Scuola Superiore
Sant'Anna

Exploiting Uni-Processor Schedulability Analysis for Partitioned Task Allocation on Multi-Processors with Precedence Constraints

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Outline

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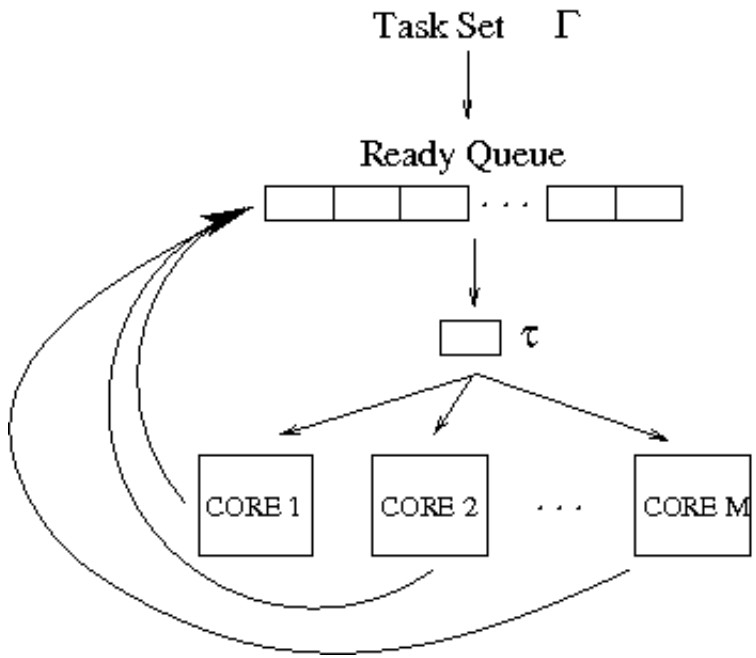
- **Global scheduling**
  - Pro: Better expectations
  - Con: Task migration costs
- Partitioned scheduling
  - Pro: Divide and conquer
  - Con: Worst-case driven, NP-hard



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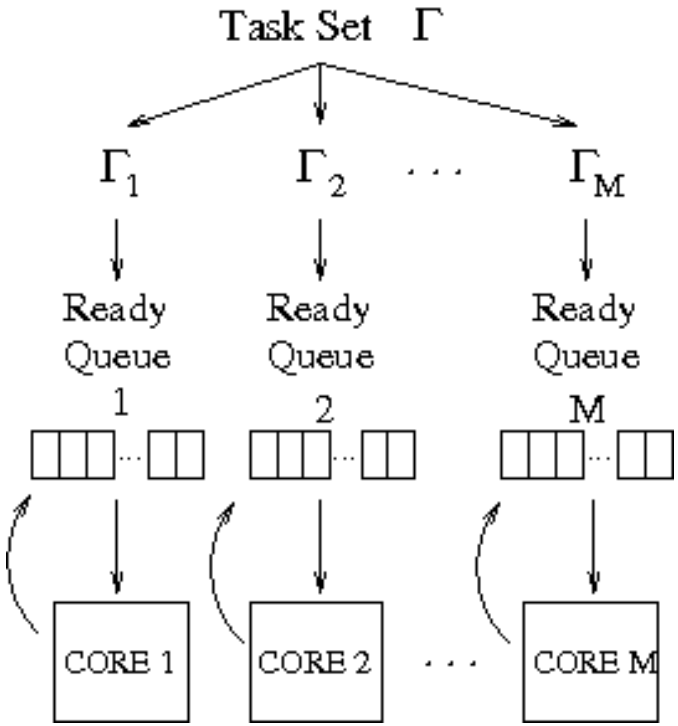

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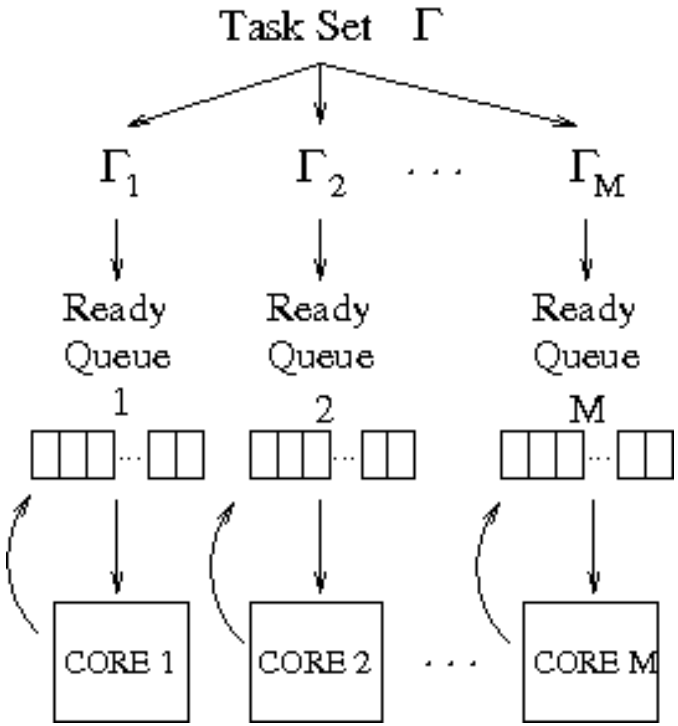

