Improving Fairness in Batch Systems

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Focus of Analysis

- Extract and combine information from three ARCo tables
  - Accounting and Reporting Console from Univa Grid Engine
- Convert to the Standard Workload Format of the Parallel Workloads Archive

- One month (November 2018)
  - **2,669,401** individual jobs

- This study was published as
  - Improving Fairness in a Large Scale HTC System Through Workload Analysis and Simulation, *25th International Euro-Par Conference (Euro-Par'19)*
    - Comes with an Experimental artifact to reproduce analyses and simulations

Question: How Fair is the Fair-Share ?

At "Macro" scale

- The overall fairnees operational objective is respected
- Pledges are served
- From a 3-month to 1-year granularity

At "Micro" scale

- Operators act on scheduling
- Fix fair-share transient issues
  - Boost or block jobs/users/groups

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- The overall fairnees operational objective is respected
- Pledges are served
- From a 3-month to 1-year granularity

At an intermediate scale

- What about fairness at 1-day, 1-week, or 1-month granularity?
- Is the Quality of Service the same for all our users?
  - Spoiler alert: Answer is NO!
- What can be done to improve fairness?

At "Micro" scale

- Operators act on scheduling
- Fix fair-share transient issues
  - Boost or block jobs/users/groups

Principle and Objectives

Principle

- Groups express pledges every year (as a computing power in HS06)
  - Well defined for LHC experiments, more approximative for small groups
- The sum of all pledges defines what CC-IN2P3 has to deliver
  - Condition the purchase of new hardware
- Each group gets a proportional share of this
  - Defines an consumption objective
  - Used by the job scheduler as a basis of its Fair-Share policy

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#1 Objective

- **Satisfy all the user group pledges**

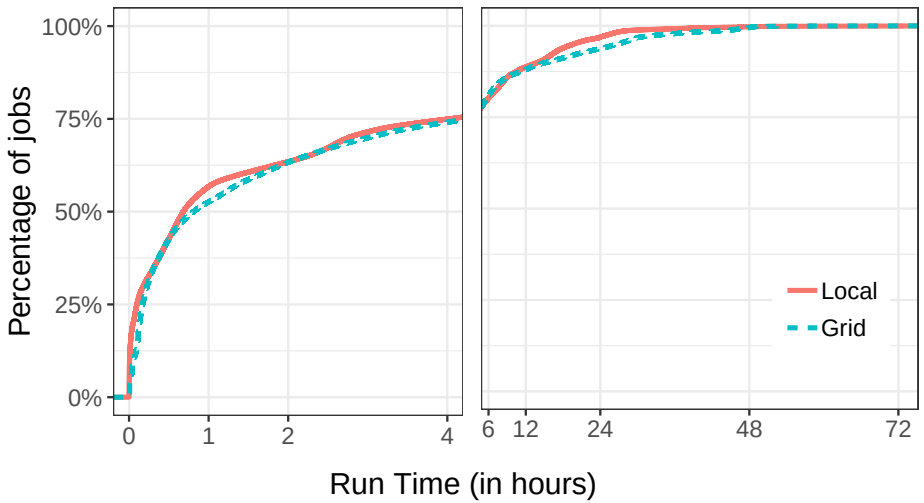
#2 Objective

- **Maximize the utilization of the machines**

Outline

- Introduction
- Characterization of the Workload(s)
- Reconfiguration of the Batch System
- Conclusion

Grid vs. Local Jobs



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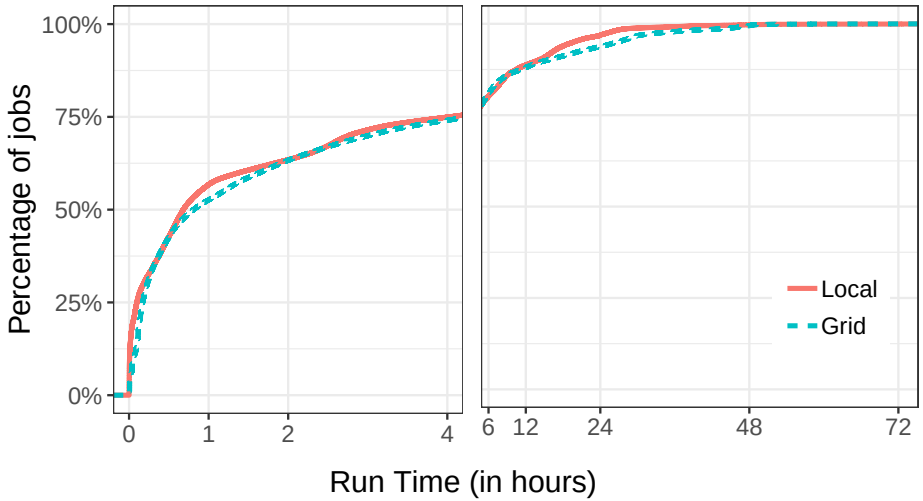

