Data Location-Aware Job Scheduling in the Grid
Application to the GridWay Metascheduler

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Data Location-Aware Job Scheduling

Agreed in grid community, data location needs to be considered for job scheduling:

To avoid lost time waiting for input data staging

Approaches to this problem:

1. Sending jobs to the sites holding the input data
   - A. May be suboptimal when these sites are busy or inaccessible
   - B. Requires independent data management
2. Balancing data transfer time and expected job delay time to select job destination
   - A. Requires estimation of the transfer costs: e.g. *Network Weather Service*
   - B. In general, does not consider restrictions like VO policies, limited storage space
   - C. More complex and costly when calculations are made for a whole grid
3. For 1 and 2, sometimes automatic replication of files is suggested

Additional problems with data replication:

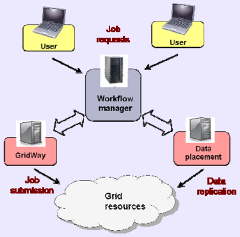
- Storage elements get filled
- VO policies on storage need to be considered when scheduling
- Competition for network and storage resources is increased

Some conclusions:

- Jobs to data much better than ignoring location
- Optimum scheduling only possible considering data location and computing resources characteristics
  - This is very difficult to achieve in practice
- Necessities, constraints vary from VO to VO
  - Need a flexible system (configurable policy)
- Other reasons to minimize data transfers exist
- It is better to decouple job scheduling and data transfers: let placement systems manage these

Towards an optimum VO-global scheduling strategy:

- Optimal scheduling of single job does not guarantee optimal global scheduling
- Coordinated management of data placement and job scheduling is required
- A workflow manager with a global view of a VO might know better
- It would have to maintain a queue of jobs and schedule data movements and job submissions according to global necessities



The GridWay Prototype

GridWay:

- General purpose metascheduler
- By the Distributed Systems Architecture Group of the University Complutense of Madrid
- Full Globus project

Current use of data location information:

- Not consider when scheduling
- Only best computer resource

New prototype:

- Possibility to take into account presence of data both in requirements and rank
- This is more flexible than glite WMS
- VO/users can set the policy to use
- Does not include transfers latency estimation

Implementation:

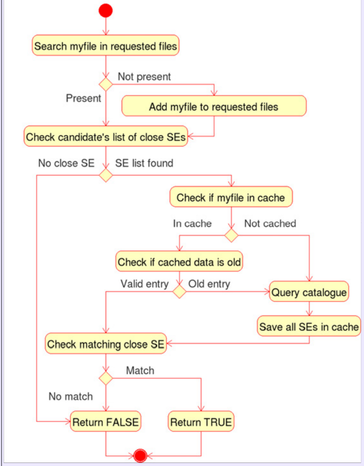
- EGEE information plugin modified: retrieve closeSE attributes
- Interface modified: data functions in requirement and rank expressions
- Daemon modified: query to specified catalogue using DLI interface
- Cache of locations to minimize number of catalogue interactions
- Remote files list available to user in job's environment

`DATA_CATALOG`	Job template var
`CLOSE_DATA(file)`	Requirem. expression

`HAS_CLOSE_DATA(file)`
`SIZE_CLOSE_DATA(file)`
	Rank expressions

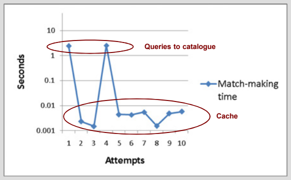
`GW_CLOSE_SE` `GW_REMOTE_FILES`	Job environment vars

Rank expression: HAS_CLOSE_DATA(myfile)

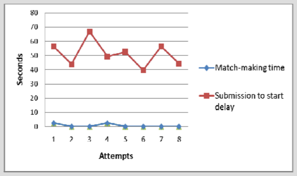


Catalogue query delay

Match-making time

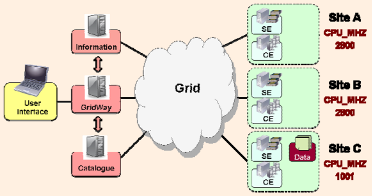


Submission delay vs match-making



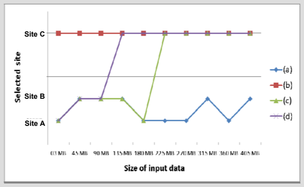
Testing

Policy testing

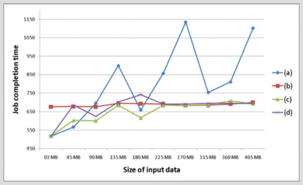


Policy		Requirem.	Rank
(a)	Don't use data loc.	–	CPU_MHZ
(b)	Jobs to data	CLOSE_DATA ("file")	CPU_MHZ
(c)	Balance transfer time and CPU	–	CPU_MHZ + Kt * SIZE_CLOSE_DATA("file")
(d)	(c) + extra transfer penalty	–	CPU_MHZ + Kp * Kt * SIZE_CLOSE_DATA("file")
Kt ≡ Transfer-CPU balance factor = 0.0075 *Kp ≡ Transfer penalty factor = 2*			

Destination by algorithm and input data



Job turnaround time by algorithm



Algorithm	Average Time	Transfers
(a)	799.4	10
(b)	687.4	0
(c)	648.4	5
(d)	674.0	3

(a) obtains the worst results

(b) avoids all data transfers

(c) achieves the best average time

(d) accepts slightly worst average time to reduce transfers