

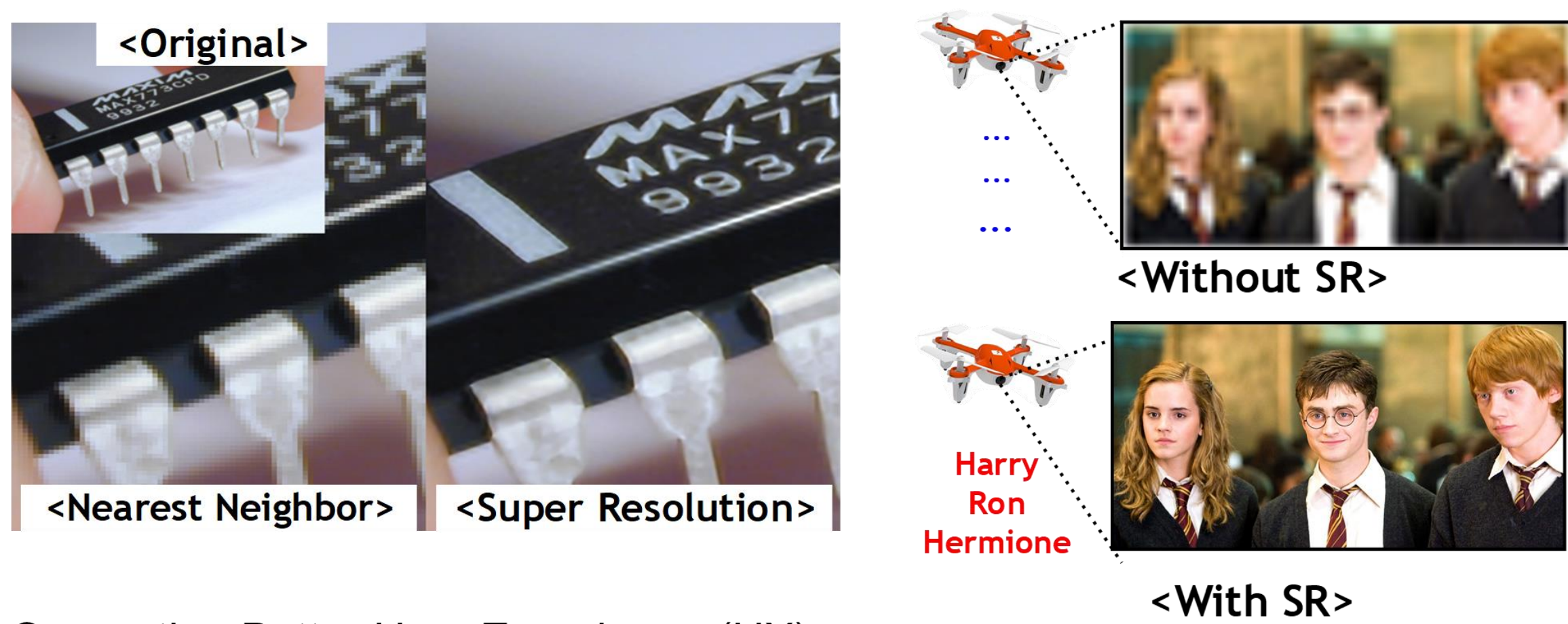
A Full HD 60 fps CNN Super Resolution Processor with Selective Caching based Layer Fusion for Mobile Devices