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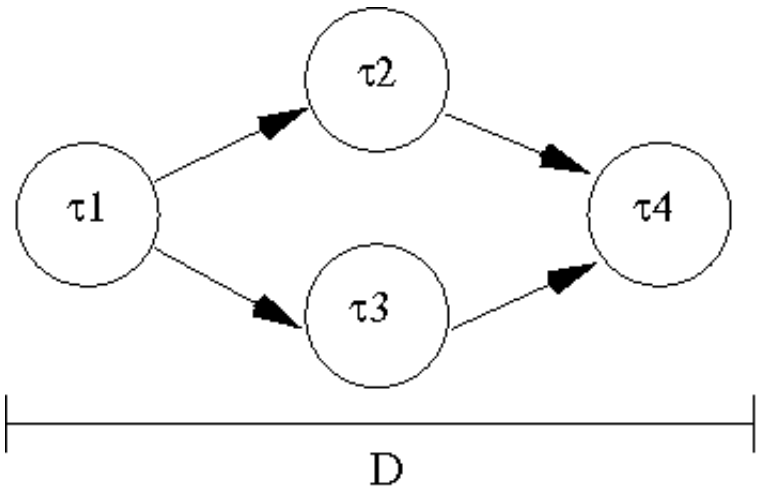
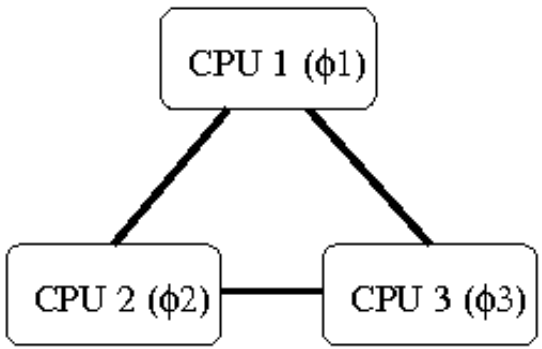
Up to date partitioned problem: Allocate n preemptive real-time tasks on m heterogeneous processors, to minimize f, considering:

- non-negligible communication costs
- precedence constraints among tasks
- application deadline and period





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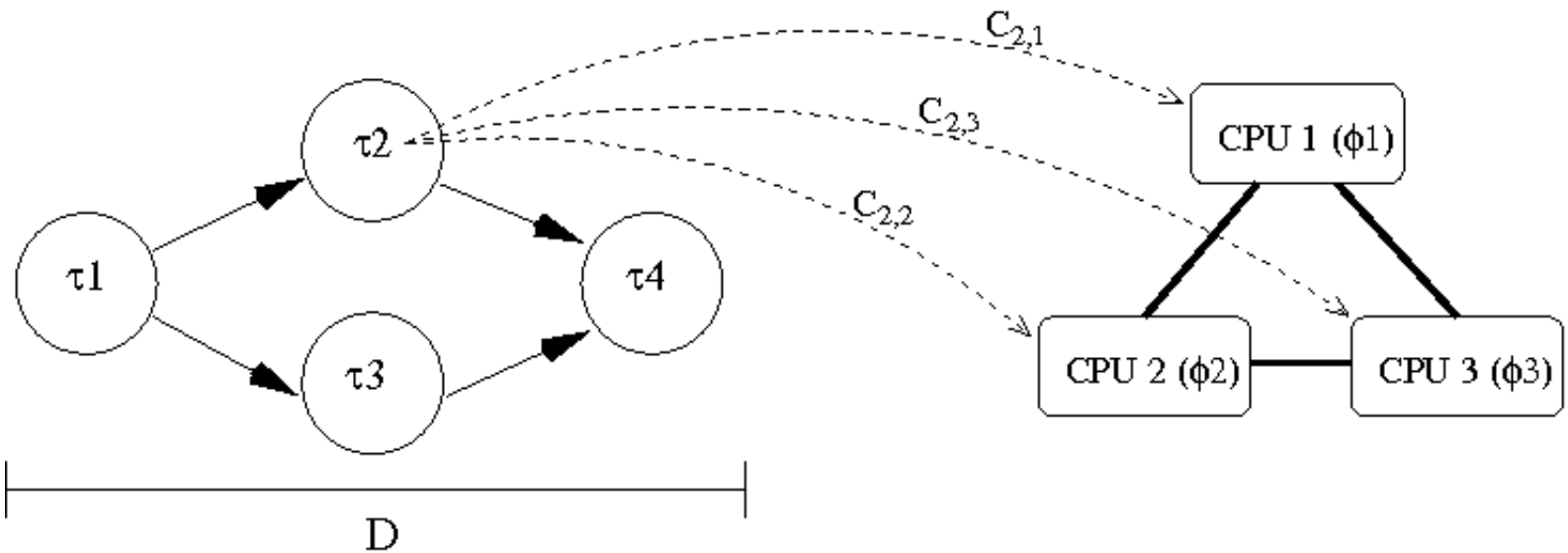

