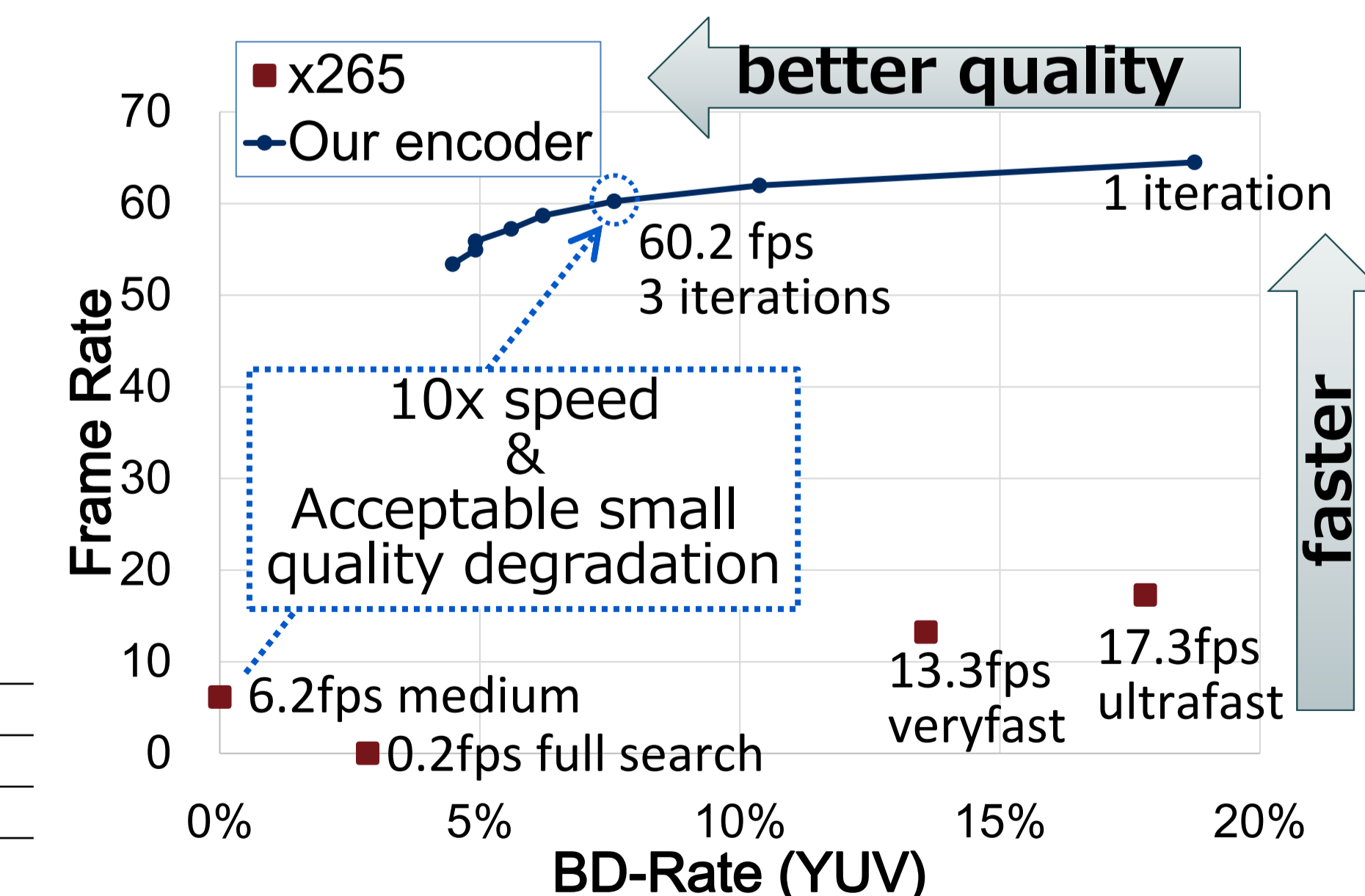


- Guaranteeing conformance with HEVC specification
 - Reference to MV on results of previous process**
 - Not change MV, only set merge index

5. Evaluation and conclusions

- Compared processing speed and video quality
 - Quality improvement with increasing iterations for Merge mode decision
 - Real-time encode for 60p with only 7.5% BD-Rate degradation**
 - 10 times faster than x265 with sufficiently quality

Experimental environment	
CPU	Intel Xeon E5-2667 v3 (8cores) x2
GPU	NVIDIA GeForce GTX TitanX x2
Sequence	SVT 4K, 10bit, 4:2:0



We proposed data dependence relaxation method for GPU parallelization
Proposed encoder achieves 4K60p real-time with sufficiently quality