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Motivation & Introduction

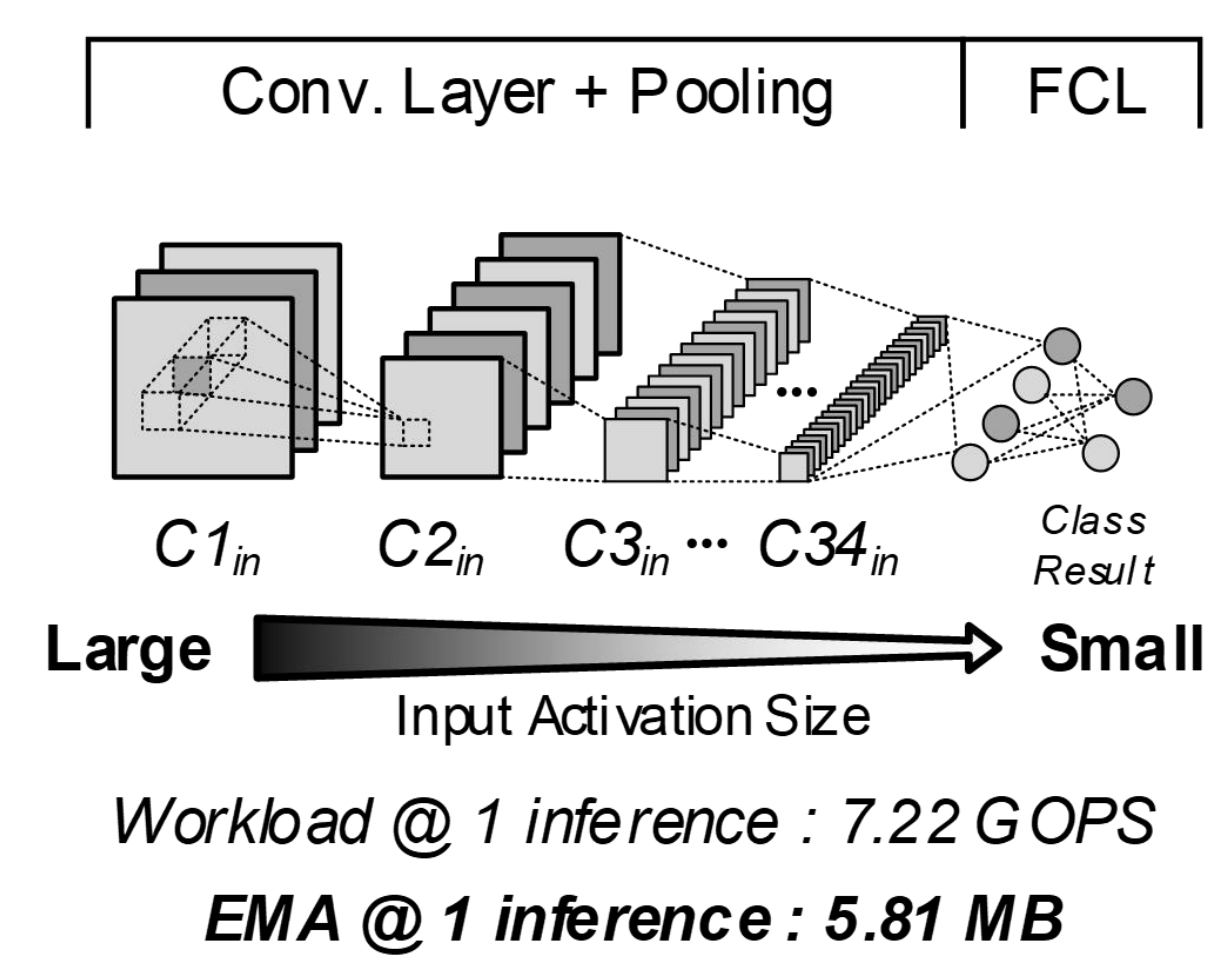
Super Resolution (SR) for Mobile Image Enhancement



