INSTITUT NATIONAL DES SCIENCES APPLIQUÉES RENNES

Distributed Memory Allocation Technique for Synchronous Dataflow Graphs

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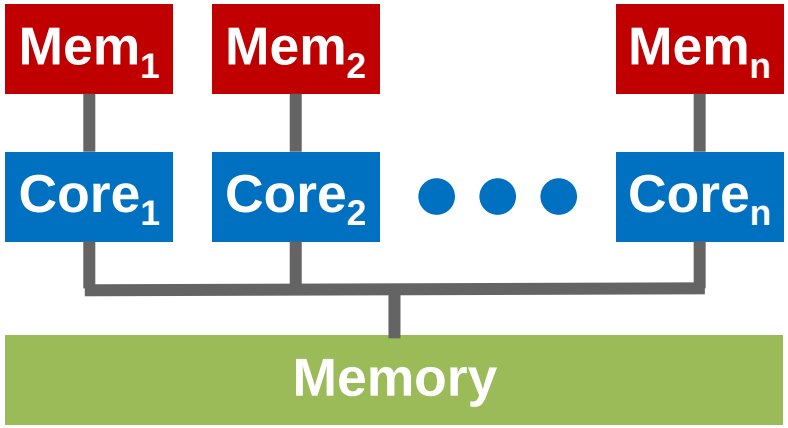
INSTITUT D'ÉLECTRONIQUE ET DE TÉLÉCOMMUNICATIONS DE RENNES

Architects: *Distributed is the new shared!*

Distributed
MPPA
Parallella

Shared
i3,i5,i7
big.LITTLE



Heterogeneous
Keystone I,II
GPUs

Embedded Software Engineer: *Distribu-what?*

- **Shared memory parallel APIs:**
  (P)threads, OpenMP, Cilk, Threading Building Blocks, …
- **Distibuted memory APIs**
  MPI, Go lang → **Mostly for HPC**

Contribution > Objectives

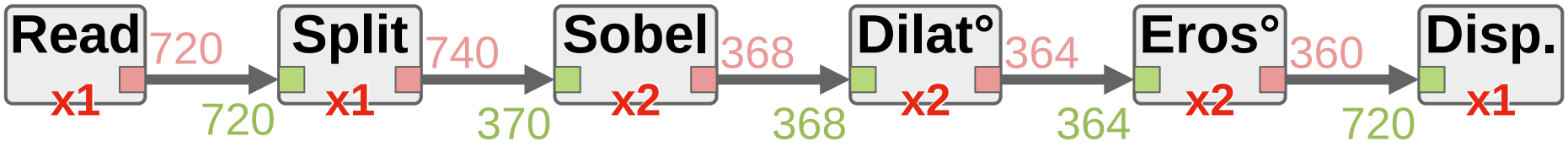
New distributed memory allocation technique:

- **Parallel:** Application described with SDF graphs.
- **Simple:** Fully automated.
- **Flexible:** Shared / heterogeneous / distributed architectures.
- **Efficient:** Memory footprint minimization with memory reuse.
- **Performant:** Improve application performance.

