SW Defined HW (SDH) Improve System Efficiency (Virtual Heterogeneity)

DARPA Program

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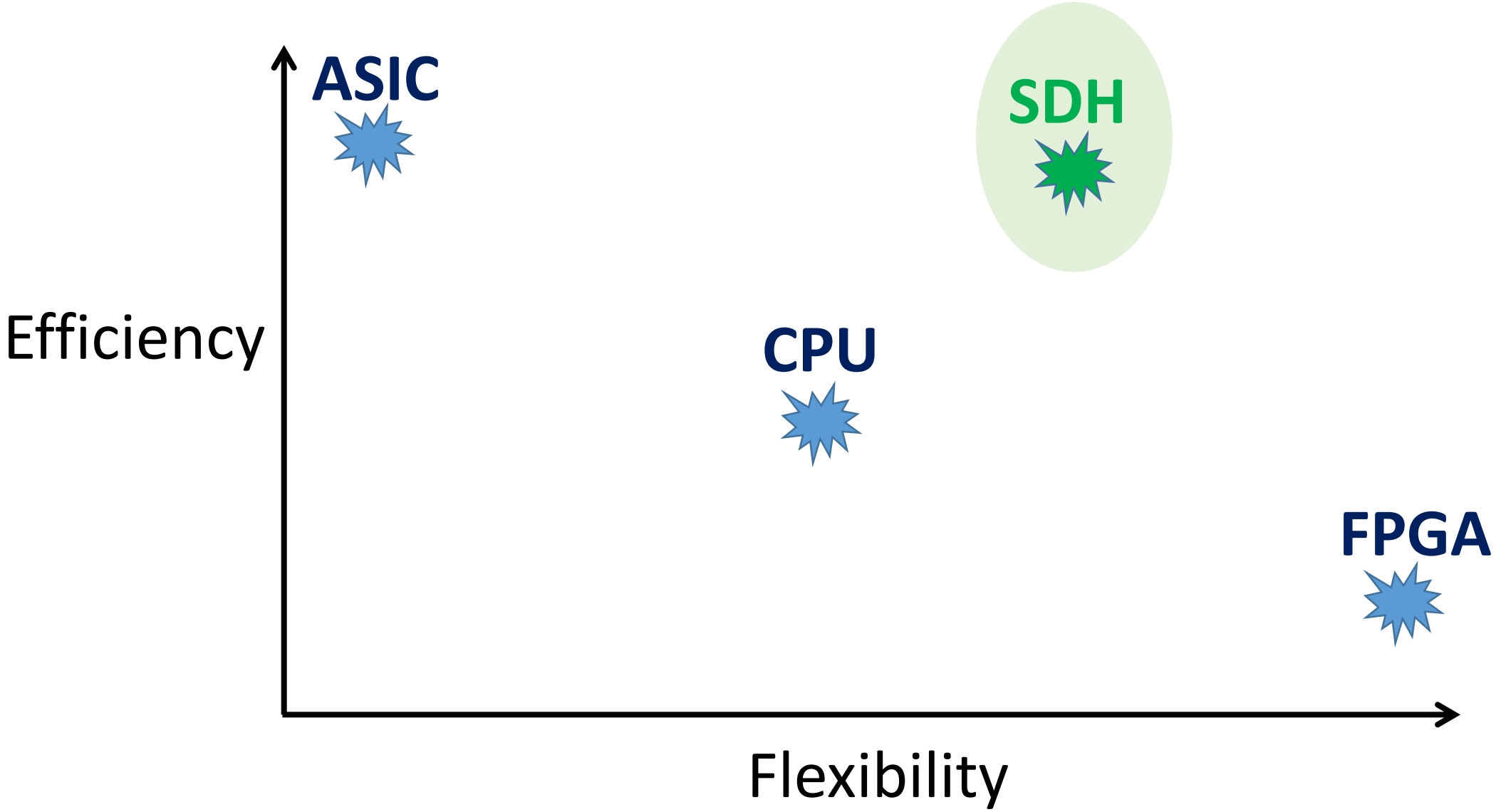
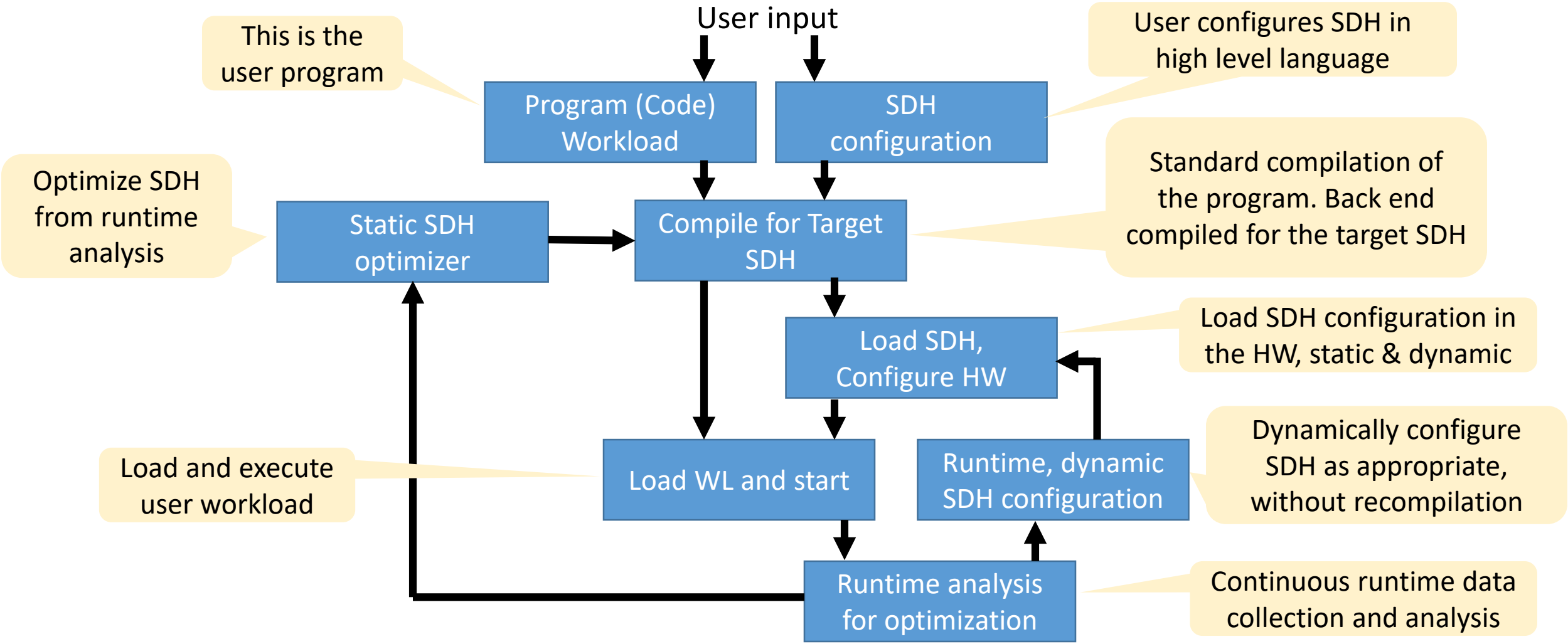
Acknowledgement: Funded in part by DARPA, ERI initiative

