

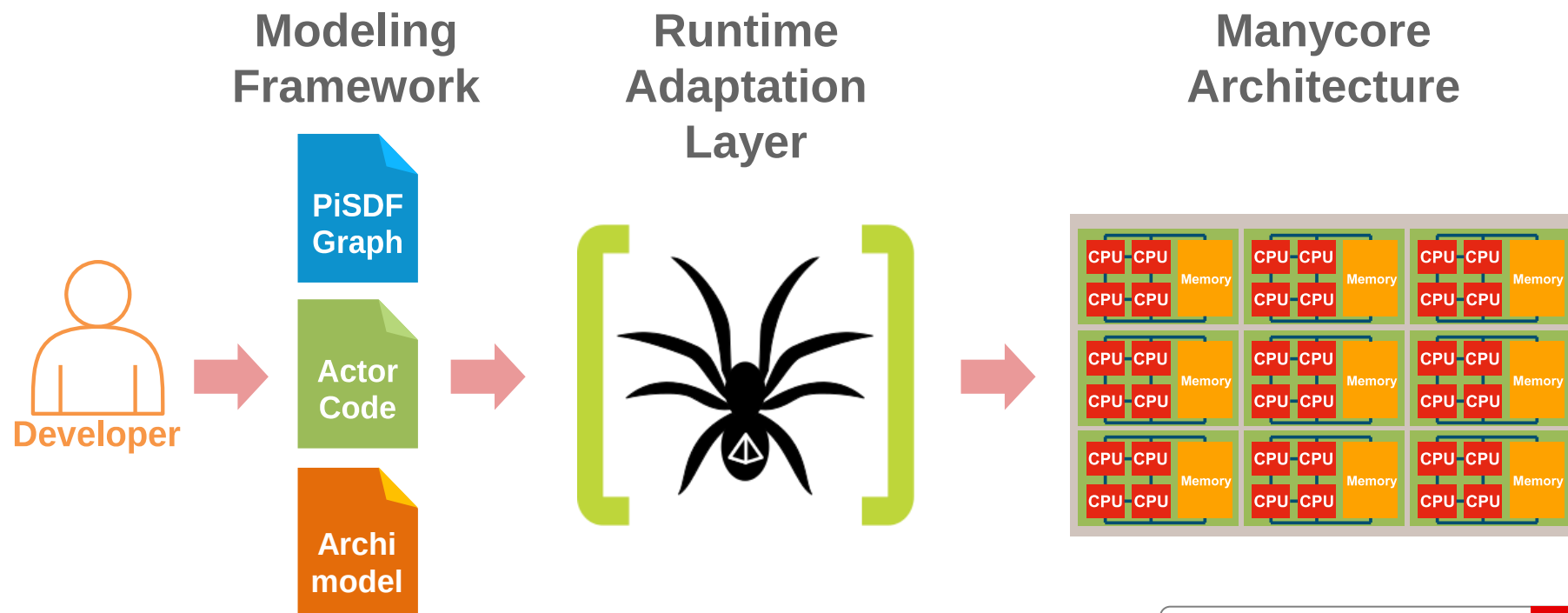
Porting the Spider Dataflow Runtime on the Kalray MPPA Manycore Architecture

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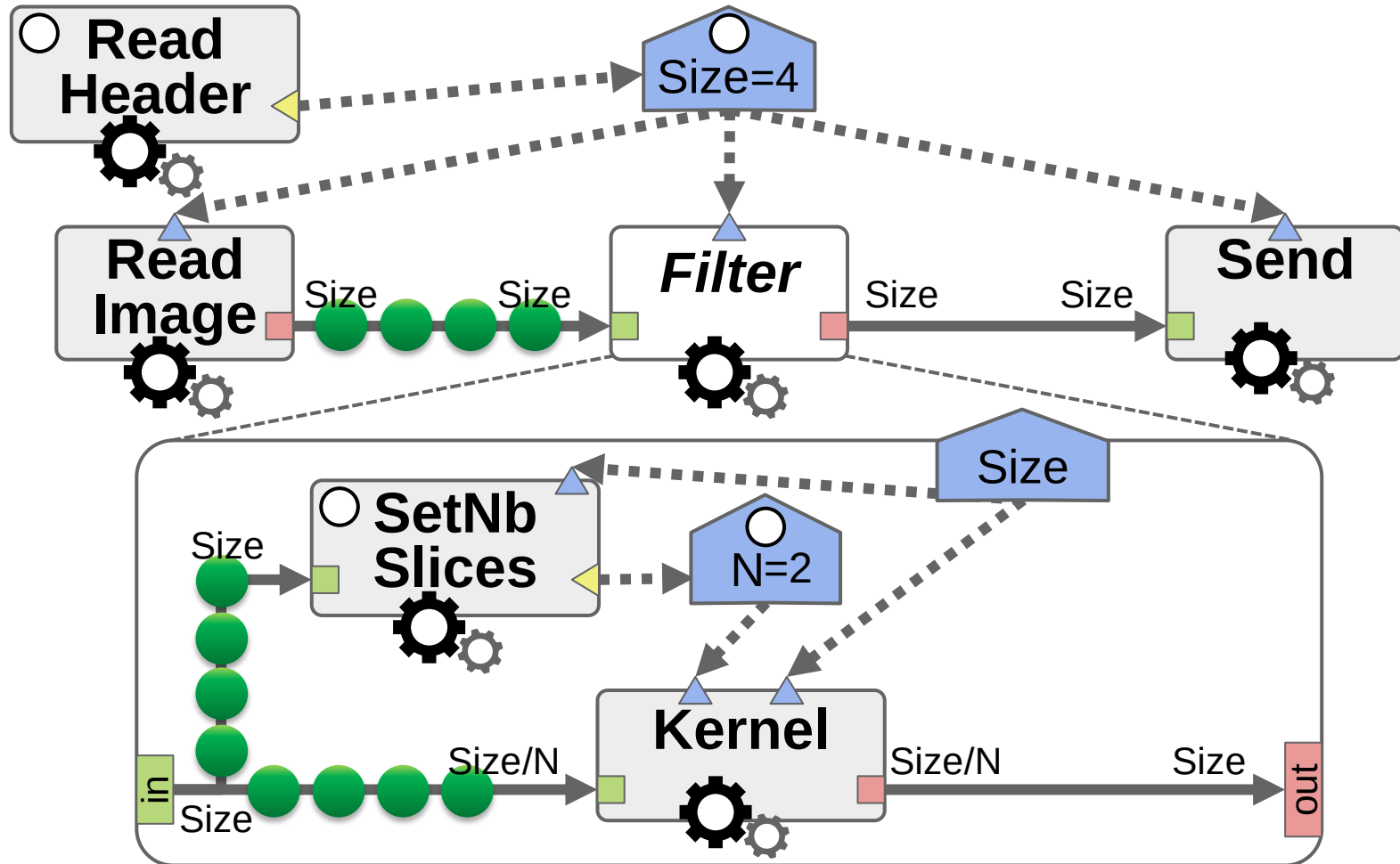