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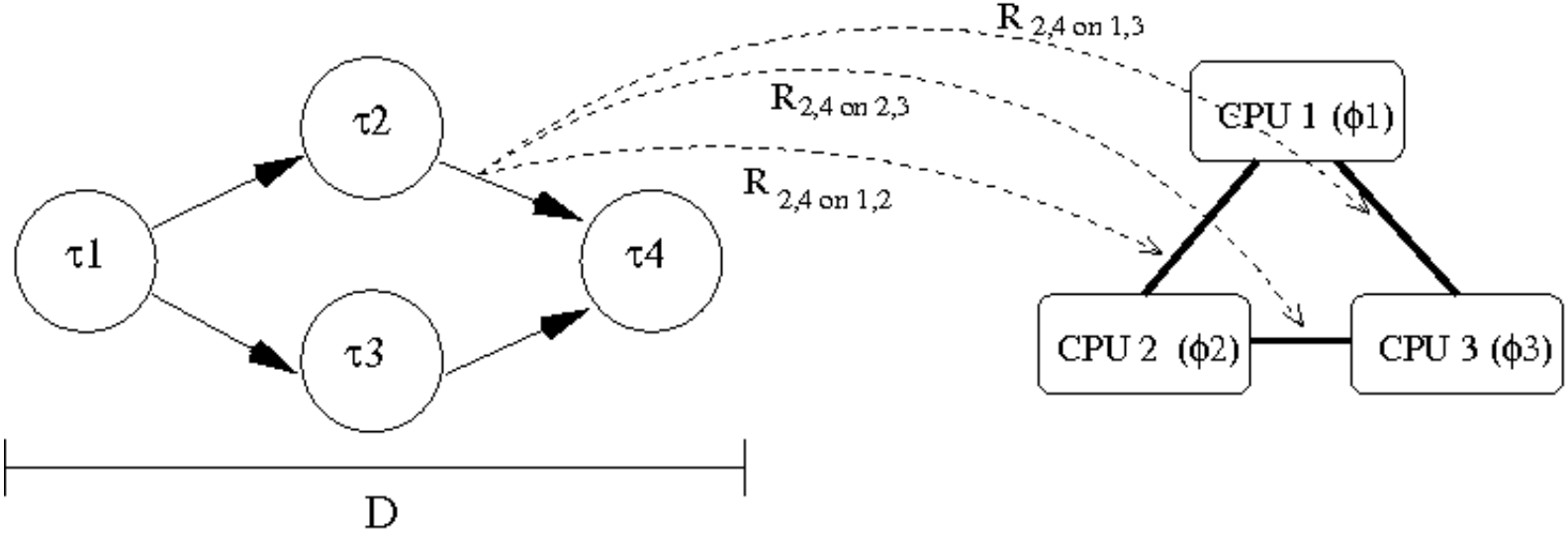

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Classical solving approach of a partitioned algorithm:

1. Task allocation
2. Static scheduling: $\forall \tau_i \in \Gamma \Rightarrow s_i, f_i$
   - 2.1 Precedence: $\forall \tau_i, \tau_j \in \Gamma | \tau_i \rightarrow \tau_j : s_j \geq f_i + comm_{\tau_i \rightarrow \tau_j}$
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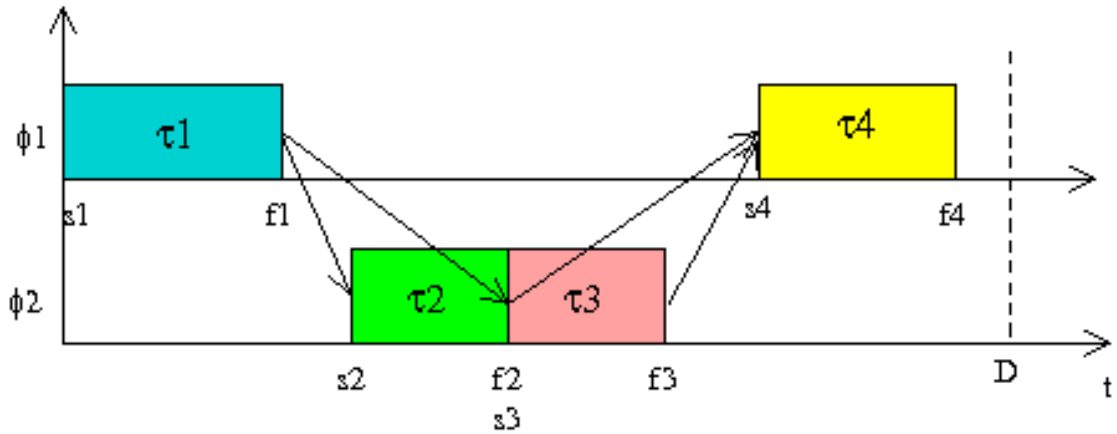

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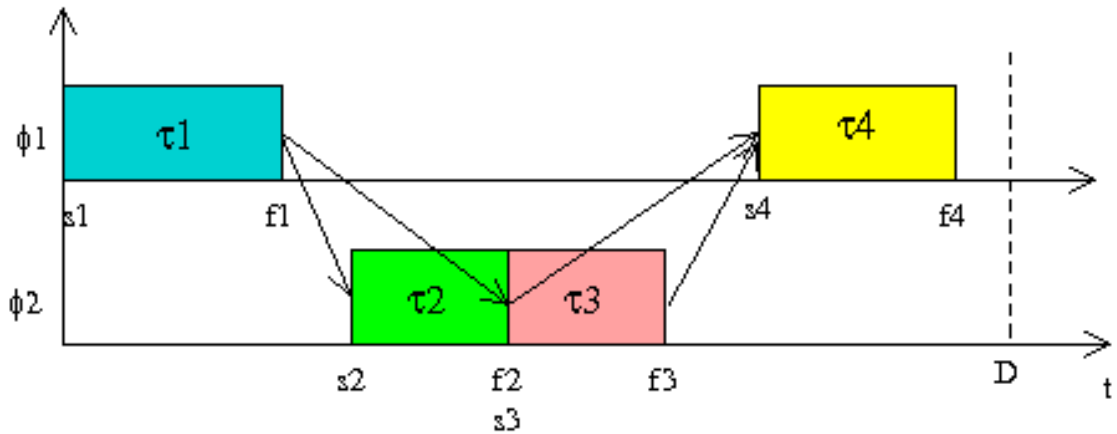

Approaches: complete search[2,3], meta-heuristics[4], heuristics[5]

Open problem

Instead of coping with static schedules, how is it possible to transform precedence constraints into real-time constraints to exploit well-known uni-processor analysis?

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1 distributed problem $\longrightarrow$ m simpler real-time local problems

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A similar assignment problem was proposed by Buttazzo et al. [9] who in turn extended the idea proposed by Chetto et al. [10]

Homogeneous systems and negligible communication costs are considered. Tasks are collected into flows (processors independent)