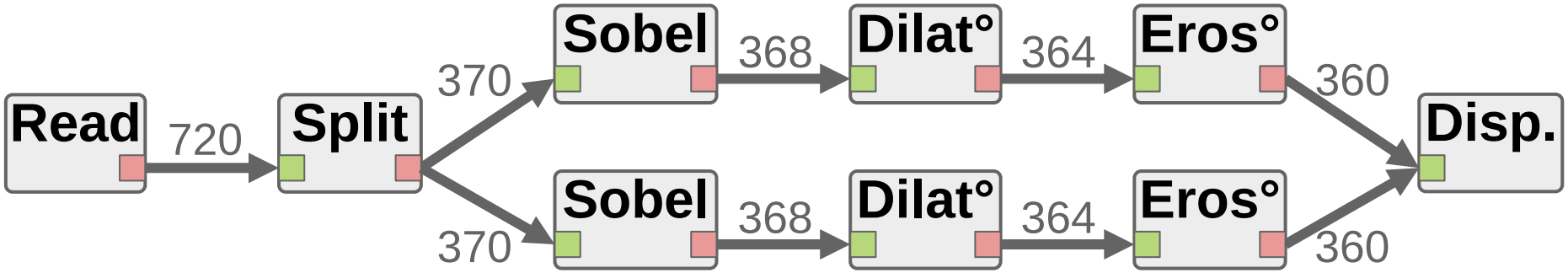
Synchronous Dataflow (SDF) Graph

- Actors and data ports
- FIFO Queues

➡ Data driven execution

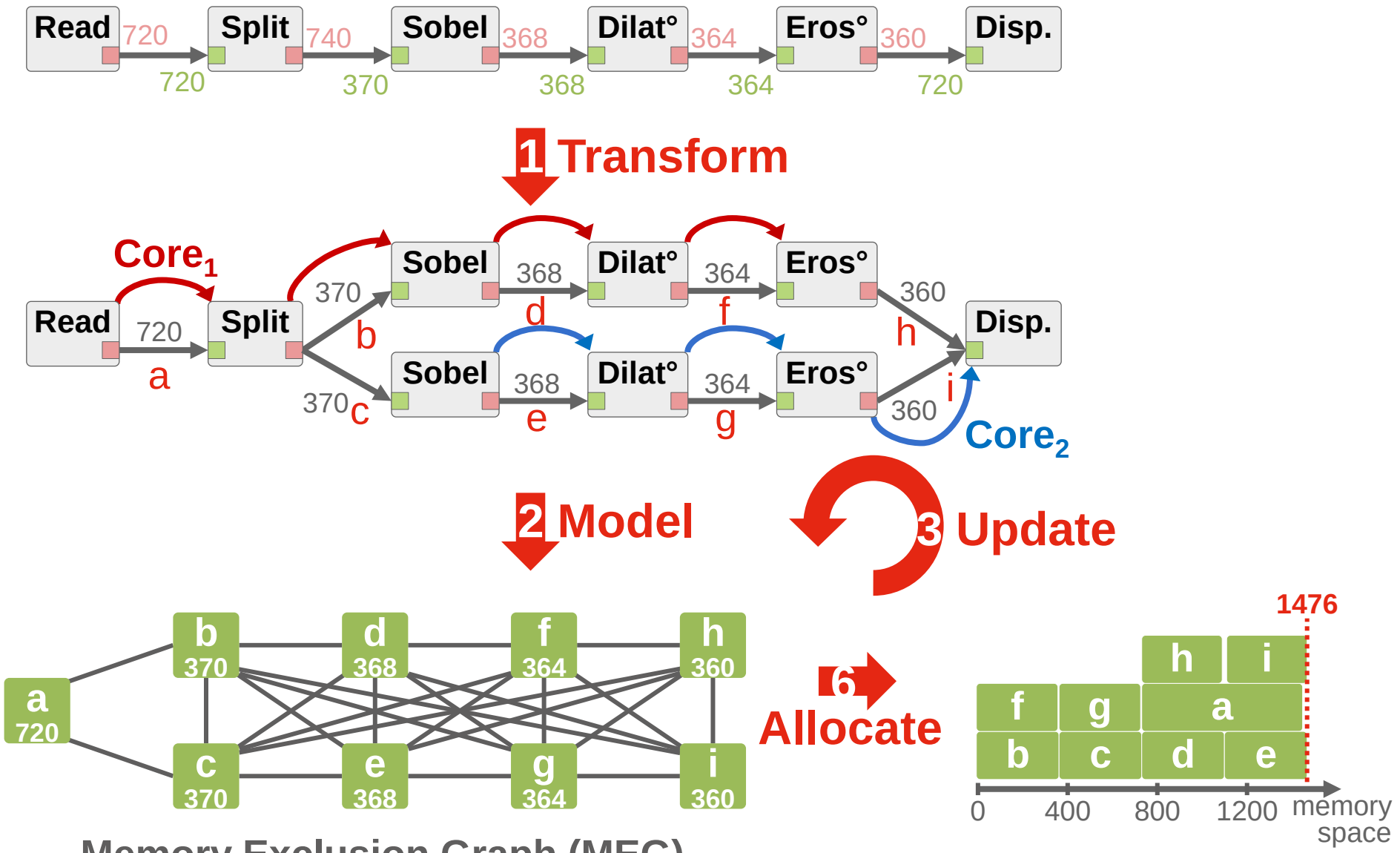


Equivalent single-rate SDF graph