Goal

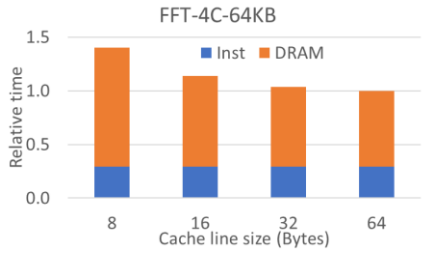


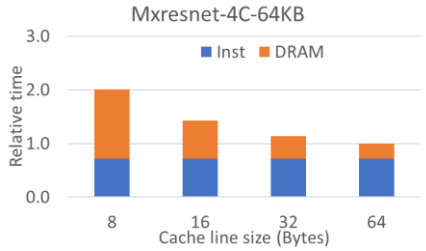
SDH Flowchart



Workload Analysis—Dense + Sparse

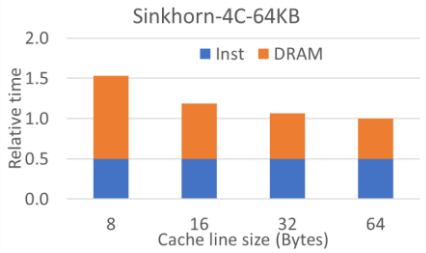
Execution Time

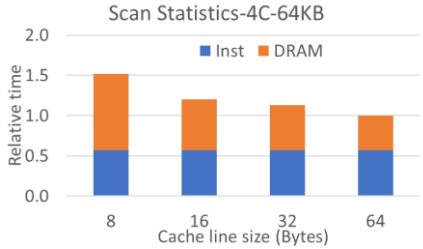




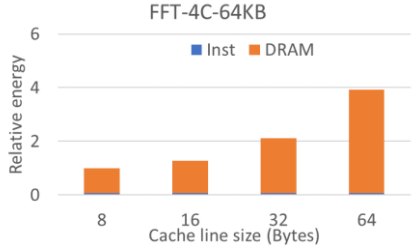
