Real-Time Support in the Proposal for Fine-Grained Parallelism in Ada

Motivation

- Real-time parallel models are now common
  - But little exists on fine-grained parallelism within real-time languages and runtimes
- Ada is a language of choice for reliable real-time systems
  - It incorporates models of computation which are amenable for real-time analysis
  - Ada 2012 supports many real-time multiprocessor scheduling schemes, global and partitioned
- Existent multiprocessor support in Ada follows a coarse-grained model
  - It needs to be augmented with lightweight fine-grained parallelism.

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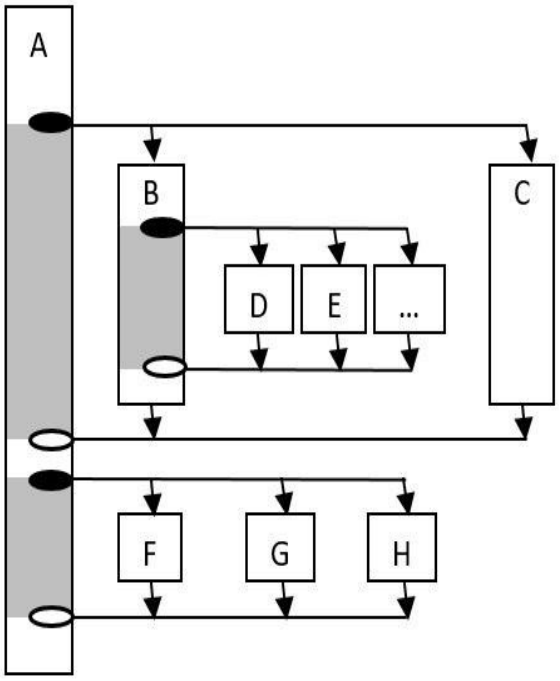
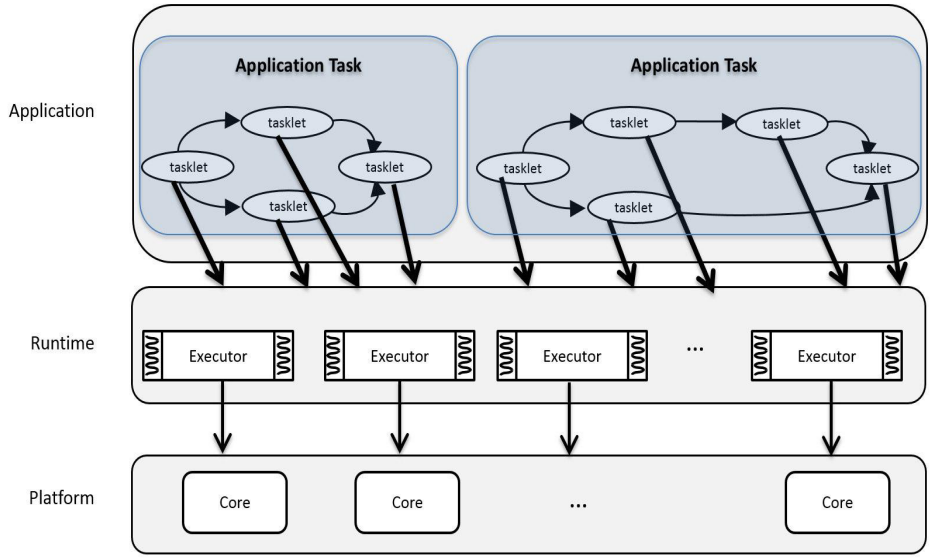
Ada 202X fine-grained parallelism

- Definition of a parallel non-schedulable unit (Tasklet)
  - Explicit or implicit parallelization
  - Ada Tasks execute graphs of Tasklets

```
task body My_Task is
begin
  -- Code of A
  parallel
     -- Code of B
     for I in parallel Some_Rage loop
          -- D, E, …
     end loop;
  and
     -- Code of C
  end;
  -- A again
  parallel
     -- Code of F
  and
     -- Code of G
  and
     -- Code of H
  end;
  Code;
  -- A again
end;
```



Execution Model



- Tasklets are executed by Executors
  - E.g. OS threads, but can be bare metal entities
- Limited form of run-to-completion
  - A tasklet is mapped to one executor, except if blocking
  - Executor might be scheduled in a preemptive, global or partitioned scheduling
- Allocation of tasklets to executors, and of executors to cores is left to the implementation
  - Models are defined to guarantee safeness and progress, even with potential blocking operations

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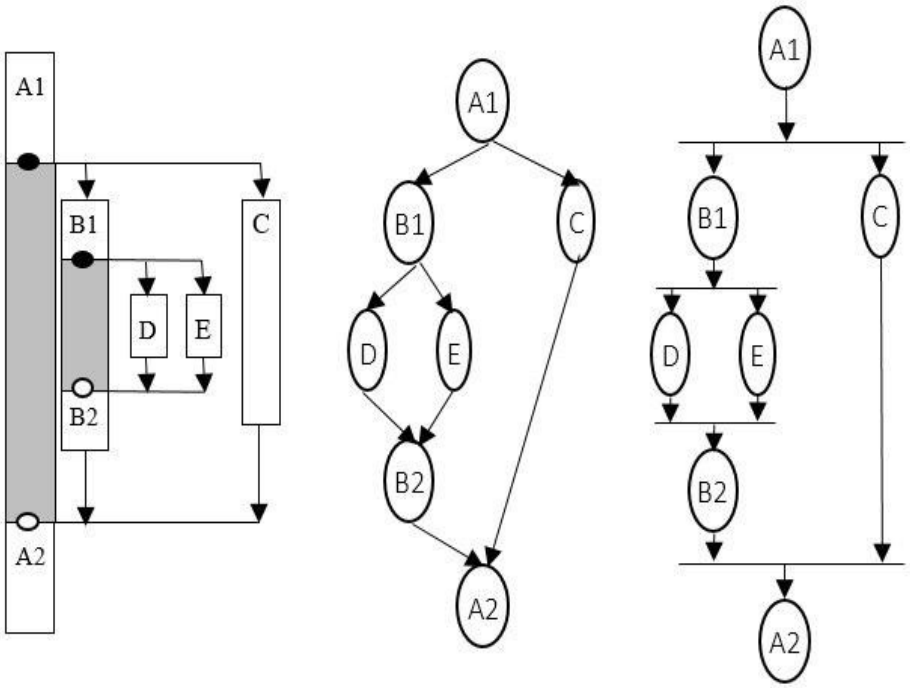
Real-time issues

- Each Ada task (or priority) is provided with a specific executor pool
  - All executors carry the same priority/deadline of the task
  - Does not support graph decomposition techniques
- Maps to a synchronous fork-join model
  - for which analysis already exists



- Important open issues
  - Supported scheduling models, such as limited preemption
  - Run-to-completion and tasklet (work-)stealing
  - Parallel models in languages introduce additional issues
    - (e.g. integration with task abortion, exceptions, etc.)