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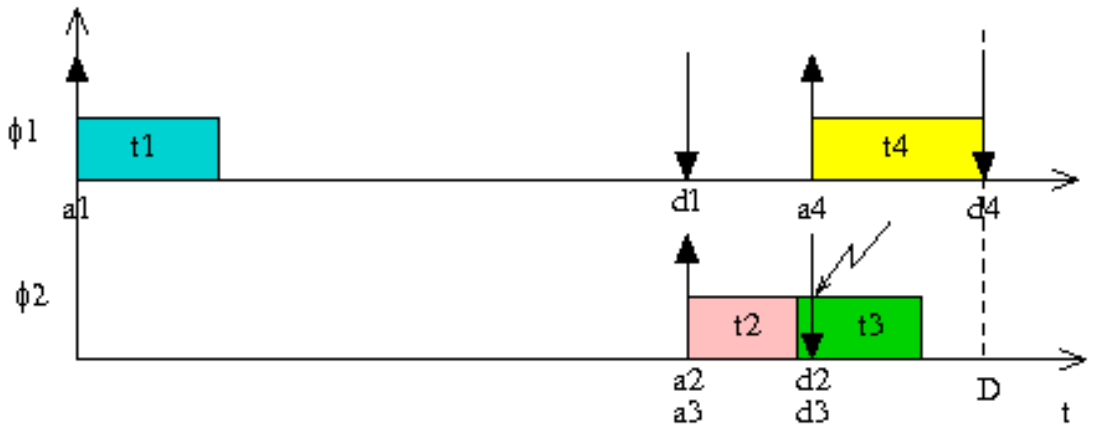
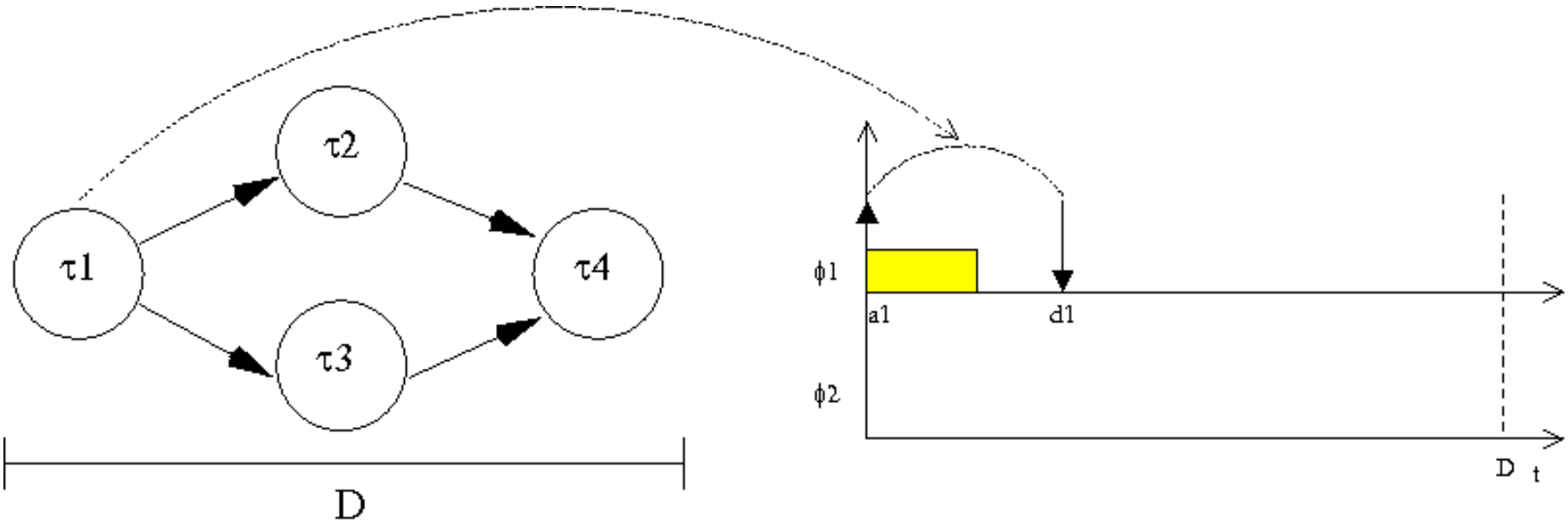


This problem is still an open question

Motivational example

Given the allocation: τ_1, τ_4 on ϕ_1, τ_2, τ_3 on ϕ_2 and ϕ_3 empty

Deadline and activation assignment step (assuming EDF):



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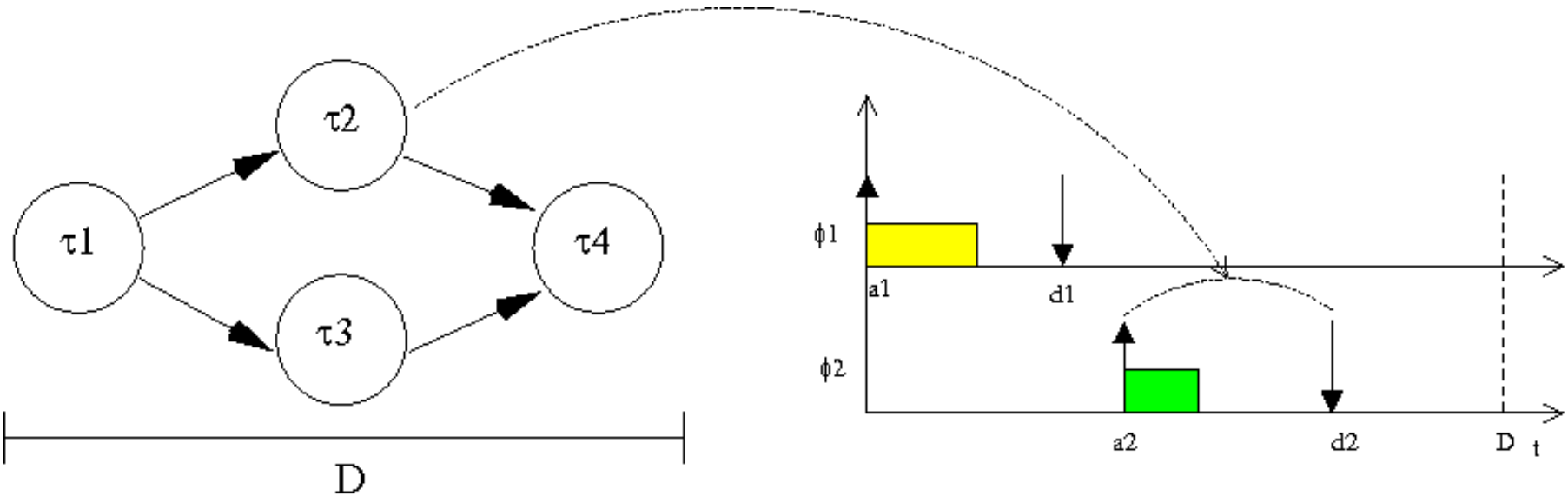