KALRAY

Reconfigurable Dataflow for Manycore

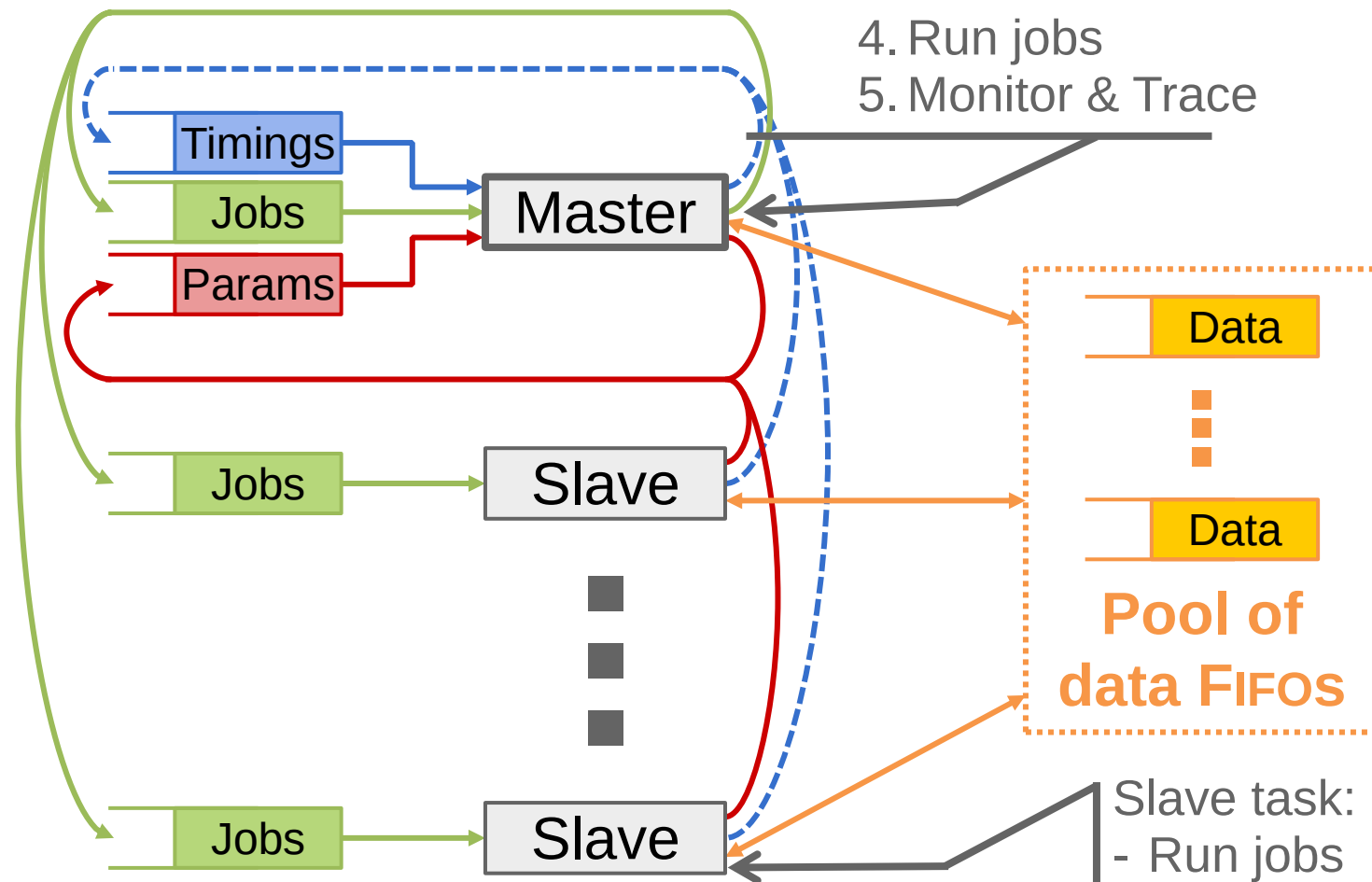


The PiSDF Model of Computation



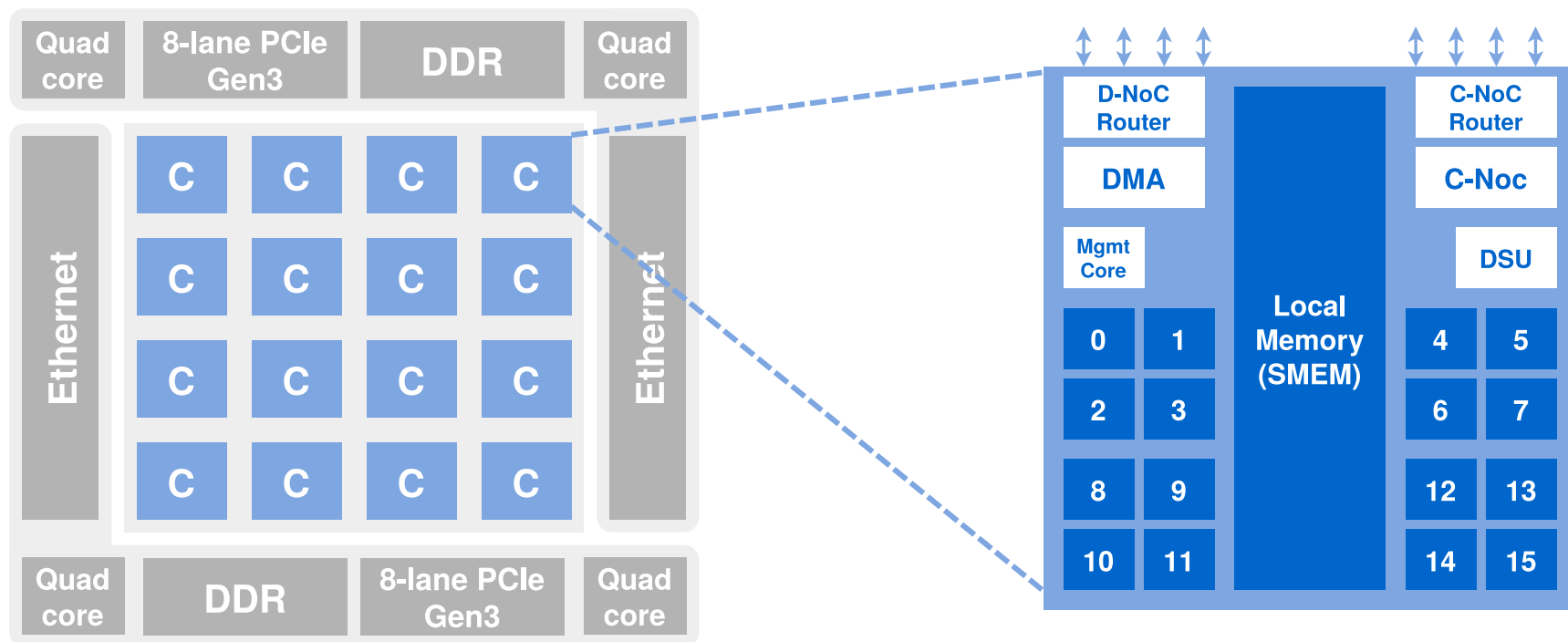


1. Manage graphs
2. Map & Schedule
3. Send Jobs
4. Run jobs
5. Monitor & Trace



Heulot et al. "Spider: A synchronous parameterized and interfaced dataflow-based RTOS for multicore DSPs" EDERC, 2014