More Orange than Blue

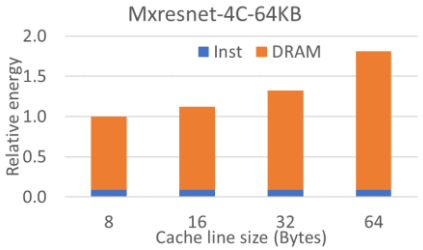
DRAM access time dominates





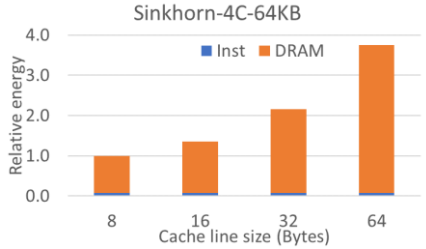
Energy

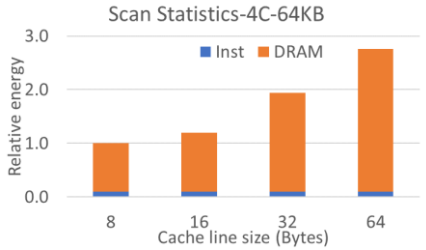




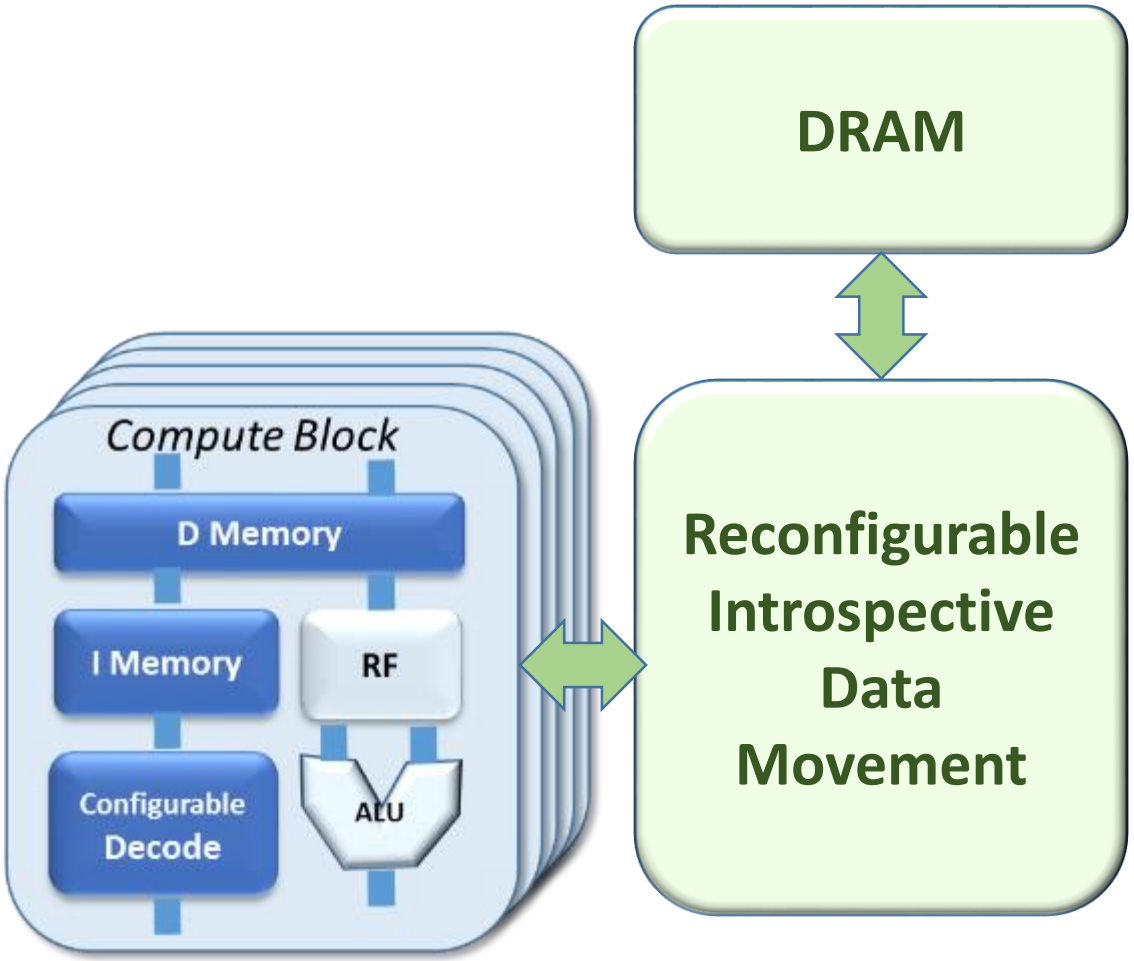
More Orange than Blue

DRAM energy dominates

