Application Architecture Adequacy through an FFT case study

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Motivations - Modeling - Limitations

**Problem**: Weak portability for a given application.

**AAA**: Dataflow application to Architectural platform model

- **Mapping adequacy**:
  - Fine grain optimizations
  - Multi-threading/Multi-processing: Tiling and scheduling.

**Code generation**

AAA requires a description of the HW (memory hierarchy, interconnect, computing elements, ...).
Motivations - Modeling - Limitations

Networks on chips replace/complement buses (for scalability purposes).
Many different NoC based platforms exist.
GPUs and CPUs have heterogeneous programming models.

Kalray MPPA256
Required steps for AAA:

1. **Dataflow SW modeling**: architecture independent
2. **Hardware modeling**
3. **Fine grain adaptation** (ILP) for each computation unit
4. **Tiling and mapping** coarse grain parallelism
5. **Scheduling** computation and communication
Dataflow process networks: fine grain parallelism

4-samples FFT Data Flow representation
Dataflow process networks: coarse grain parallelism

Coarse 4096-samples FFT Data Flow representation
Motivations - Modeling SW - Limitations

Dataflow process networks: refined application

H264 encoding annotated Data Flow representation
Motivations - Modeling HW - Limitations

- **Sparse compiler parameters:** streamIt
- **Sparse code annotation:** openMP (nb of threads), openCL (clDevice class), cuda (cudaDeviceProp structure).
- **High level descriptions:** sysML, TLM systemC
- **Very accurate descriptions:** Cycle Accurate Bit Accurate SystemC
- **Synthesizable descriptions:** HDL languages

AAA requires a hardware description: nb of threads and which address space they share, cache sizes, nb of DMA engines, throughput/latency/routing of the **interconnect**.
The AAA methodology is required for efficient design ans portability.

**Going further**: Consider all non-functional properties (Temperature/Power/Performance).

**Limitations**: It is much harder to model dynamic behaviors with dataflow process networks (data-dependent execution, temperature/power thresholds). HOPE (Hierarchically Organized Power/Energy management).

http://anr-hope.unice.fr/.