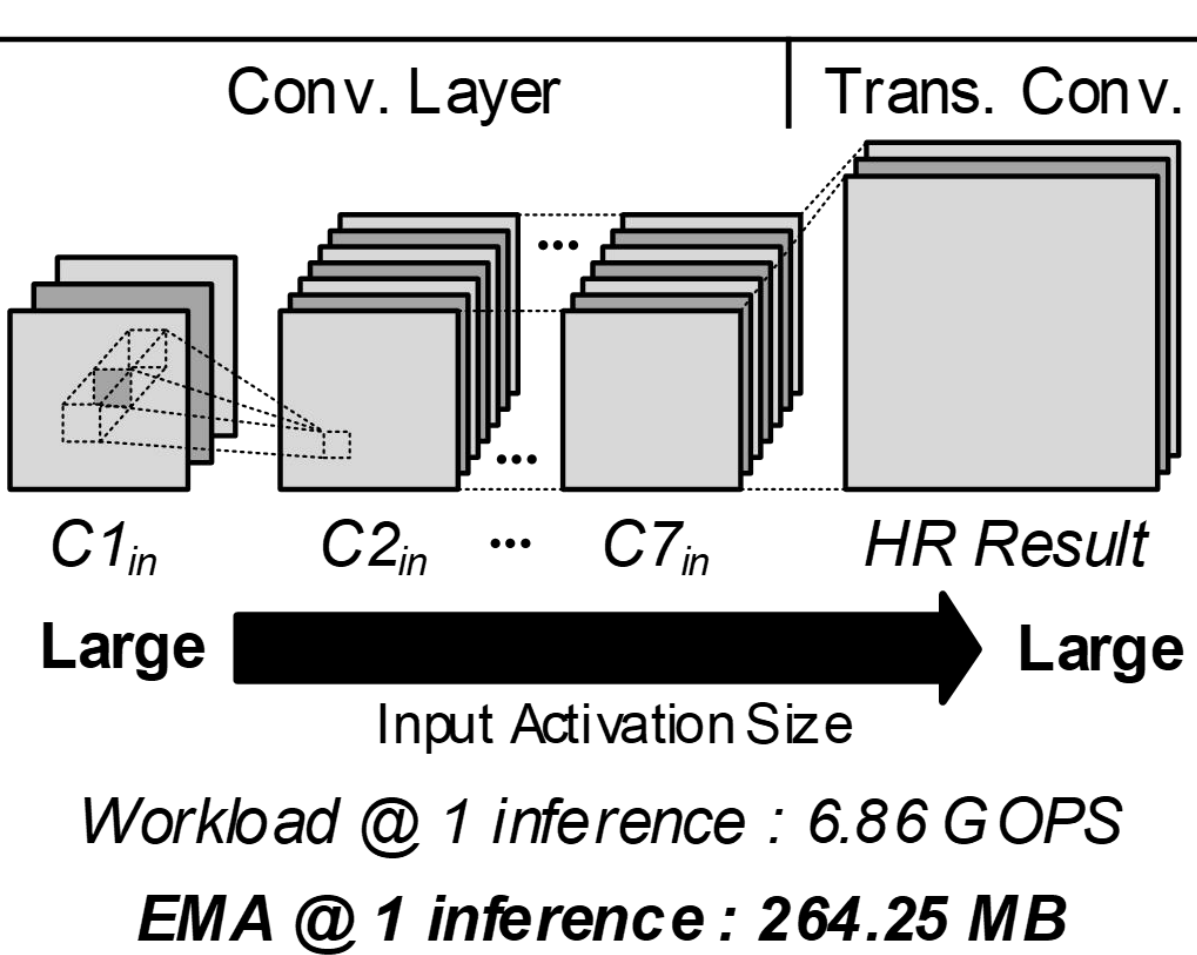
- Supporting Better User Experience (UX)
- Video quality enhancement, far object detection, etc