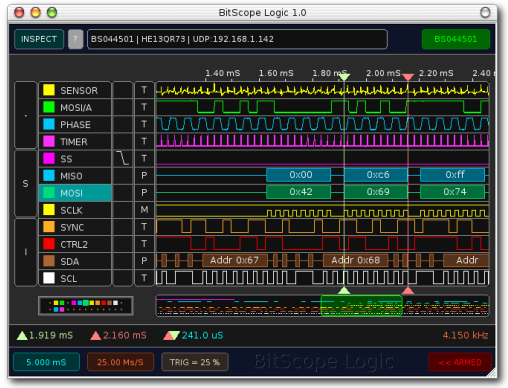




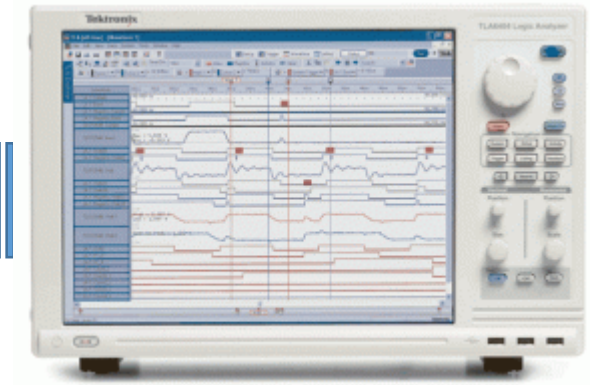
SDH HW Architecture with Introspection



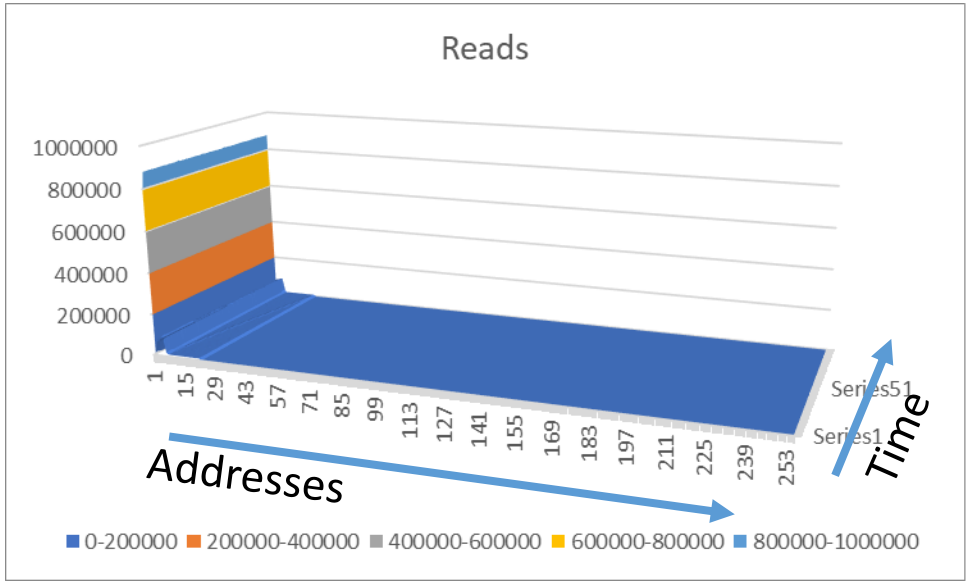
Logic analyzer
Data acquisition system

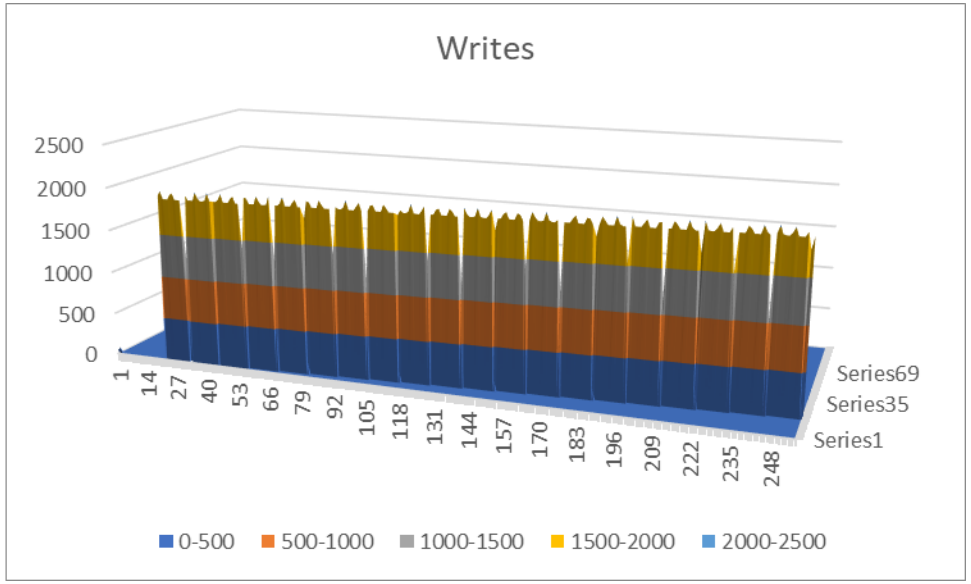


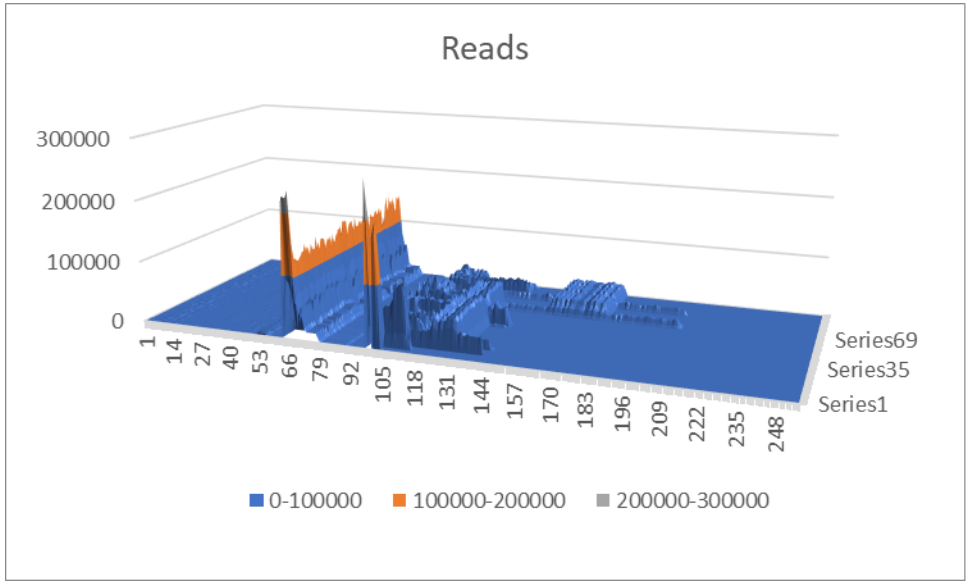