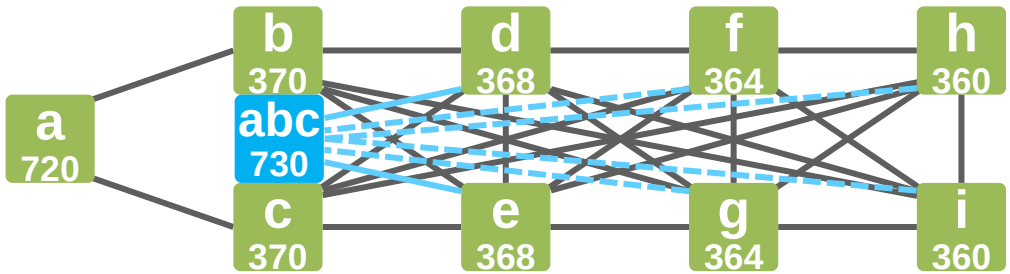
Ref: E. Lee et al. "Synchronous data flow", Proceedings of the IEEE, 1987.

Memory Reuse > SDF Graph-Level

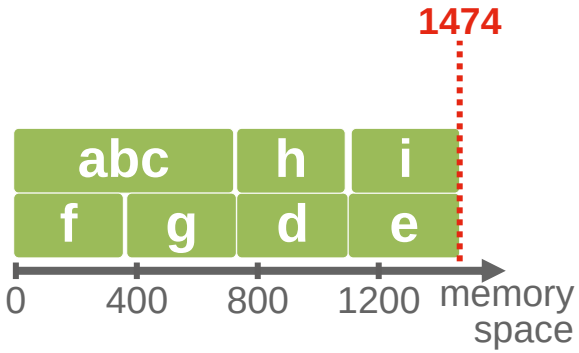


Memory Exclusion Graph (MEG)