Challenge of Super Resolution

Classification CNN



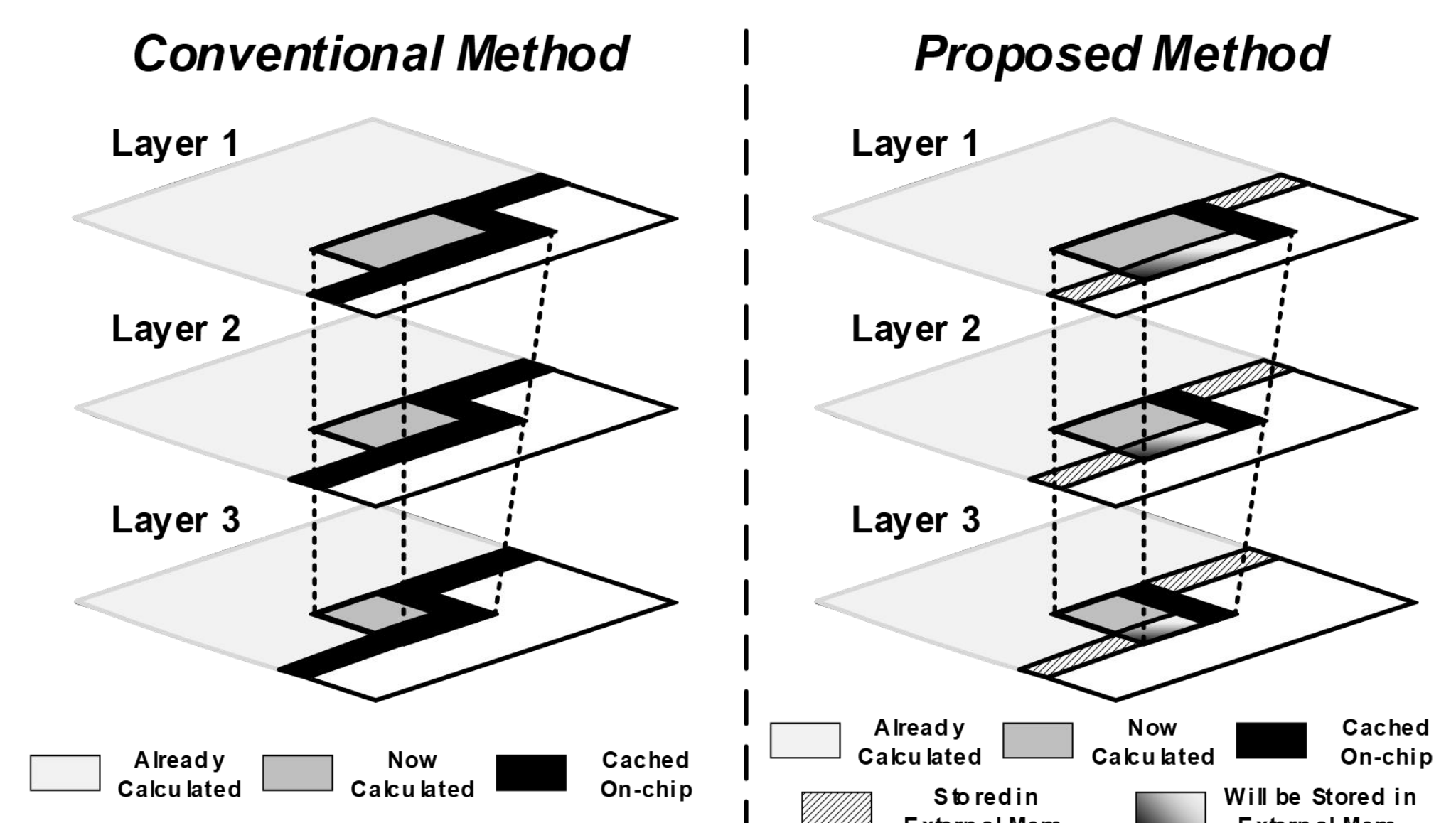
Super Resolution CNN



- Large Computational Workload (> 6.86 GOPS)
- Large Memory bandwidth problem (> 264.25 MB)