Manycore Architecture: Kalray's MPPA256B

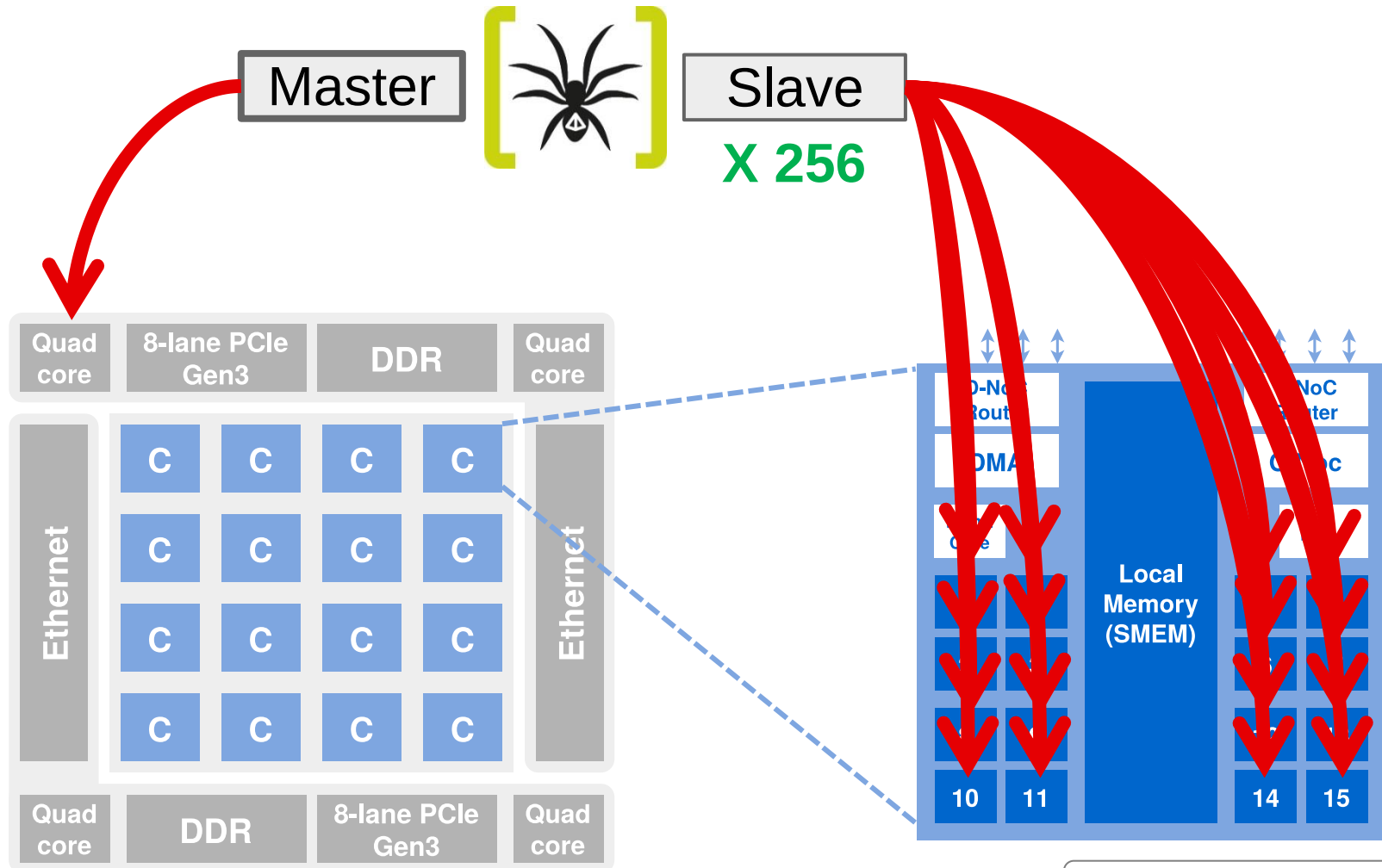


Challenges

- Distributed scratchpad memory
- Massive parallelism
- NoC-Based communications

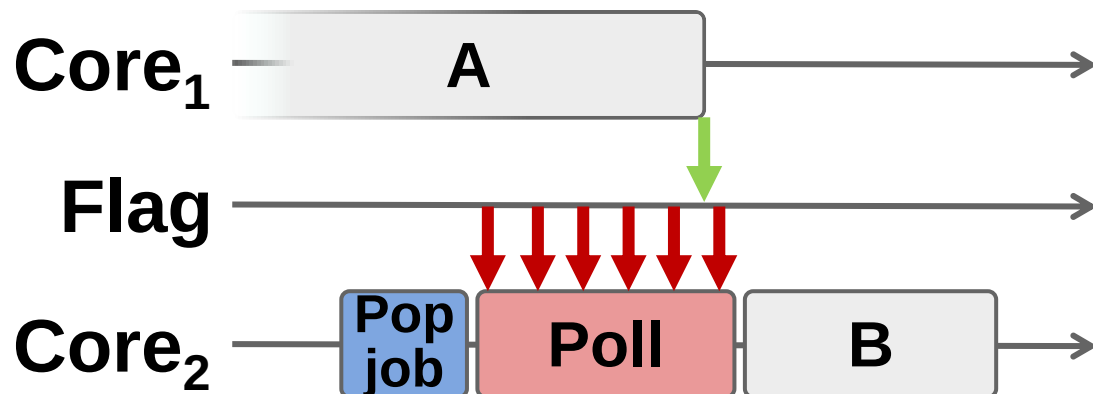
- **Distributed synchronization**
- **Lightweight manycore scheduling**
- **Dataflow-based distributed memory allocation**

Spider distribution on MPPA

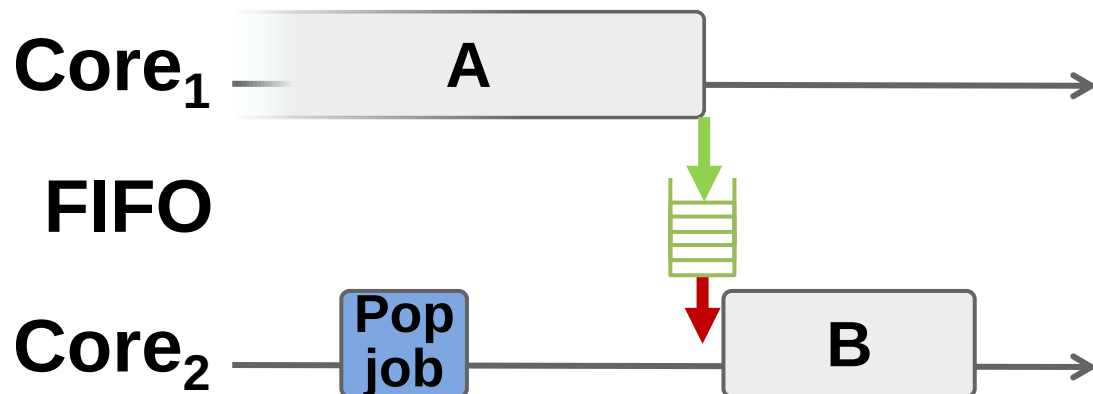


Previous Synchronization Mechanisms

Shared-Memory Based
(x86, Big.LITTLE)