Integrate

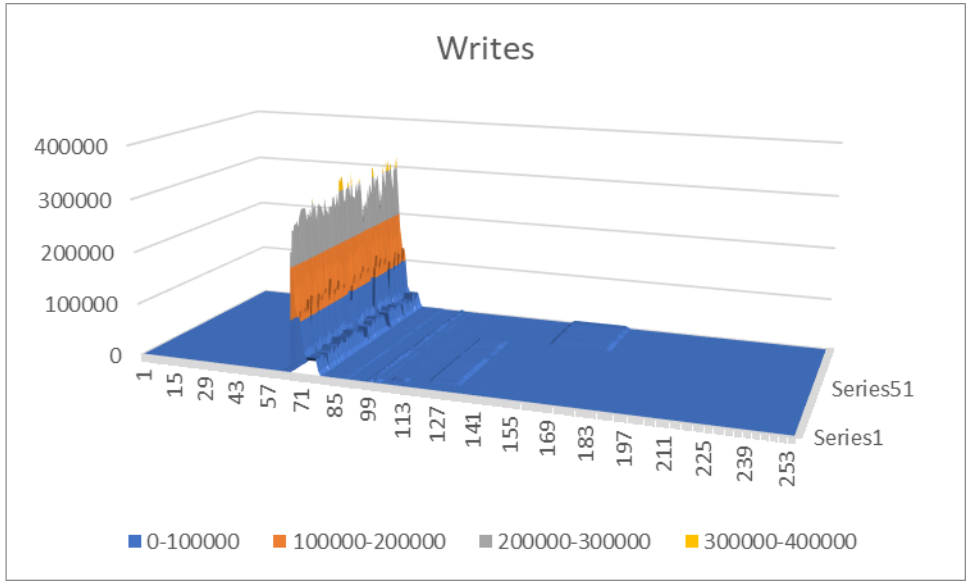


Example: Introspection

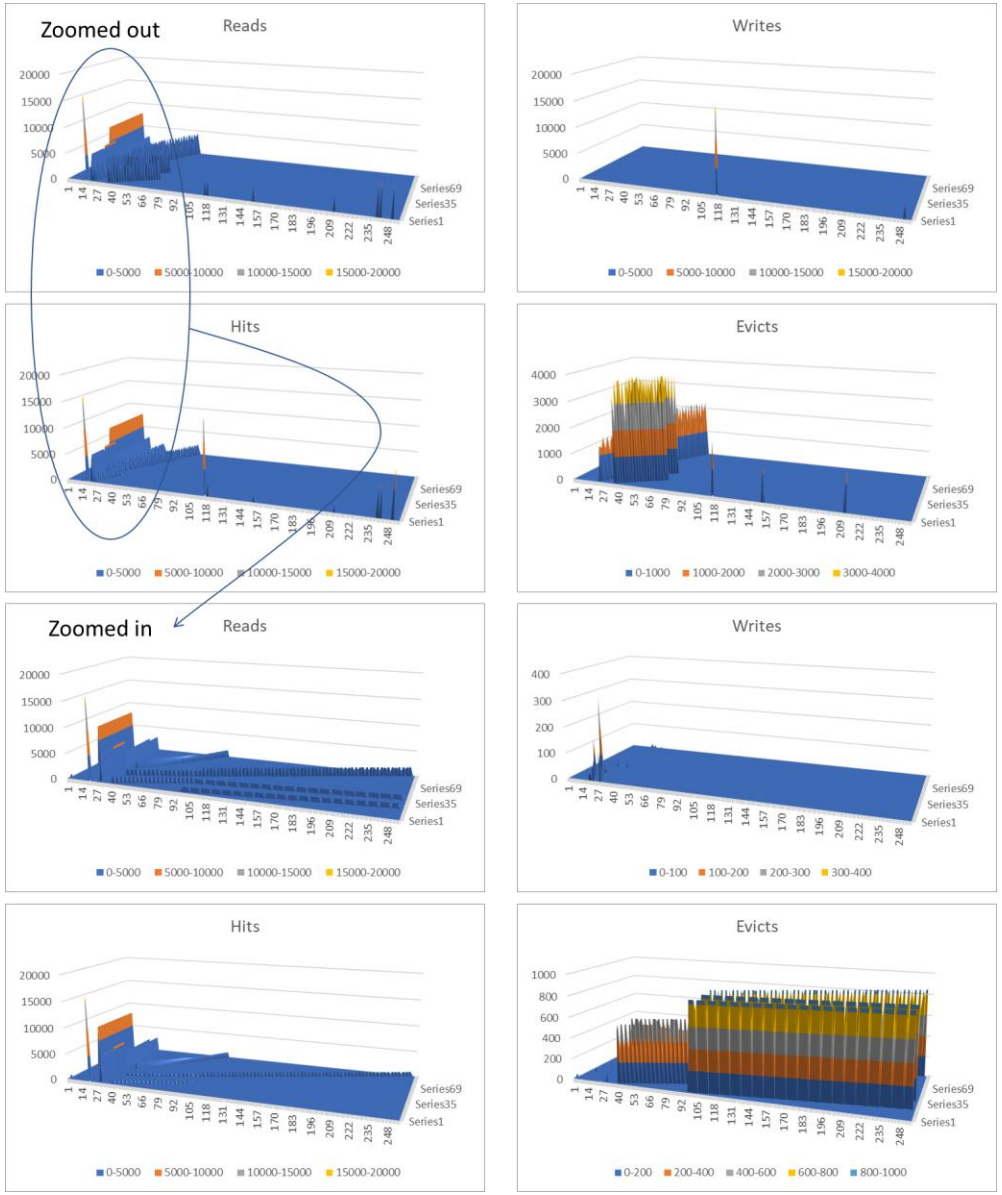


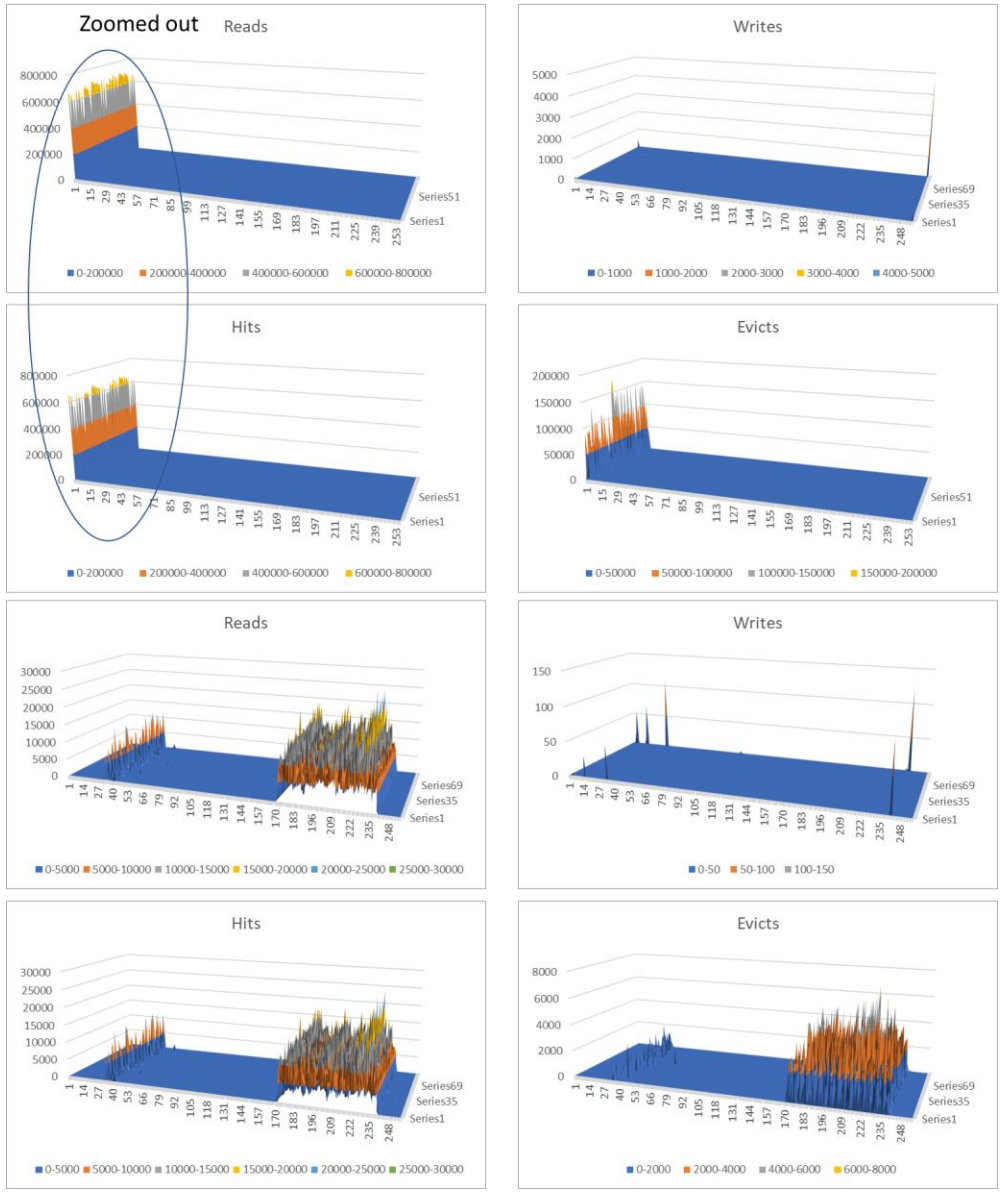






Example: Introspection (Zoom in)





One of *Many* Optimization Criteria

1	Performance	Higher is better (Lower time to solution)