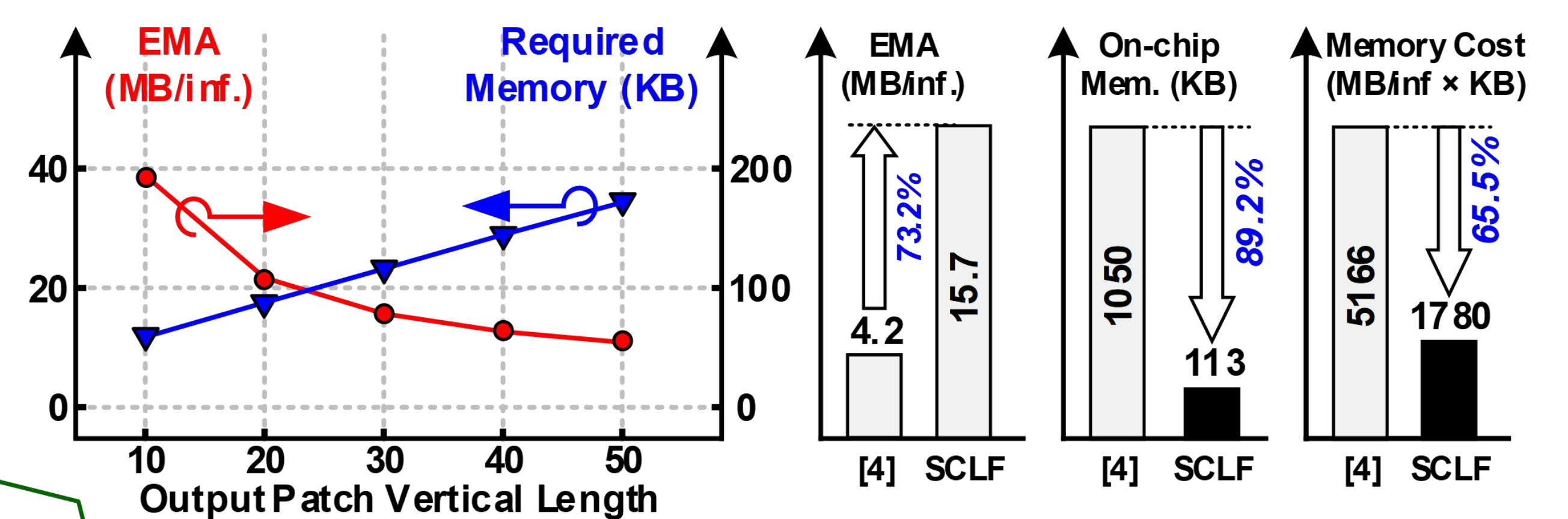
Selective Caching Layer Fusion

Selective Caching Layer Fusion



- Conventional Method: Calculating subsequent layers at once for 1 pixel
- Proposed Method: Selective Caching Intermediate Feature Maps

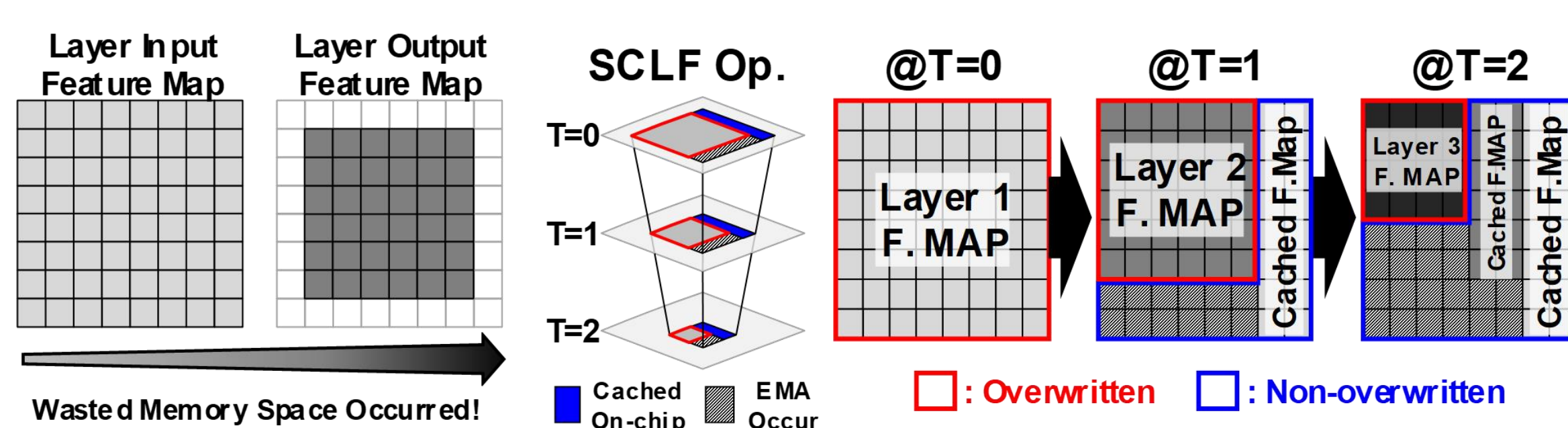
Performance of Selective Caching Layer Fusion



- Memory-efficient Computing Method
- By optimizing EMA & on-chip memory footprint through SCLF

