The Performance of the Czech National Grid Infrastructure after Major Reconfiguration of Job Scheduling System

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1. Introduction
This work describes the outcomes of a large reconfiguration of the job scheduling system in the Czech National Grid MetaCentrum which was done in 2014. With the significant growth of MetaCentrum (1,500 CPU cores in 2009 vs. 10,000 CPU cores in 2014) we had to revise our scheduling approaches to better reflect the increased size of the system and the growing heterogeneity of hardware resources and users’ workloads.

2. Queue Reconfiguration [2]
Main features of the applied solution [3]:
- an extended Proc. Equiv. (PE) metric
- a multi-resource aware mechanism
- fair regardless the heterogeneity of jobs and machines
- reflects various speeds of machines
- a job penalty (i.e., a user priority) is not scheduler-dependent

3. Complex Fair-Sharing
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4. Plan-based Scheduler with Optimization
Newly developed TORQUE scheduler [1]:
- Complete job schedule data structures
- Schedule construction using backfill-like algorithm
- Maintenance routines adjust the schedule in time upon dynamic events such as (early) job completions
- Schedule optimization metaheuristic

5. The Results of Complex Reconfiguration
Queue Reconfiguration
- Average wait time decreased 5.6 hours → 3.9 hours
- Nearly twice as many jobs processed 1.16 millions → 2.12 millions
- Higher CPU time utilization utilized CPU hours increased by 23%
- Improved system utilization system utilization increased by 9.1%

Complex Fair-Sharing
- RAM-heavy jobs affected
  average wait time increased significantly (3.9 hours → 16.7 hours)

Plan-based Scheduler
- Improved utilization
  efficient backfilling with planning
- Planning and predictability
  advanced job-to-machine mapping
- Problem detection and avoidance
  scheduling plan allows for advanced problem detection

6. Conclusion and Future Work
So far, the reconfiguration, new fair-sharing solution and the new scheduler used in CERIT-SC seem to work as expected:
- increased throughput and utilization
- significantly reduced job wait times
- improved fairness
- higher penalties for RAM-heavy jobs

In the future, we will further consider:
- complex evaluation of the performance of the new plan-based scheduler
- a development of a heuristic to dynamically adjust the amount of resources assigned to different queues in the system

Acknowledgments
We kindly acknowledge the gracious support of the Grant Agency of the Czech Republic provided under the grant No. P202/12/0306. We also acknowledge the tight cooperation with MetaCentrum including the access to the MetaCentrum’s computing infrastructure and historic workload-related data.

References