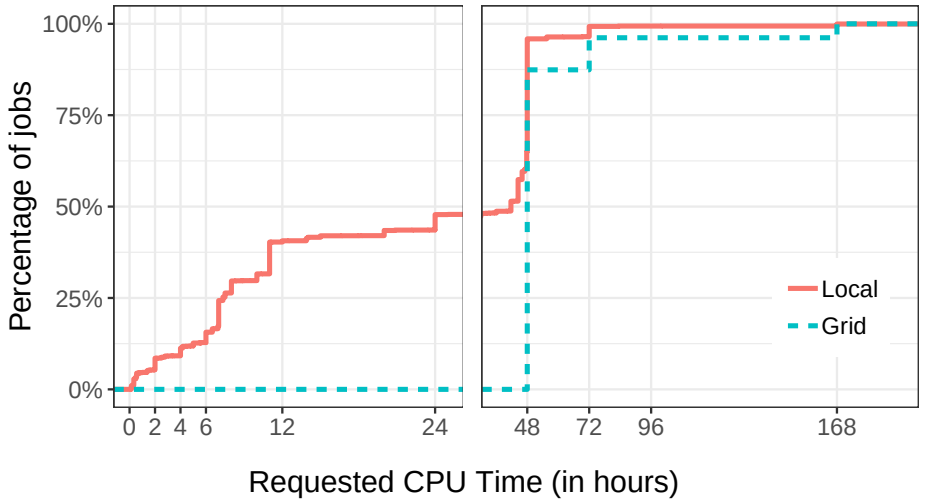

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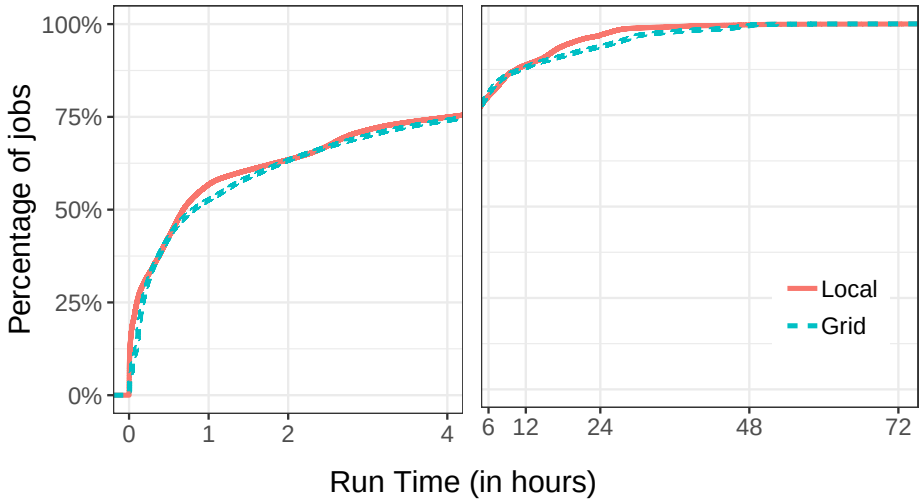