2	Energy	Lower is better
3	Memory Bandwidth	Lower is better—but optimize until it does not exceeds BW limit

Performance ~ V (voltage)

Delay = 1/Performance ~ 1/V (voltage)

Energy ~ V^2 (voltage)

and

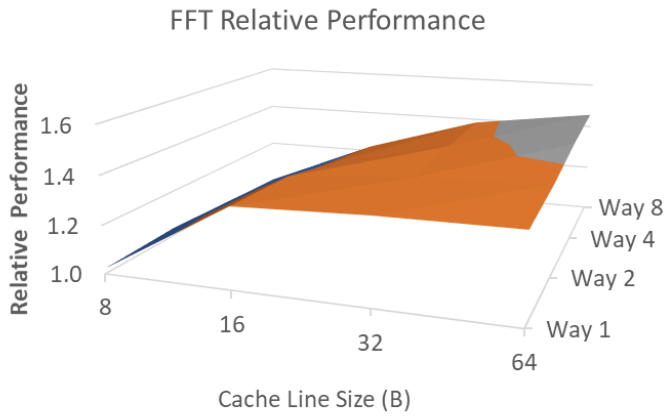
dE/E = 2 x (dP/P), i.e. 1%P = 2%E

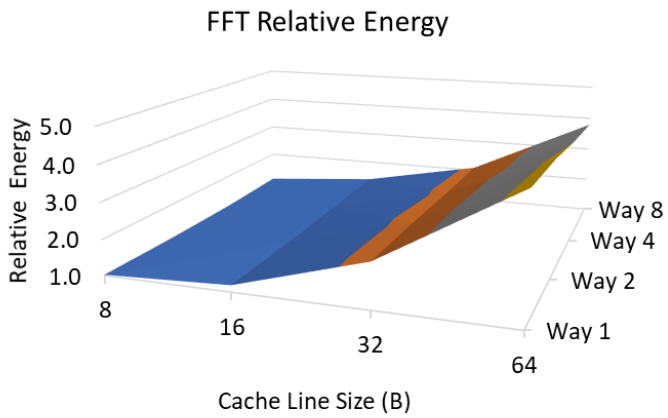
∴ Energy x Delay^2 = 1 (voltage invariant metric)

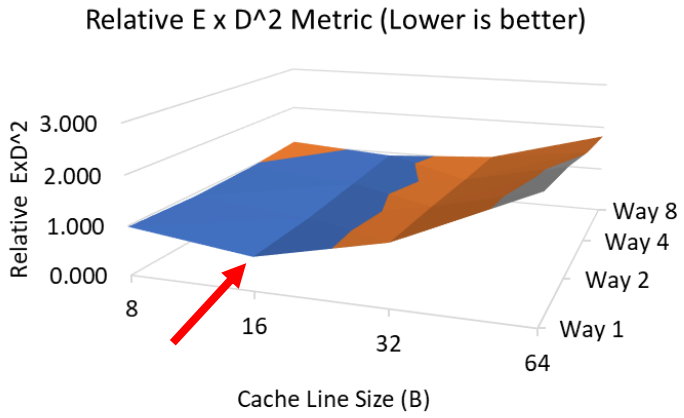
Optimize for the lowest E x Delay^2

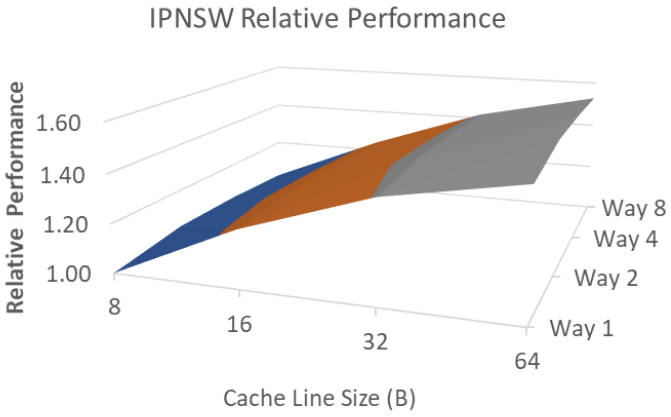
2% Energy for 1% Performance is break-even