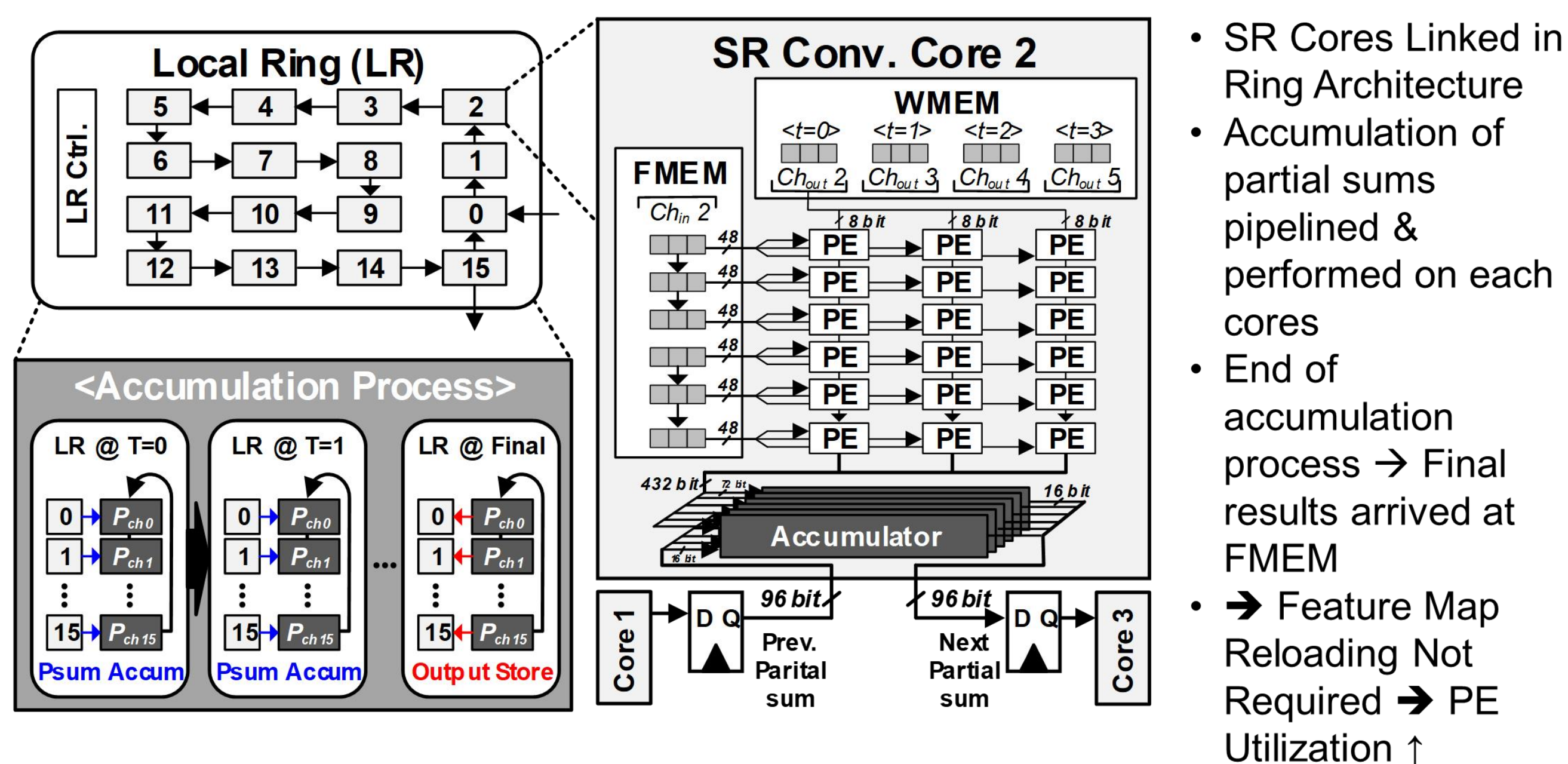
Processing Architecture

Memory Compaction Scheme



- Receptive Field of Convolution Layer (CL)
 - Output feature map size << Input feature map size
- Wasted Memory Space at the Final CL

Cyclic Ring Core Architecture



- SR Cores Linked in Ring Architecture
- Accumulation of partial sums pipelined & performed on each cores
- End of accumulation process → Final results arrived at FMEM
- Feature Map Reloading Not Required → PE Utilization ↑