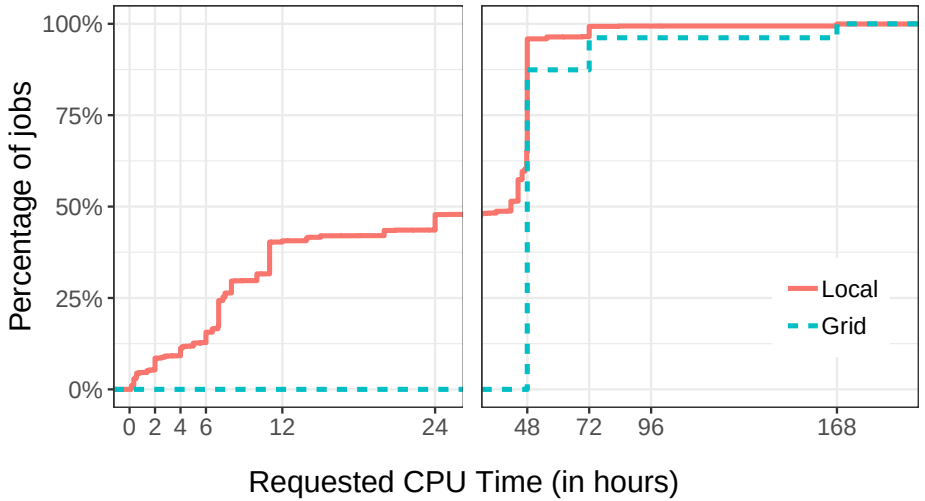
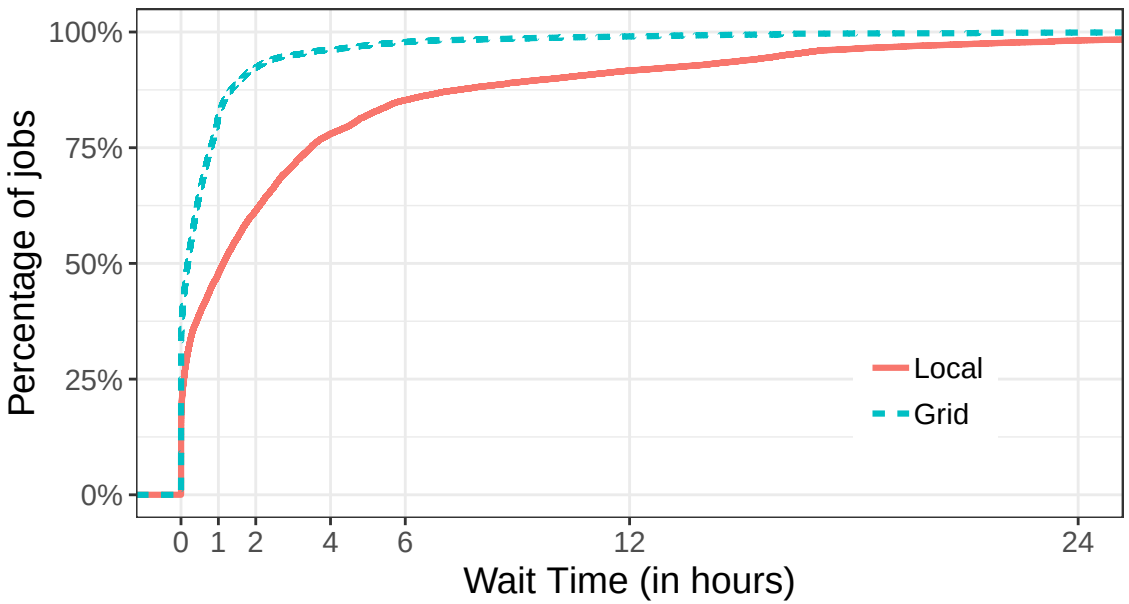
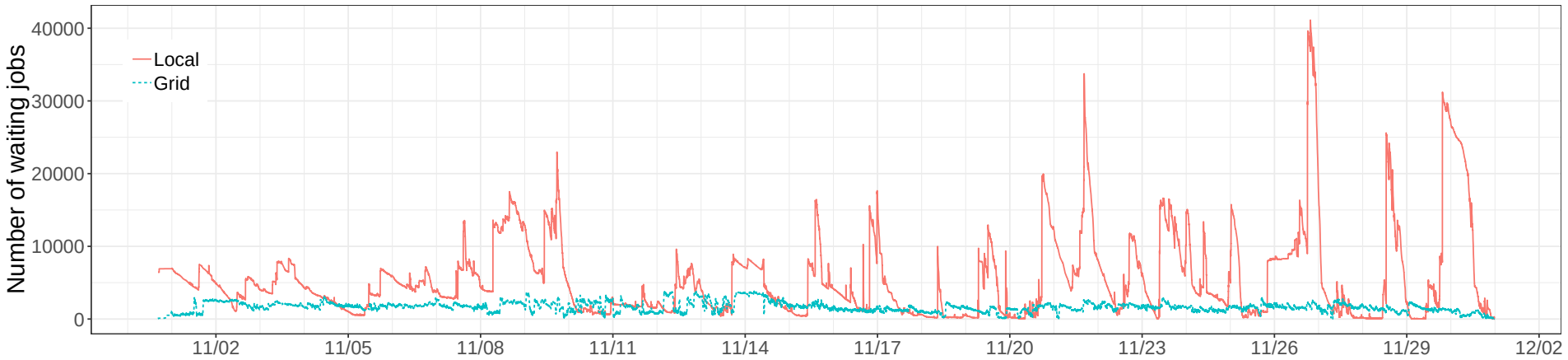