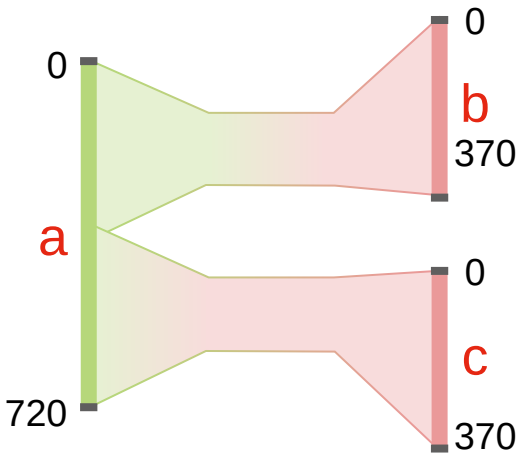
Memory Reuse > Actor Level

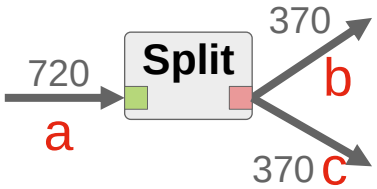


6 Allocate

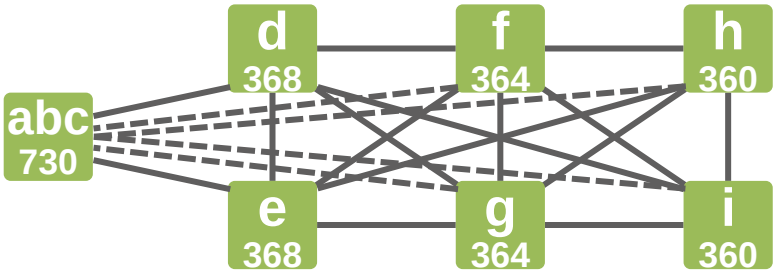


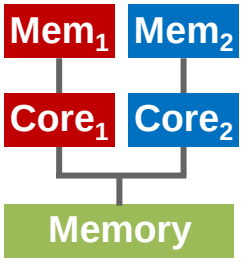
4 Merge

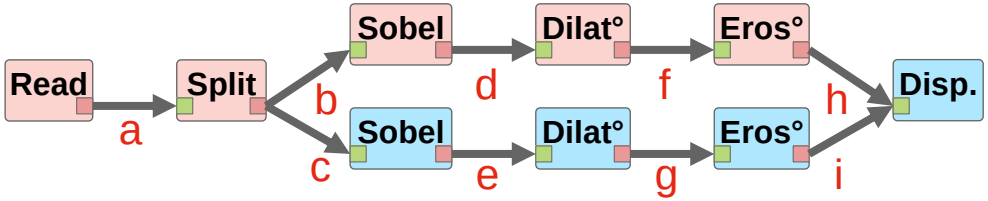




Distribution > Heterogeneous Archi.

