Resource Allocation Strategies to be Implemented in the Resource Broker

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Resource Allocation by the Resource Broker

One of the goals of the Resource Broker is:

- Resource Allocation, i.e. identification of the set of resources (CEs) that best match the job requirements

Actual Resource Allocation Strategy

- Based on FCFS scheme
- The queuing policy is based on time arrival
- Choice of the most suitable CE is performed considering only one job at a time (the other job submission requests in the queue are not taken into account)
- For each job, the first CE matching the job requirements is chosen

Advantages of the Actual Resource Allocation Strategy

The FCFS-based Policy is:

- Easy to implement
- Very low computational complexity

Limits of the Actual Resource Allocation Strategy

- Many jobs (featuring very similar computational requirements) may be allocated on the same CE
- Processing of the job requests may be delayed due to the unavailability of resources to allocate the current job (waiting for data transfer, for example)
- No performance indexes are optimised (like overall throughput or response time)

Improvement of the Resource Allocation Strategy

Complexities to be Solved:

- **Distributed Organisation**. Several Community Schedulers co-exist in a DataGrid (the lack of coordination causes low performance)
- **Predictive Estimation**. Dynamic variation of the resource status or execution time of single application on a specific resource.
- **Different Cost Functions.** High-throughput or low response time for a single application

Solutions in the Current Literature

- Due to the Complexity of the Resource Allocation Problem in a DataGrid Environment, **a Solution is still lacking**
- Scheduling Solutions in Centralised/Distributed Computing Systems exist
- Starting from the known solutions, try to apply them (through modification or re-design) to the DataGrid environment

Some Work Done

- A state of the Art on the Solutions to the Resource Allocation Problem in Distributed Computing Environment.
- Scenarios very close to the DataGrid environment have been considered:
  - Resource Allocation performed by the RB was seen as a NxM scheduling problem, where N is the number of job submission requests and M is the number of CEs.
  - Different Cost Functions
  - Heuristic Approaches

Cost Functions

- Completition Time/MakeSpan
- Completition Time/MakeSpan including the data transfer costs

Completition Time

Special Purpose Algorithms:

- Fast Greedy/ Minimum Completition Time
- MIN-min/ MAX-min
- Switching Algorithm
- BackFilling (Easy and Conservative)

General Purpose Algorithms:

- Genetic/Neural

Completition Time and Data Transfer Cost

Special Purpose Algorithms:

- X-Sufferage

General Purpose Algorithms:

- Genetic/Neural

Information Needed

- Completition Time for each resource (CE) and for each job:

$$ct(i,j) = TT(j) + \sum_{\substack{s \in N \\ s \in S(j)}} ETC(s,j)$$

where:

•ct(i,j) is the completition time of the i-th job on the j-th CE

•TT(j) is the actual Traversal Time of j-th CE

•N is the set of job to be scheduled

•S(j) is the subset of N, made up by the jobs already scheduled on the j-th CE

•ETC(s,j) is the Expected Time to Compute for the job s on the j-th CE

Availability of Information

- Traversal Time for each CE: **Available**
- ETC(i,j)-Expected Time to Compute: **Not Available**. It must be on-line evaluated for each job and for each CE

Evaluation of ETC

Different Solutions:

- The user may provide for an estimation of the time needed to execute its job.
  - Simple Solution
  - Very close to the accounting work
  - Limit: the estimation may not be linked to the computing features of each CE

Evaluation of ETC

Another Solution:

- Literature provides for algorithms aimed to evaluate the estimation of the time needed to execute each job on each CE.
  - the estimation allows to highlight differences in the mapping of each job on each CE
  - Limits: it requires tools (local to the user) to evaluate the ETC

Proposal of Activity at University of Catania-DIIT

- Use the DataGrid architecture available at PM-9 release for:
  - Evaluating and Comparing the most relevant scheduling solutions known in literature
  - Tuning the scheduling solutions in order to fit the requirements present in DataGrid
- Collaboration with research units at:
  - Turin, about the execution time (ETC) estimation
  - Bari, about scheduling approaches