Origins of the Unfairness



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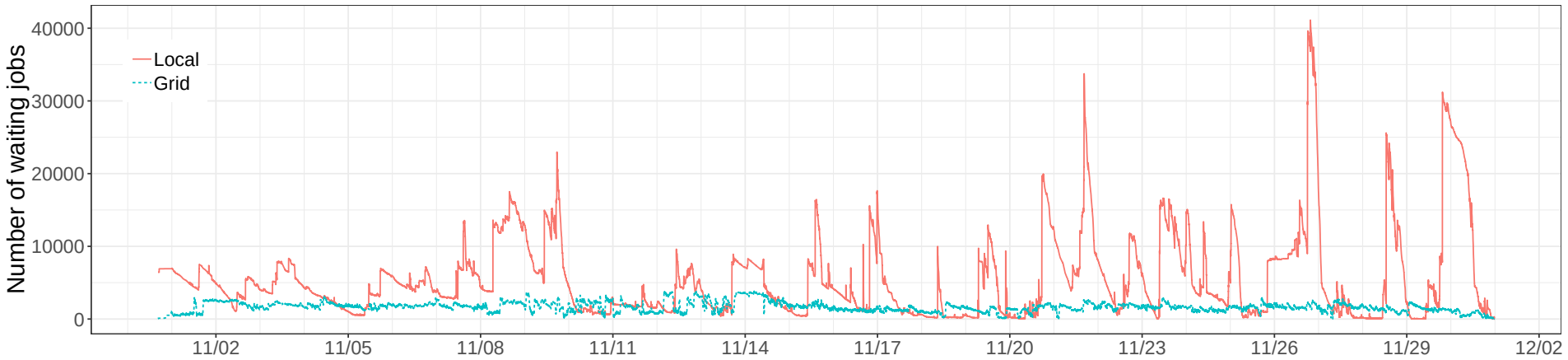