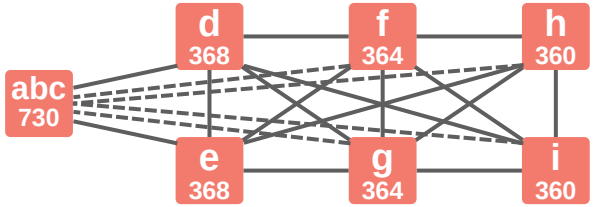




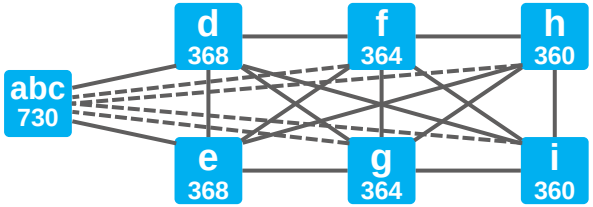


5 Distribute

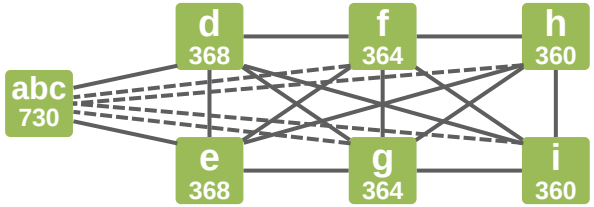
Mem$_1$



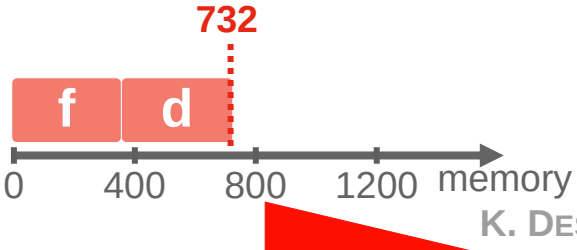
Mem$_2$

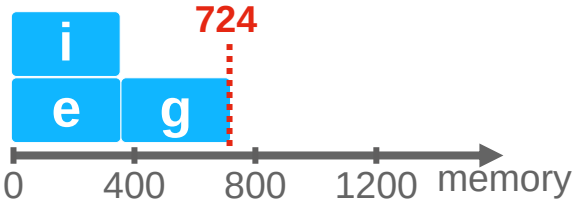


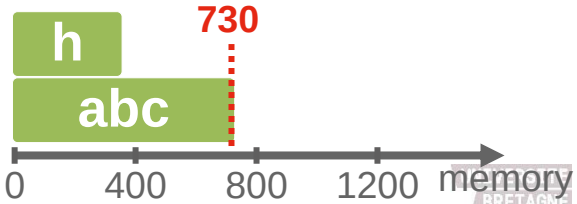
Shared



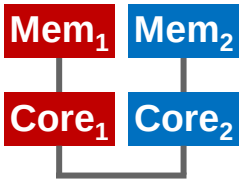
6 Allocate

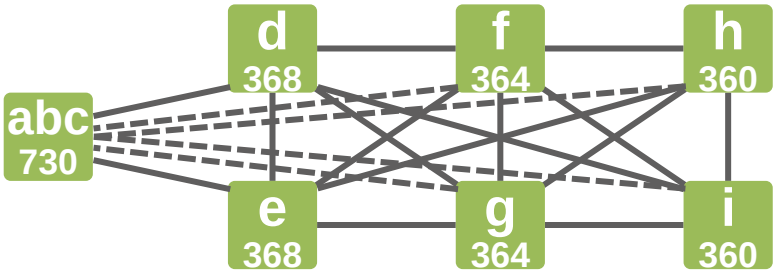


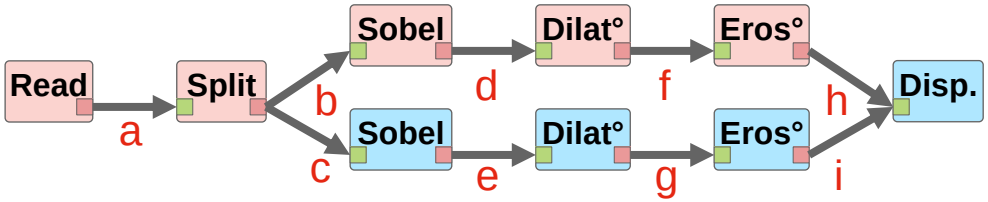




Distribution > Distributed Archi.