Implementation Results

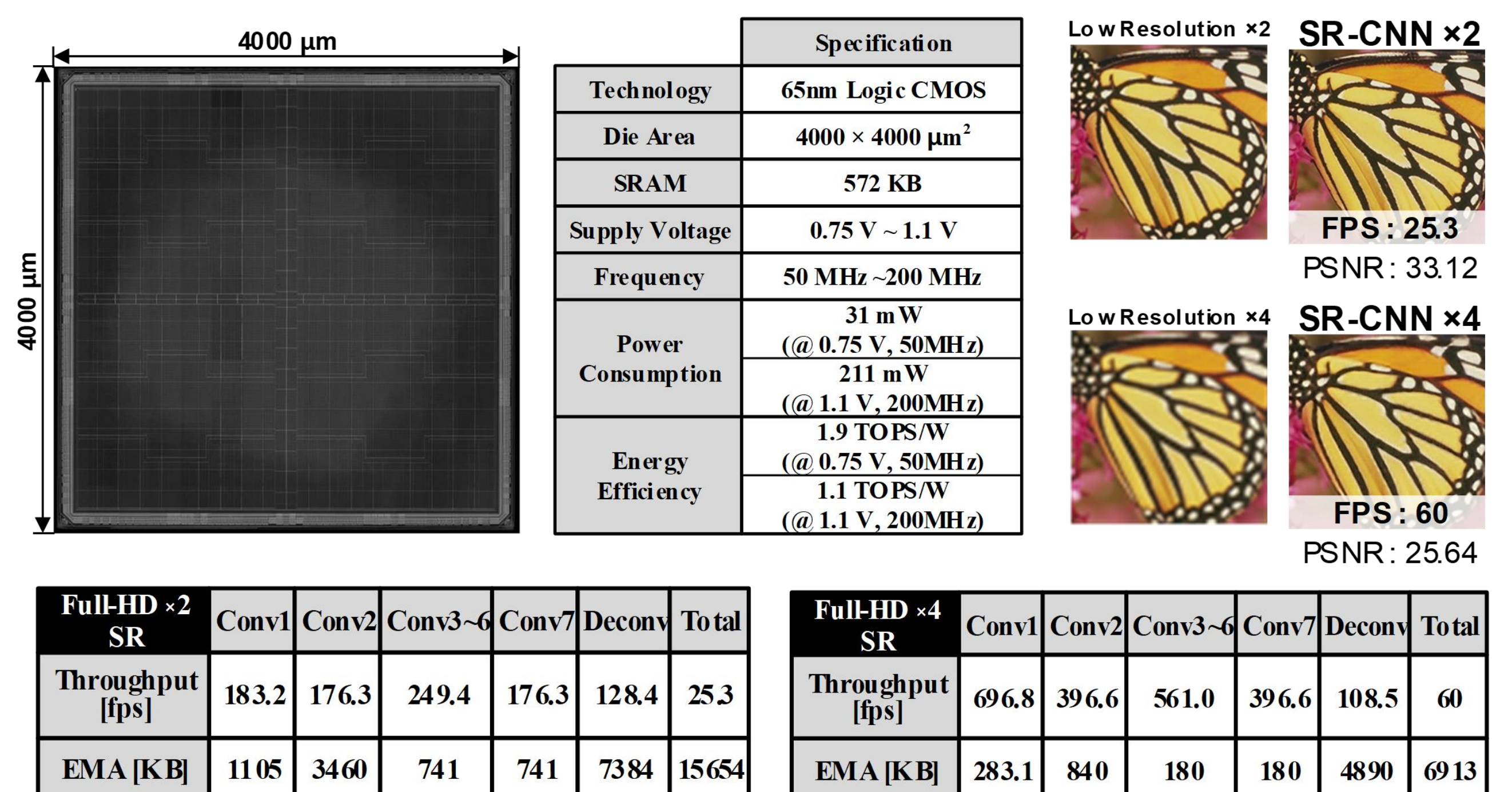
EMA & Performance Measurement

CV (L1)	Stall	CV (L2)	CV (L2)	Stall	@ Prev. Accum. Arch. [6]
AC (L1)	AC (L1)	Stall	AC (L2)	AC (L2)	Stall
		ReLoad			ReLoad
CV (L1)	Stall	CV (L2)	CV (L2)	Stall	@ Cyclic Accum. Arch.
AC (L1)	AC (L1)	Stall	AC (L2)	AC (L2)	PE Utilization: 49.2% → 71.8%

* CV : Convolution, AC : Accumulation, L1 : Layer1, L2 : Layer2

- FMEM Memory Footprint Additionally Reduced by 31.9%
- SR-CNN PE Utilization Increased by 45.9%

Layout Photograph & Performance Summary



- Framerate: 60 FPS (Realize real-time super-resolution at x4 scale restoration)