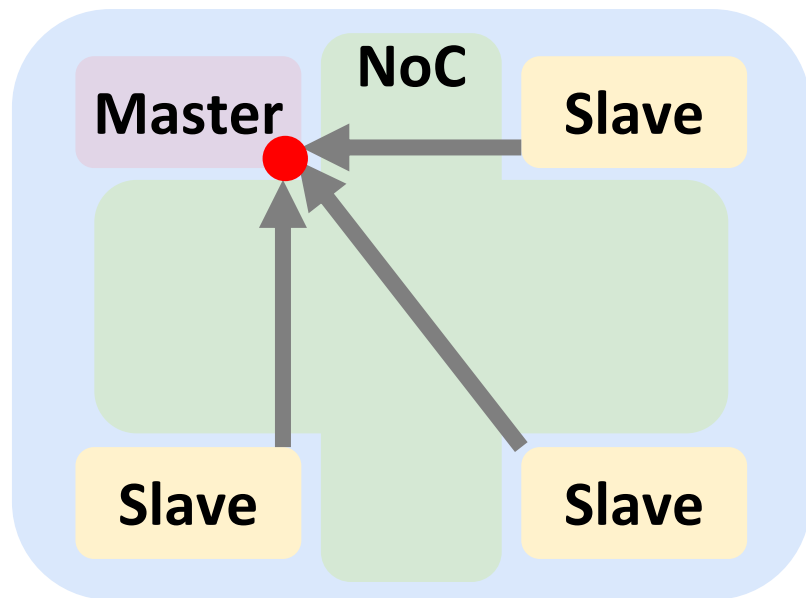


Hardware supported
(TI Keystone 2)



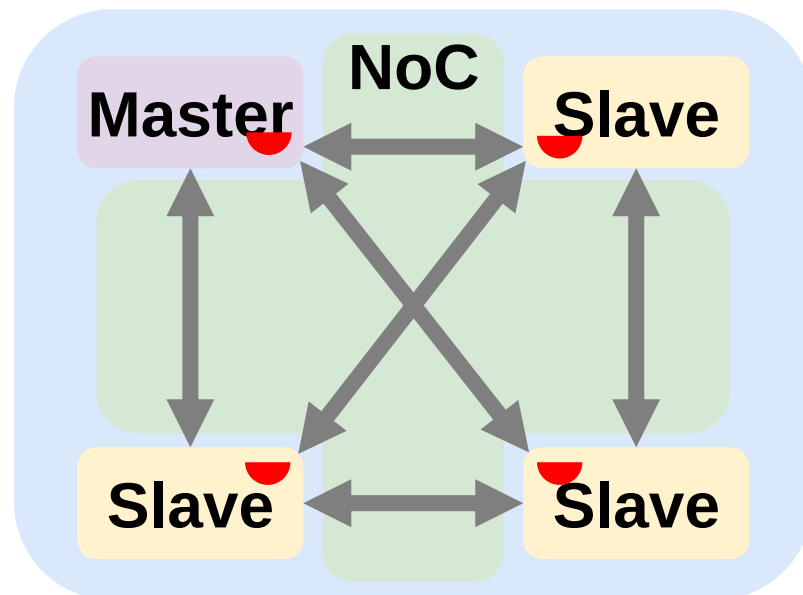
Synchronization Mechanisms

Before:
Centralized Polling



- **Unbounded communications**
- **Contention**

After:
Distributed notifications



- **Notifier/Observer pattern**
- **Bounded communications**

Complexity issue for manycore



Good'ol List scheduling

1. Create a sorted list of all actors to map/schedule.
2. Schedule first actor of the list of first available core.
3. Go back to step 2 until the list is empty.

Complexity:

$$O(A \cdot \log(A) + P \cdot A)$$

A : # actors

P : # processors

Multicore architectures:

P smaller than $\log(A)$

$\Rightarrow A \cdot \log(A)$ dominates

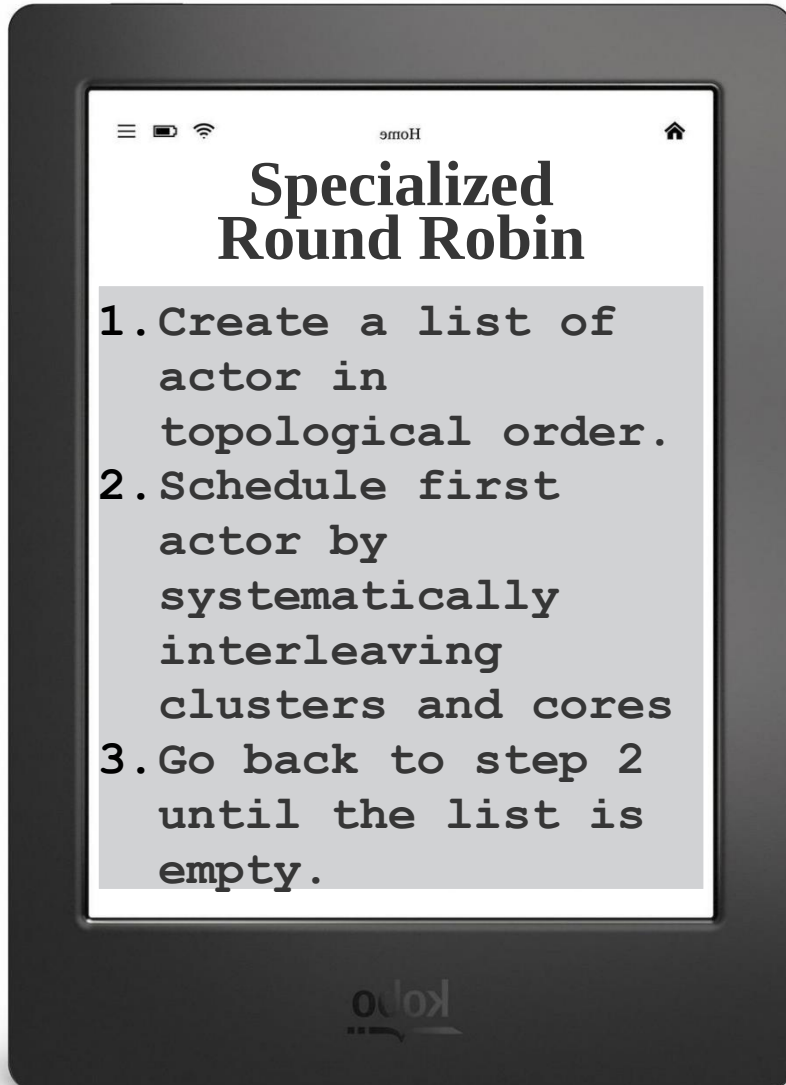
Manycore architecture:

P is large

$A \propto P$ (by designer)

$\Rightarrow$ Complexity  quadratically

Lightweight Scheduling



Complexity:

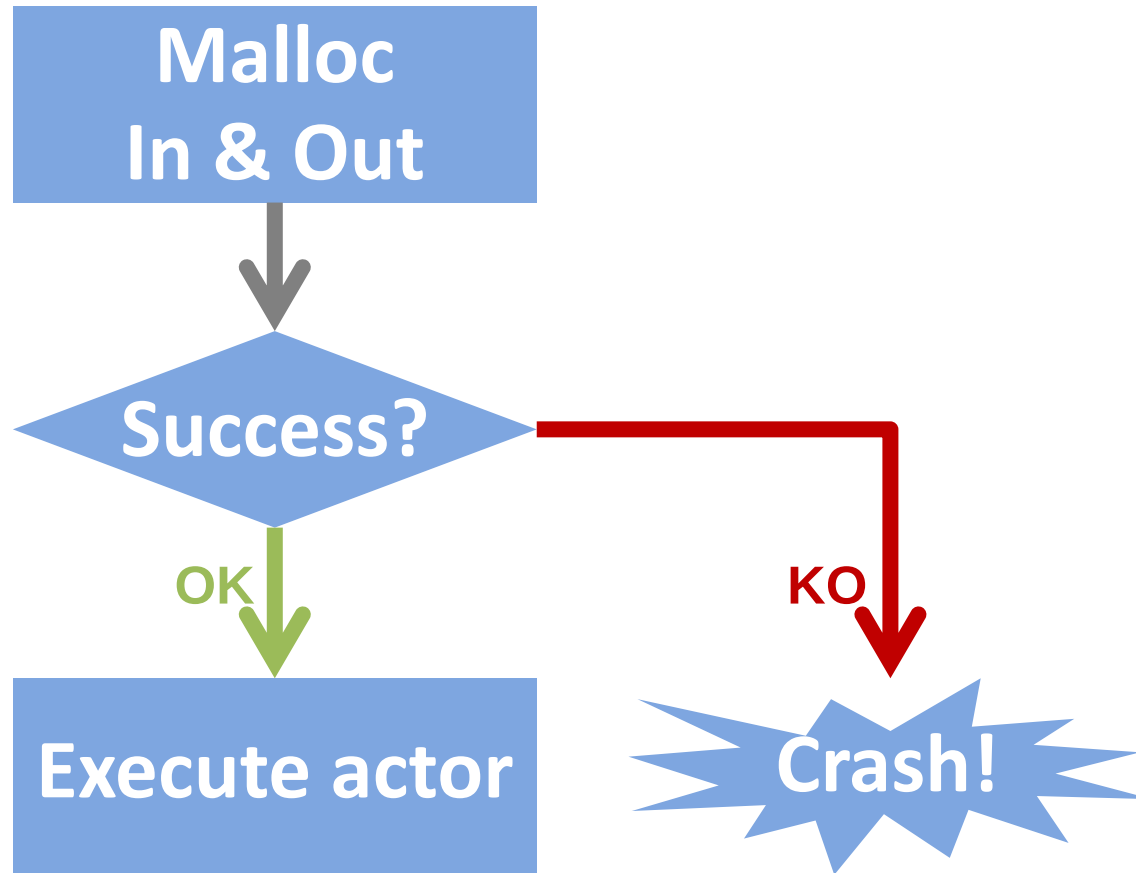
$$O(A)$$

A : # actors

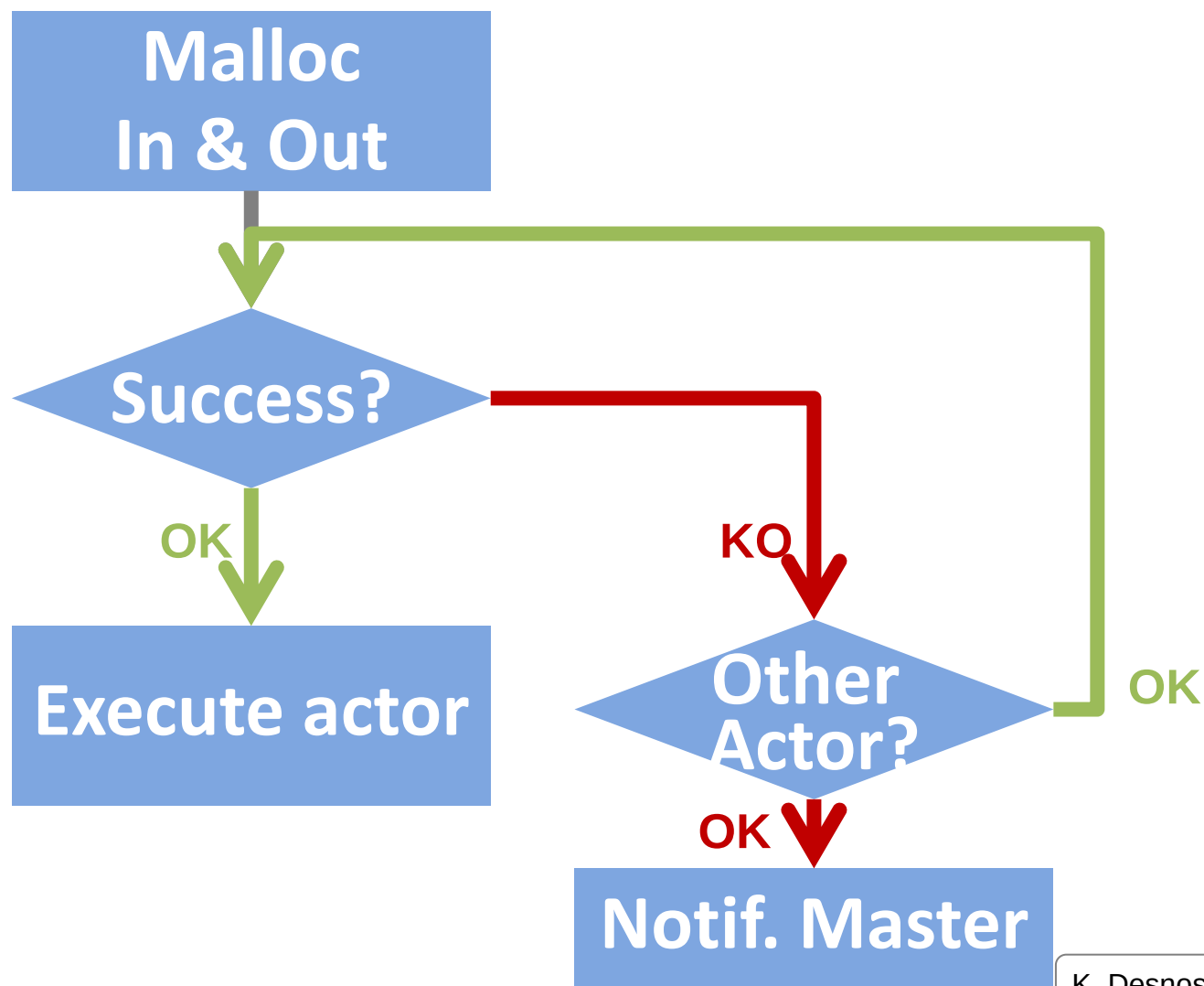
Advantages:

- Low complexity
- Interleaving clusters avoids communication contentions between starting actors.
- The scheduler controls the number of jobs in the queue of a core.