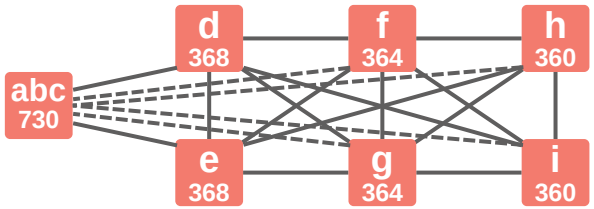




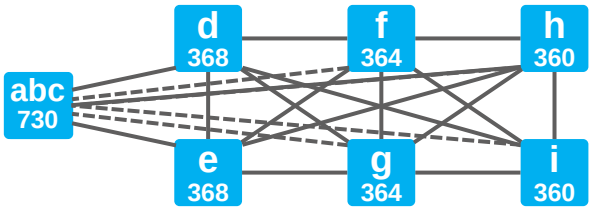


5 Distribute

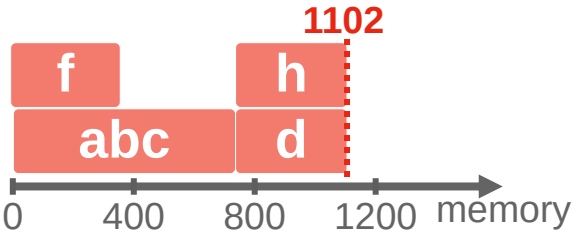
Mem$_1$



Mem$_2$



6 Allocate



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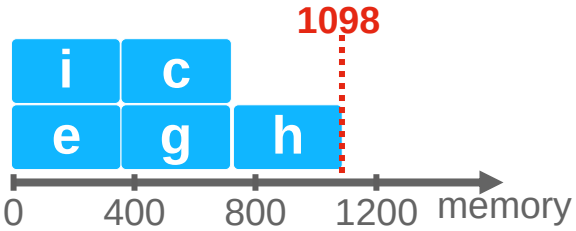
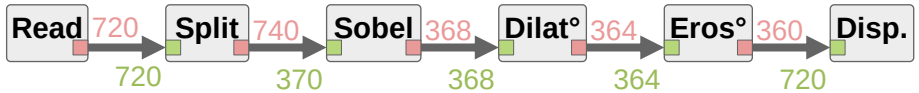
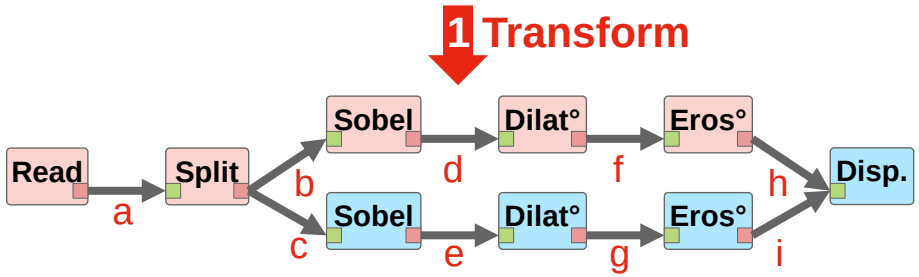
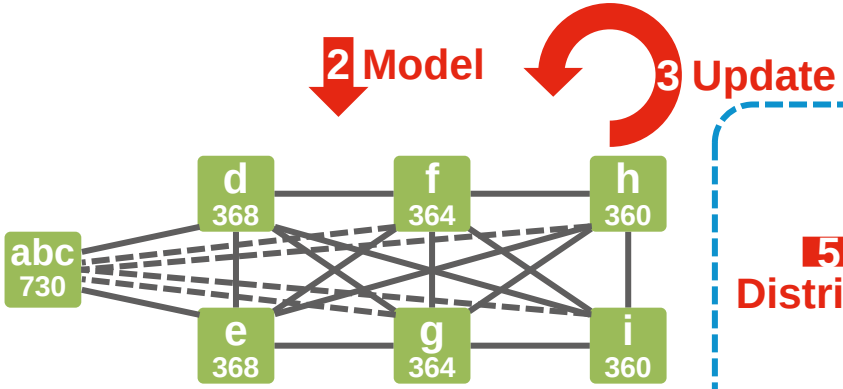
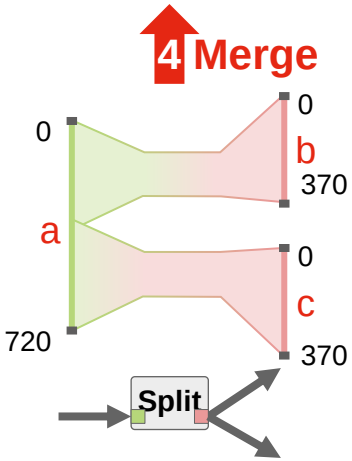


