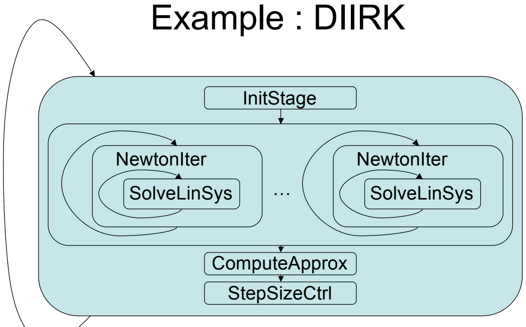
Anticipated Distributed Task Scheduling for Grid Environments

Thomas Rauber and
Gudula Rünger

Multiprocessor Tasks

- Decomposition of an application algorithm into a set of modules realized as M-Tasks
  - Well-defined independent parts
  - No relation between internal computations of different M-Tasks
- Input/output data form dependencies between modules (Task Graph)
- Each M-Task is executed on an arbitrary amount of processors

Example : DIIRK



Diagonal-implicitly iterated Runge-Kutta

The Grid Environment

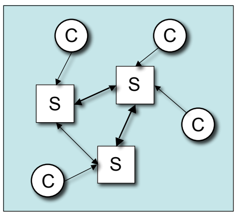
- Abstract/fuzzy concept
  - *"the technology that enables resource virtualization, on-demand provisioning, and service (resource) sharing between organizations."* (Plaszczak/Wellner)
  - *"a service for sharing computer power and data storage capacity over the Internet"* (CERN)
  - *"a computer facility operating 'like a power company or water company'"* (Corbató)

The Grid Environment (cont'd)

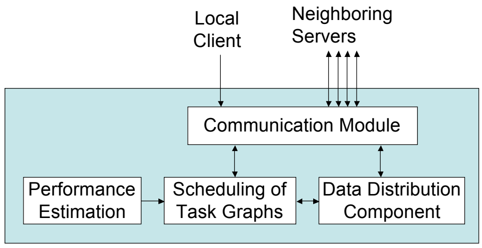
" … a service for sharing computer power … over the Internet"

- Open standards

- Clients
- Servers
- Communication



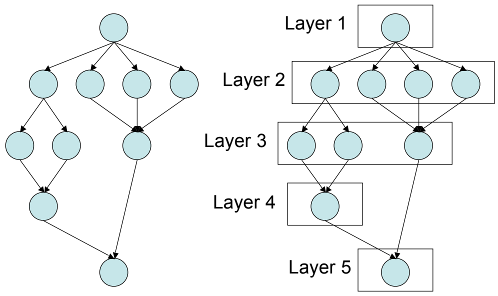
Server Node



Scheduling

1. Partition Task Graph into a sequence of layers, L_i, $i = 1,2,\ldots,n$
   - The different layers are executed in sequence.
   - Minimize number of layers.
2. Schedule each layer
   - Sequentially or concurrent
   - Locally or remote

Example



Anticipated Task Placement

- The decision for the placement of layer L_{i+1} is taken after layer L_i is placed.
- When L_{i+1} is placed, the total cost, $T_i(S)$ for the servers S is known.
- A task M of layer L_{i+1} should only be migrated if the migration cost $C(M)$ can be hidden.
  - Each server maintains sets of migratable and non-migratable tasks.

Migration of Tasks

- A server S with neighboring servers S_j sends tasks as long as there exist a server S_j, such that
  - $T_{i+1}(S_j) < T_{i+1}(S)$
  - $T_{i+1}(S) = T_{nmig}(S_j,L_{i+1}) + T_{mig}(S_j,L_{i+1})$
- A task M to be migrated is selected as
  - After the migration, the above still holds
  - The execution time of M is as large as possible

Sub-Optimality Bound

- We consider a ratio α, such that

$$T(M_x, p_1) = \alpha \cdot (T_{i+1}(S_1) - T(M_x, p_1))$$

- Where
  - M_x is the task with the smallest execution time
  - $T(M_x,p_j)$ is the execution time of task M on p_j processors

Sub-Optimality Bound (cont'd)

- Assuming $0 < \alpha < 1$ and $1 - \alpha \cdot \frac{p_1}{p_n} > 0$ the accumulated execution time T_{i+1} of the scheduling algorithm has the following sub-optimality bound

$$T_{i+1} \leq \frac{1+\alpha}{1 - \alpha \cdot \frac{p_1}{p_n}} T_{OPT}$$

Sub-Optimality Bound (cont'd)

- For a large numbers of tasks $\alpha \rightarrow 0$, which in turns means that

$$\frac{1+\alpha}{1-\alpha \cdot \frac{p_1}{p_n}} \rightarrow 1$$

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