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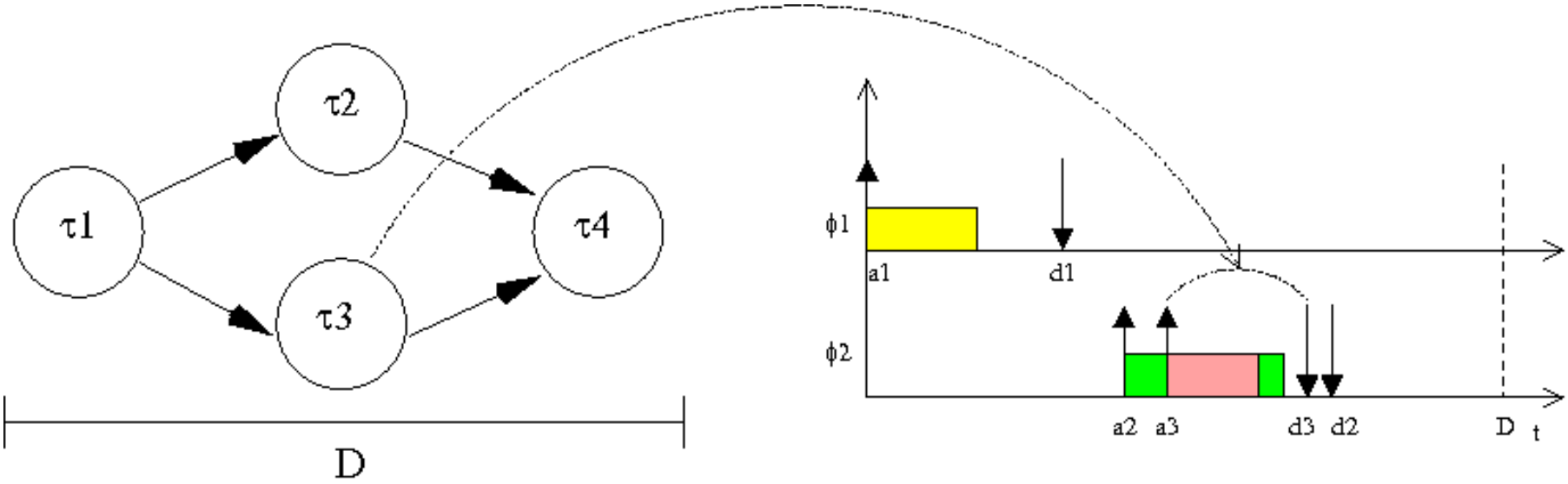

