Planning and Optimization in TORQUE Resource Manager

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MetaCentrum

Overview

- **Contribution**
  - new scheduler for TORQUE RM
  - **job schedule optimized by a metaheuristic**
  - improves the quality of job schedule (initial schedule built by backfilling)
  - **applied in practice** (CERIT-SC system, ~ 5,000 CPUs, 7 clusters)

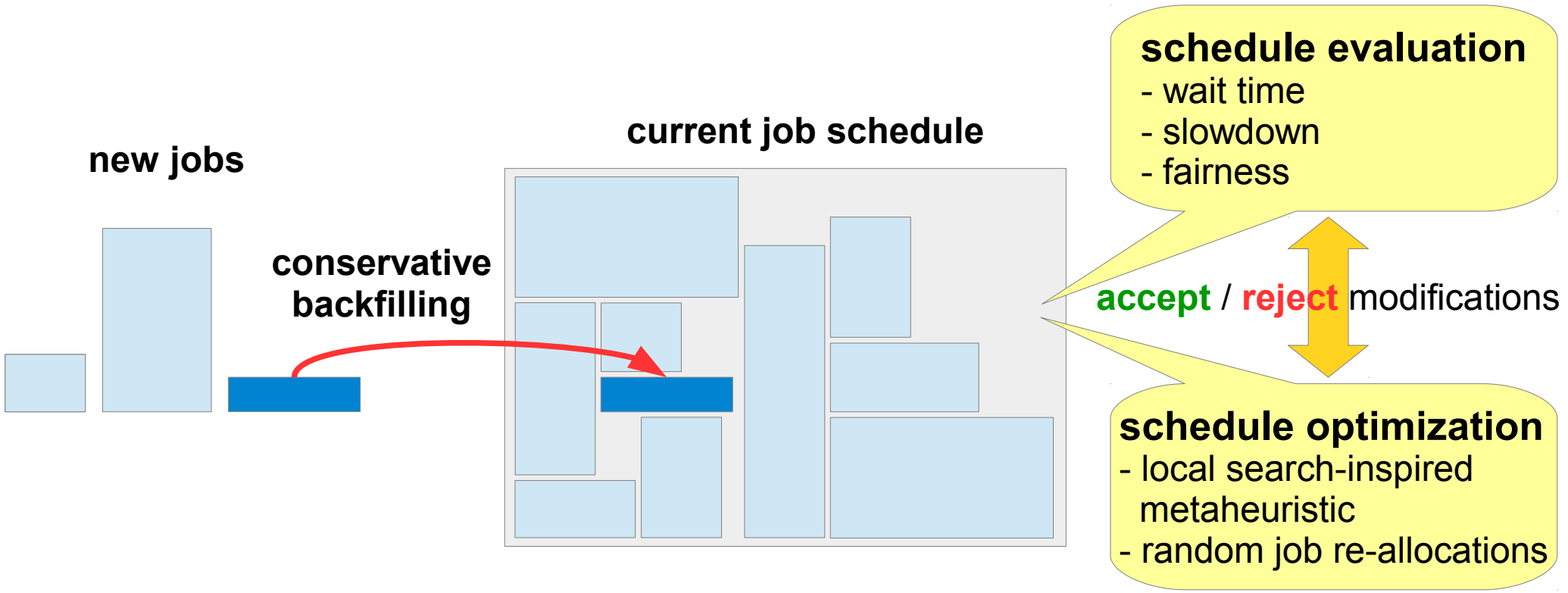
- **State of the art**
  - **queue-based schedulers** (PBS, Moab, Maui, Slurm, …)
  - **backfilling** (optimizes resource utilization/wait time/slowdown)
  - further “tailoring” (fair-share, priorities, per user/group limits, …)

Importance

- **Metaheuristics are popular in “theoretical” works**
  - results indicate improved performance wrt. current solutions
  - **actual implementations and applications are very rare**
- **It is quite hard to make it work in the real life...**
  - **“theoretical” models are far from the needs of real providers/users**
    - fast decisions
    - detailed system setups (priority, limits, fairness, …)
    - multi-criteria optimization problems (performance, fairness, …)
    - complex job specifications, job dependencies, SW licenses …

Applied Solution

- Initial schedule built by **conservative backfilling**
- Schedule is periodically optimized using a **local-search inspired metaheuristic**, optimizing
  - performance (wait time and slowdown)
  - fairness (fair-share-like “max-min” approach)