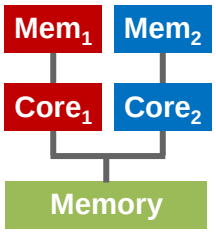
Distribution > Overview

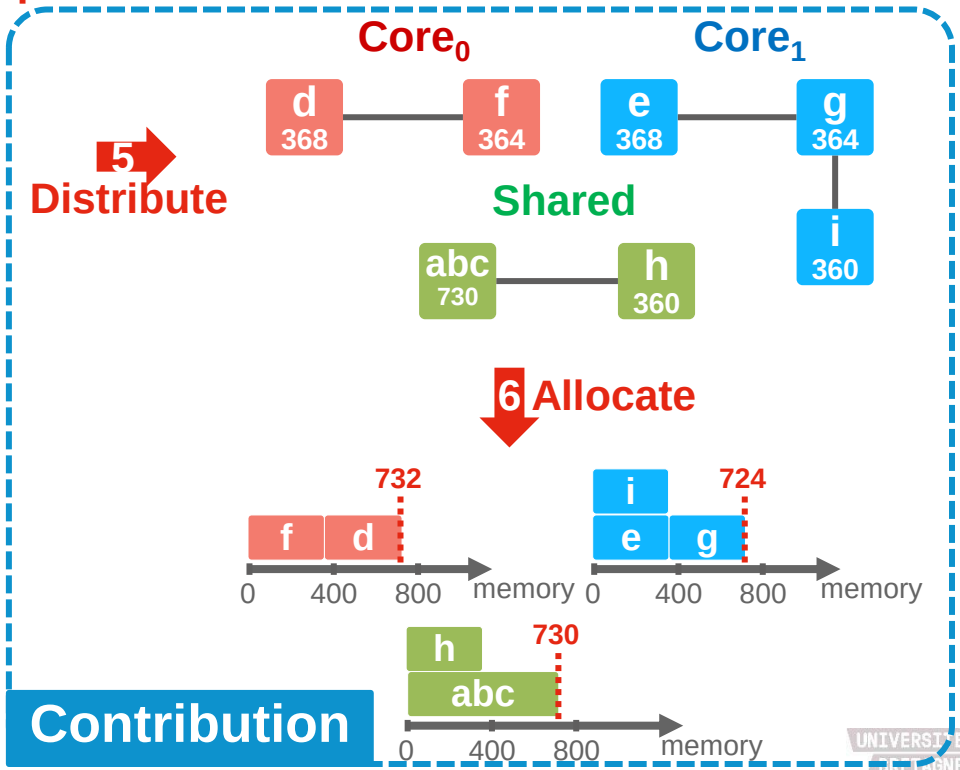








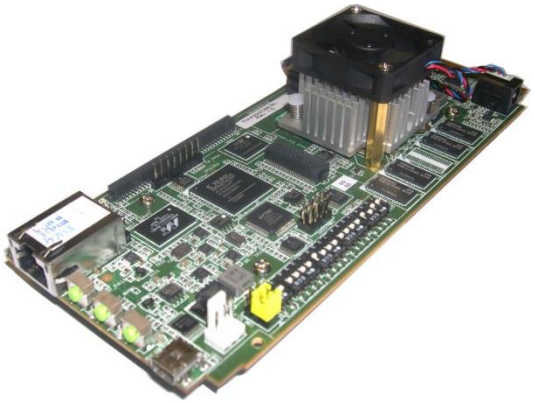




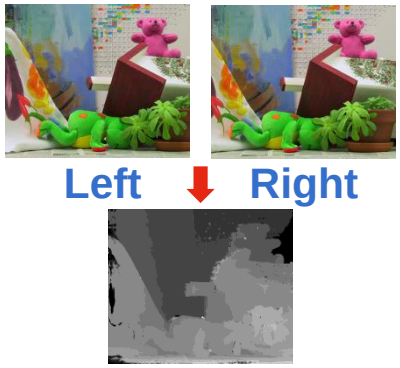
Experiments > Setup

- **PREESM**
  - **Rapid prototyping framework**
  - **Open-source** ➡ **Reproducibility**

- **Texas Instruments C6678**
  - **8 DSP cores**
  - **Heterogeneous memories:**
    - Optional L1 caches: 32 kBytes / core
    - Distributed memories: 512 kBytes / core
    - Shared memory: 512 Mbytes