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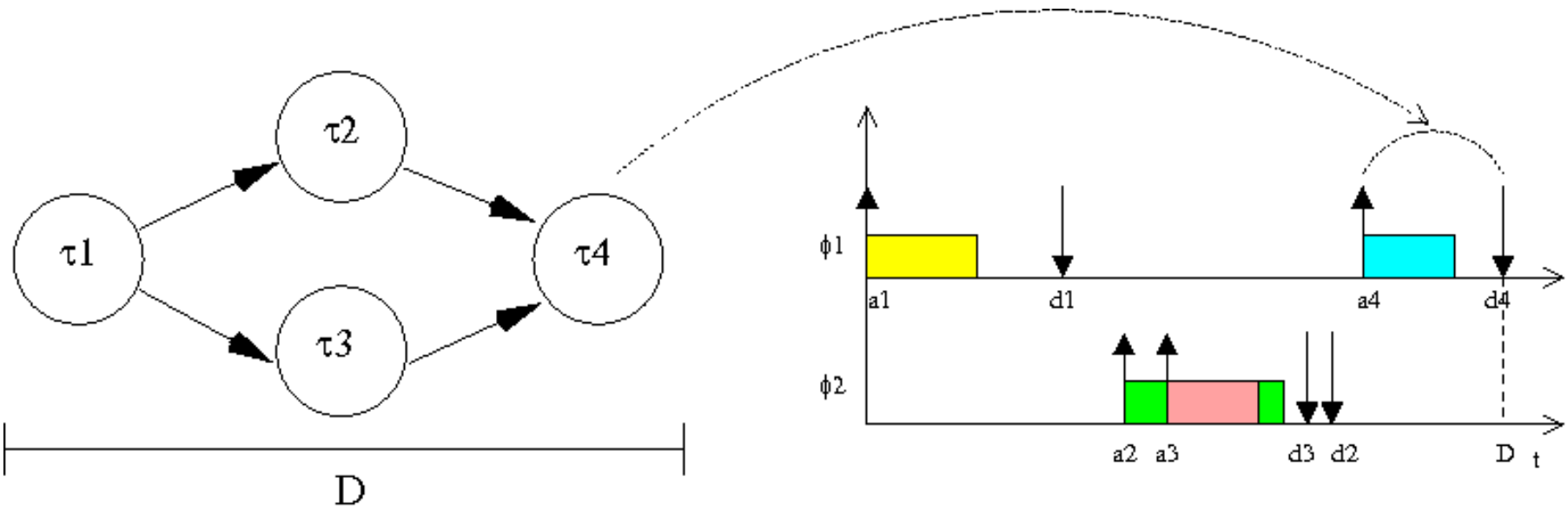

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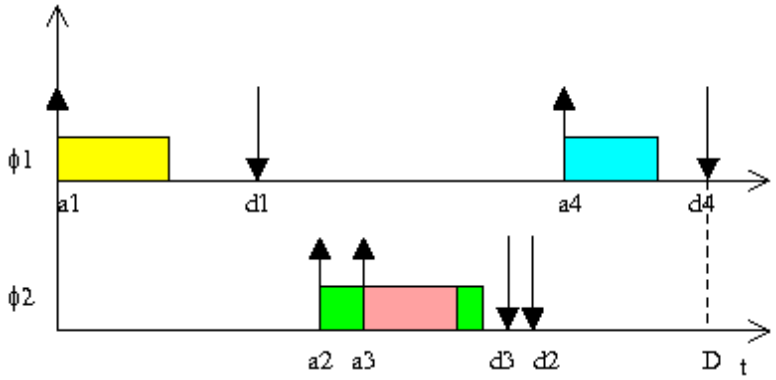

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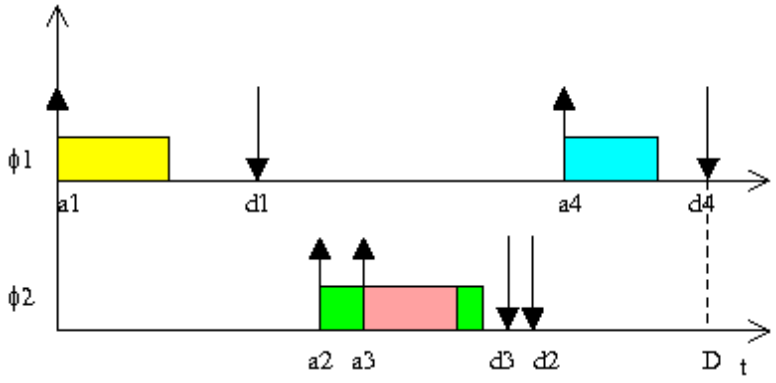

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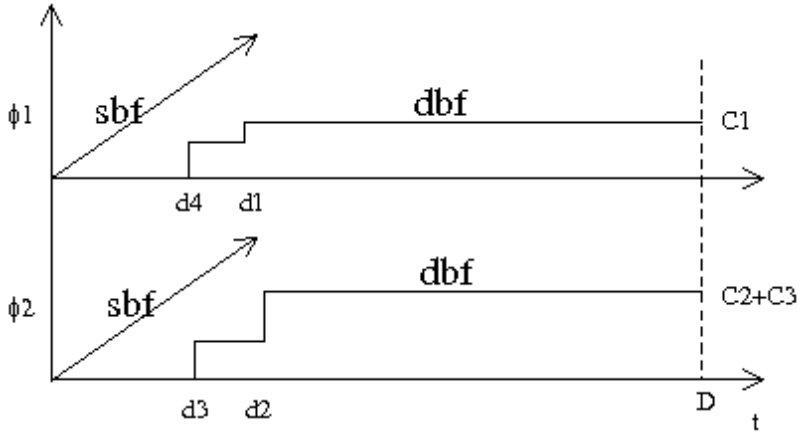