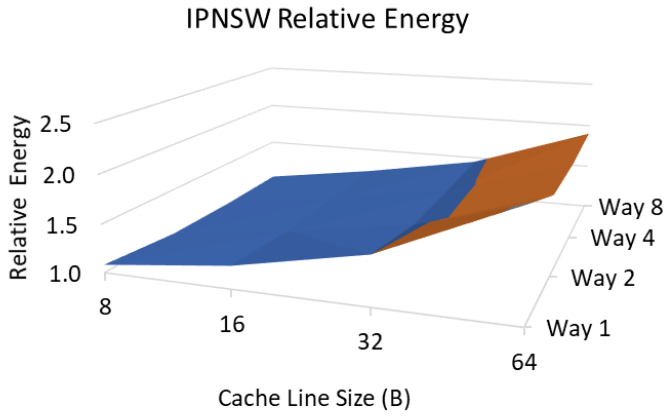
Multi-variate Optimization—Example E x D^2 Metric

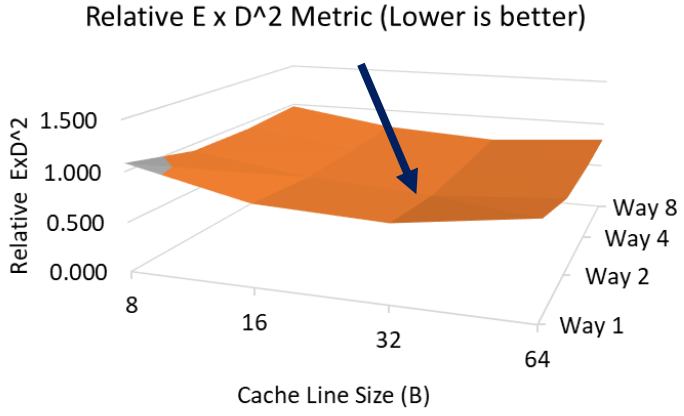






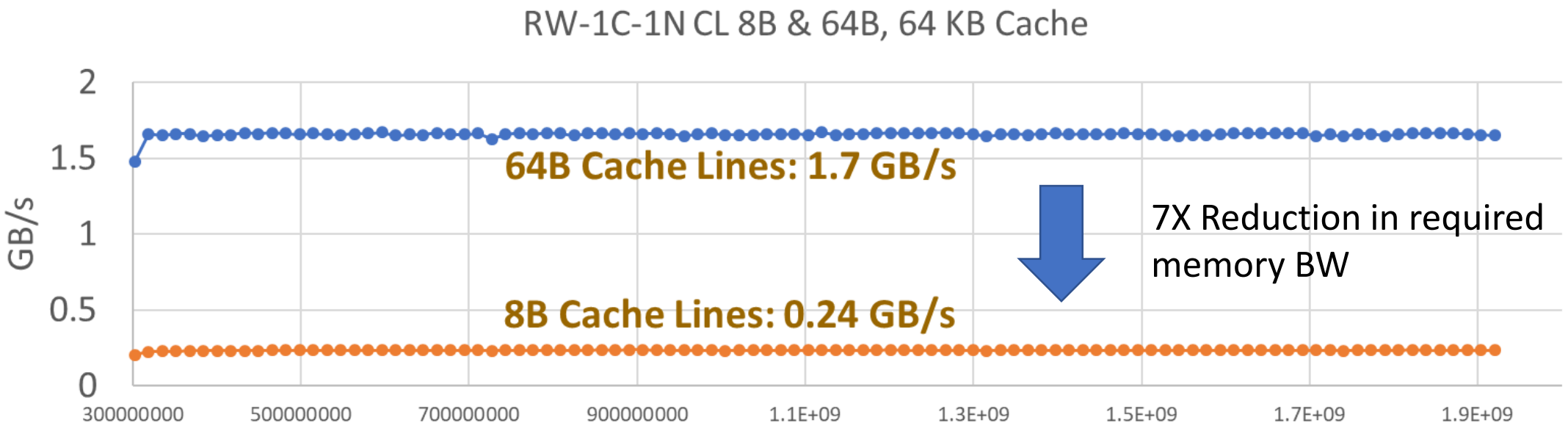






SDH software determines reconfiguration for the given objective

Implications to Memory BW (Data Movement)



Why you keep on asking for more Memory BW?

Conventional approach wastes Memory BW

And you asks for more and more…