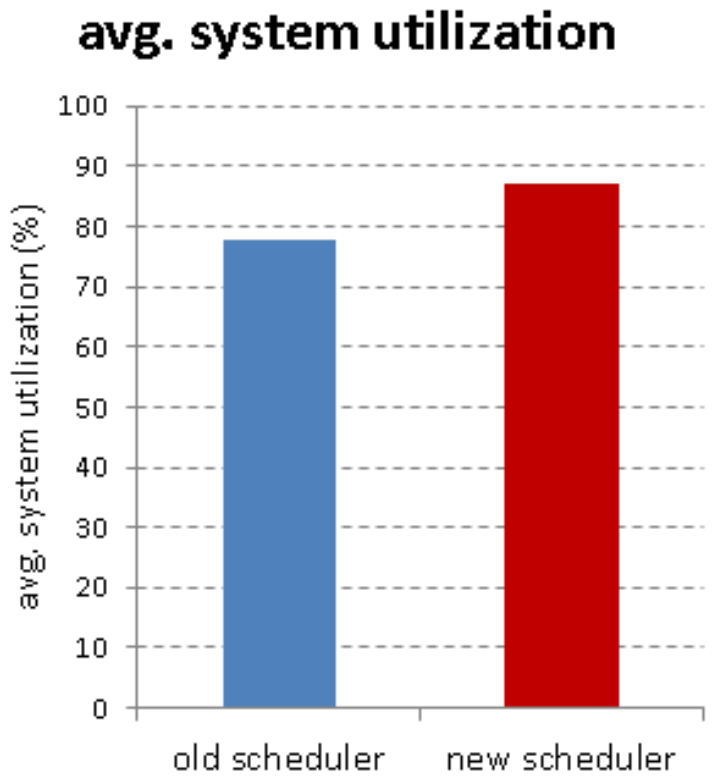


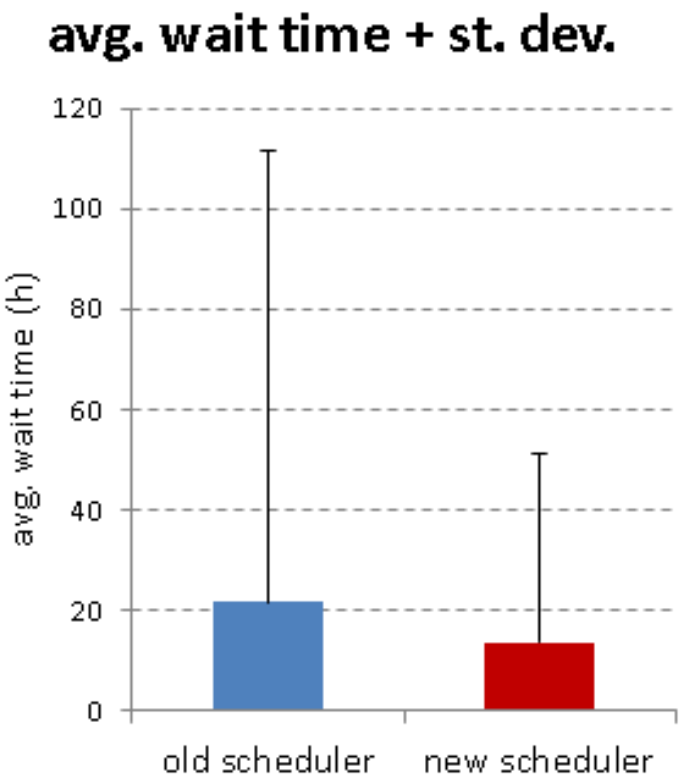
Realism

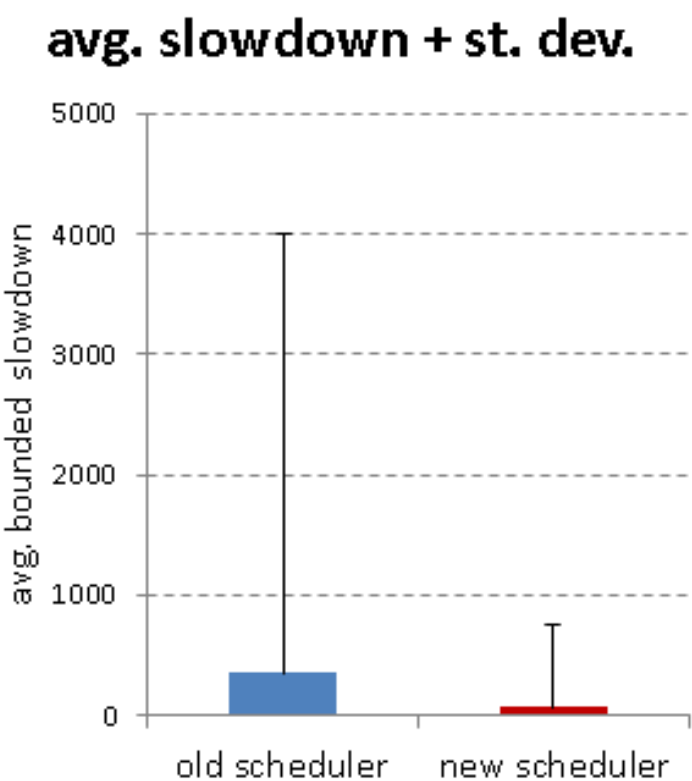
- **All major features of “classic” schedulers are supported**
  - **adaptation to dynamic events** (inaccurate estimates, failures)
  - **support of various limits** concerning max. exec. time/CPU
  - **complex job specifications** (CPUs, RAM, HDD, SW-licenses,...)
  - **multi-resource fair-sharing** (CPU and RAM consumption)
  - **inter-job dependencies**
  - **maintenance-aware planning** (assuring that jobs complete prior a maintenance period)

Deployment

- **CERIT-SC system** (~ 5,000 CPUs, 7 clusters)
- **Since July 2014** (11 months)
- **“before – after” comparison**







Conclusion

- **Realistic application of a metaheuristic**
  - improved performance both in the simulations and in the reality
  - detects and fixes “pathological” job assignments
- **Schedule (execution plan)** is available to the users and system administrators
  - (partial) predictability (planned start times may change)
- **Easy (advanced) problem detection**
  - bad job specification (no planned start time, very frequent)
- **Easier setup of critical system constraints**
  - e.g., too strict resource limits (planned start times are very high)