Task set feasibility can be computed by the Processor Demand Criterion [7] or the offset analysis [8]

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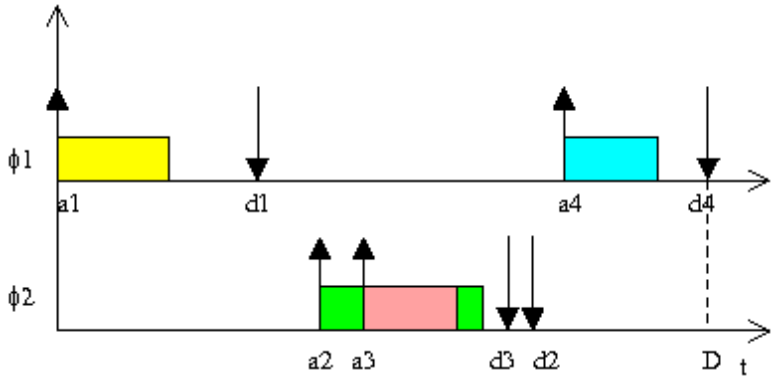

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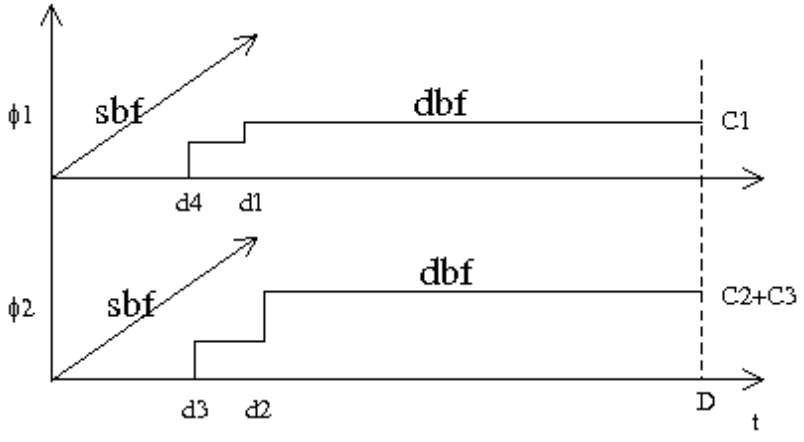

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Polynomial complexity: hyper period == the application period

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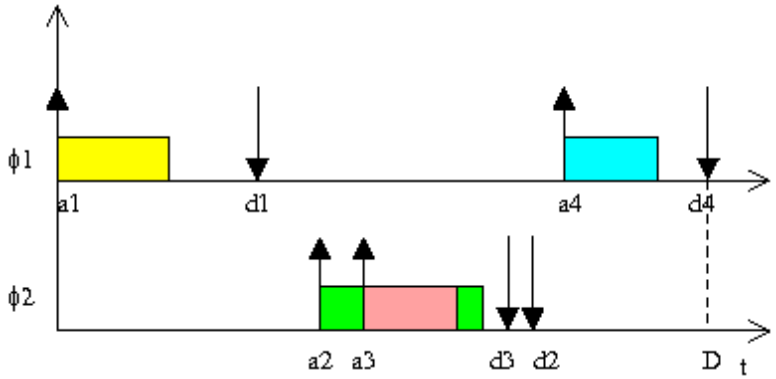

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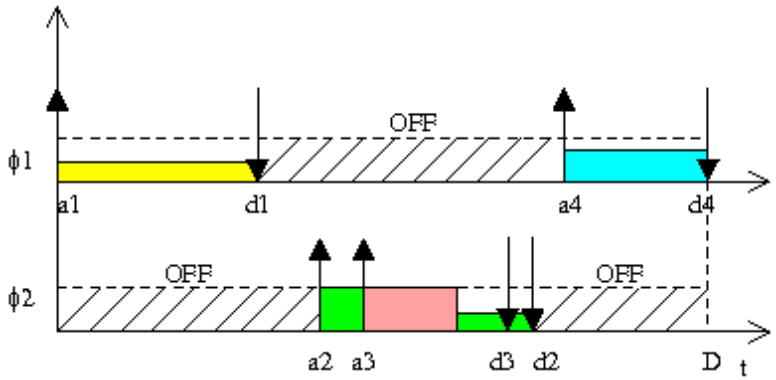

Moreover, knowing tasks' arrival and deadline can help us to further minimize the cost function
Es.: energy consumption

Final remarks

Transforming the precedence constraints into real-time constraints

The scheduler automatically guarantee the precedence constraints.

All the analysis for uni-processor systems can be exploited

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How can we do the assignment? Would it be more convenient than a static schedule?

thank you

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