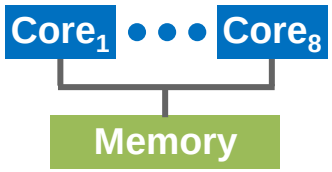
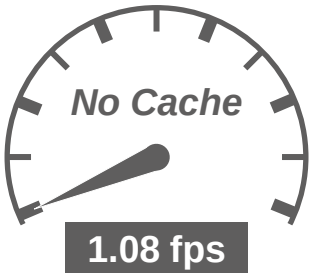
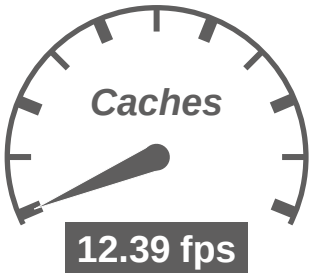
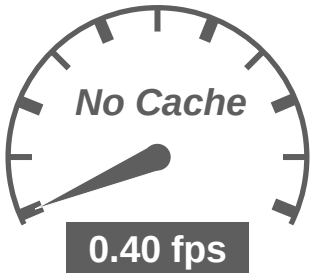
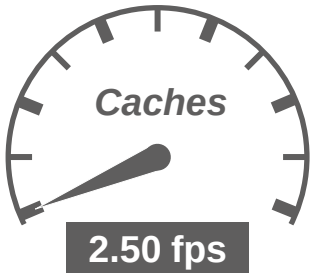
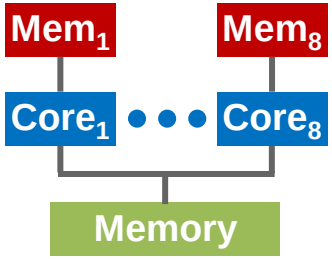
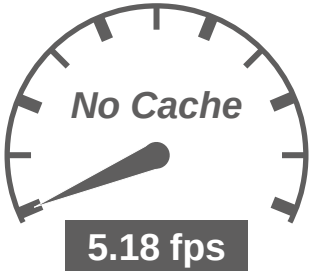
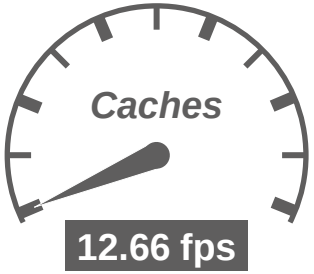
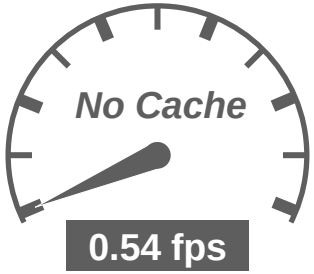
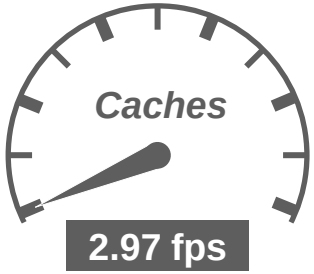
- **Computer vision algorithms**
  - **Sobel & morphological operations**
  - **Stereo Matching:**
    - 28 actors, 42 FIFOs,1067 buffers



Experiments > Memory Footprints

	Sobel	Stereo
Shared Core$_1$ • • • Core$_8$ Memory	3800kB	5.50 MB
Heterogen. Mem$_1$ Mem$_8$ Core$_1$ • • • Core$_8$ Memory	240kB 2400kB total: 4320kB	0.21 MB 0.31 MB 4.93 MB total: 6.81 MB
Distributed Mem$_1$ Mem$_8$ Core$_1$ • • • Core$_8$	248kB 2300kB 1900kB total: 5688kB	4.32 MB 4.09 MB 4.30 MB 4.20 MB 4.43 MB 4.40 MB 3.78 MB 4.07 MB

Experiments > Performance Impact

	Sobel		Stereo	
Shared 				
Heterogen. 				
Distributed	***Distributed code generation: Future work***			

Conclusion

New distributed memory allocation technique:

- **Parallel:** SDF Graph
- **Simple:** Automated
- **Flexible:** Memory architectures
- **Efficient:** Memory reuse
- **Performant:** Applications

Future work

- **Code generation for distributed architecture** (W.I.P)
- **Memory aware mapping/scheduling**

http://preesm.sf.net **@PreesmProject**