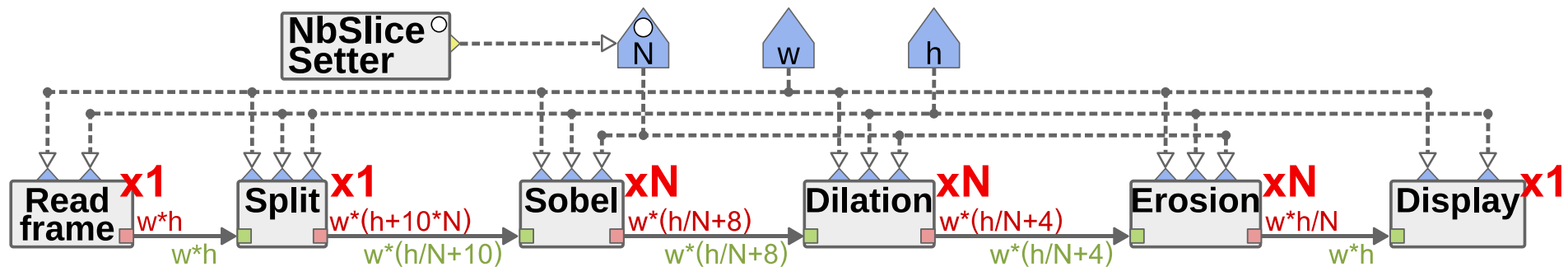
Classic Memory Allocation



Cluster-Level Dataflow Aware Memory Allocation

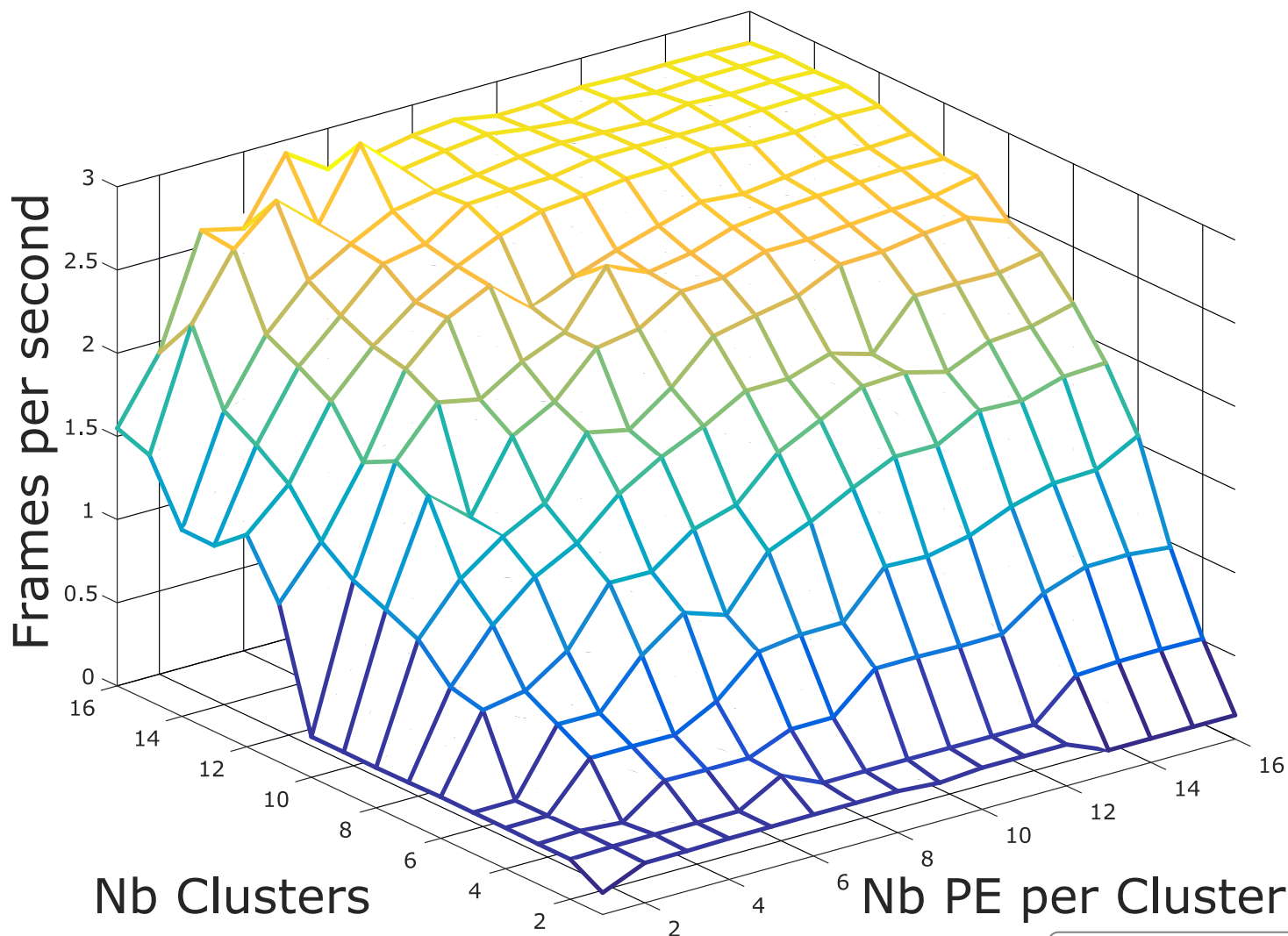


Sobel + Morphological operator



Results > Performance

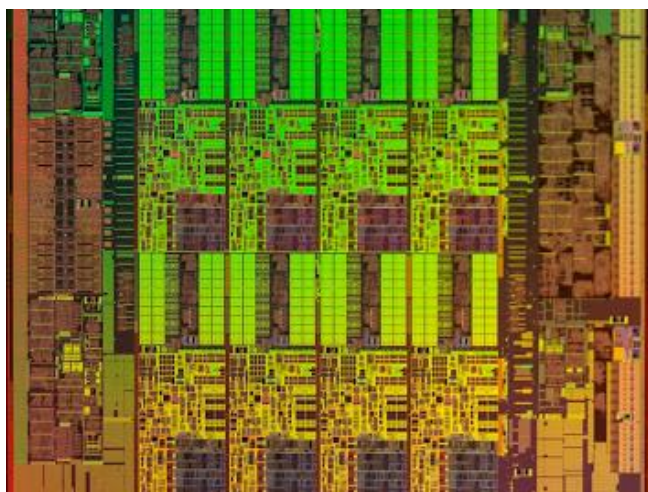
Max speedup: 22 on 256 cores (on 4k video)



Results > Energy

2.5 more energy efficient (On 4k video)

Intel
Xeon E5-1650
6-hyperthreaded x86



11.40 fps
~120W

Kalray
MPPA256 Bostan
258 RISC Cores



2.81 fps
~12W

Successful porting of Spider on MPPA

- **Feasible:** Reconfigurable Dataflow Runtime for manycore
- **Promising:** Energy efficiency beats x86
- **Open source(-ish):** On github!

Future Work

- Better
 - Faster
 - Stronger
- 
- A large, dark gray curly bracket is positioned to the right of the 'Future Work' list, grouping the three items.



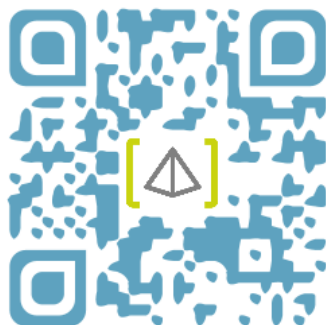
Julien, Florian, Alexandre,
Hamza, Claudio, ...



Achievement unlocked
Thanks for your attention



Achievement unlocked
Question time



<http://preesm.sf.net>



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