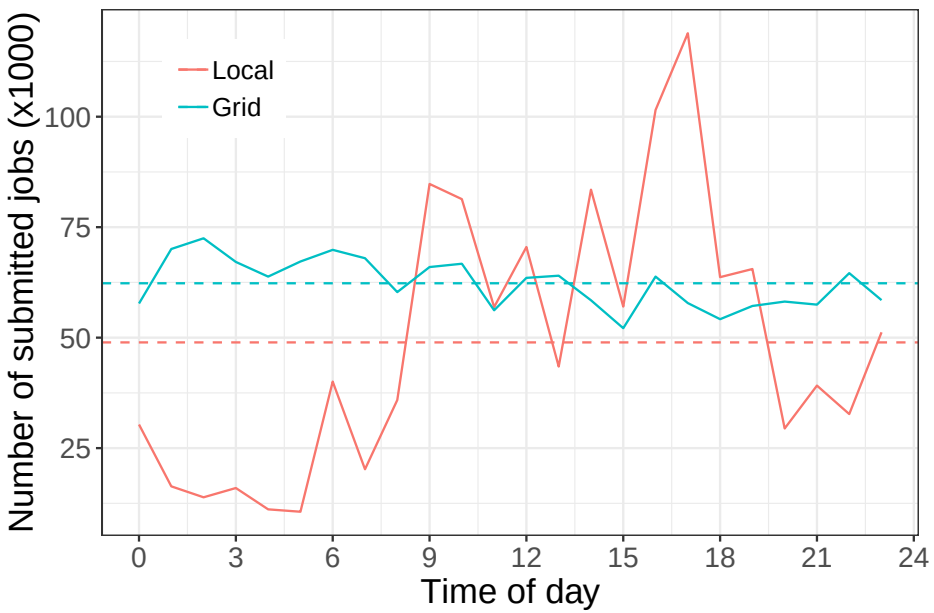

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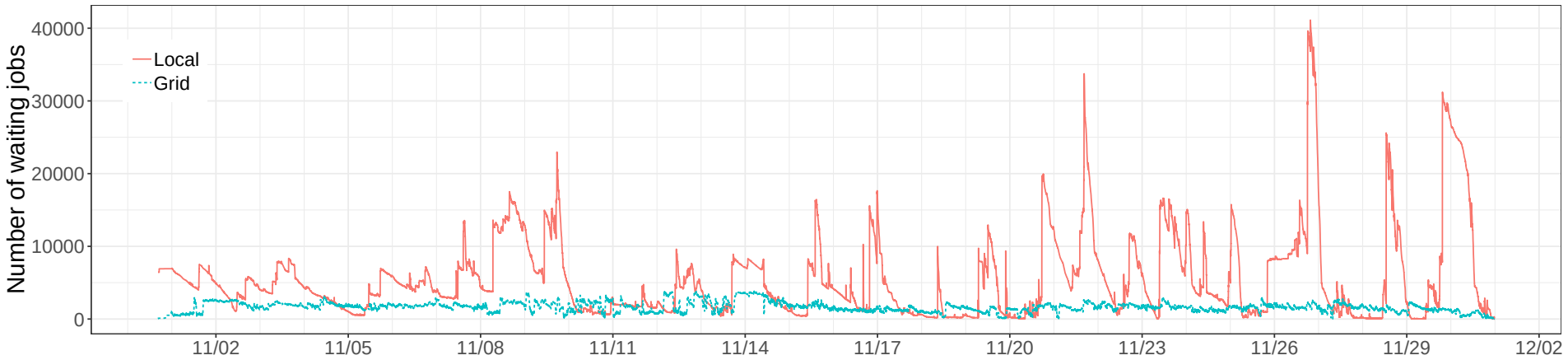

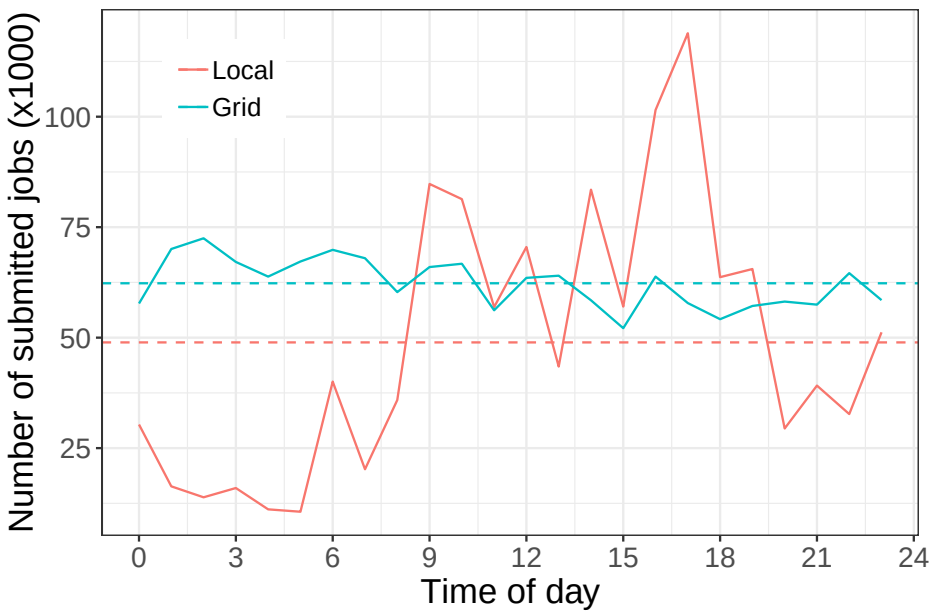

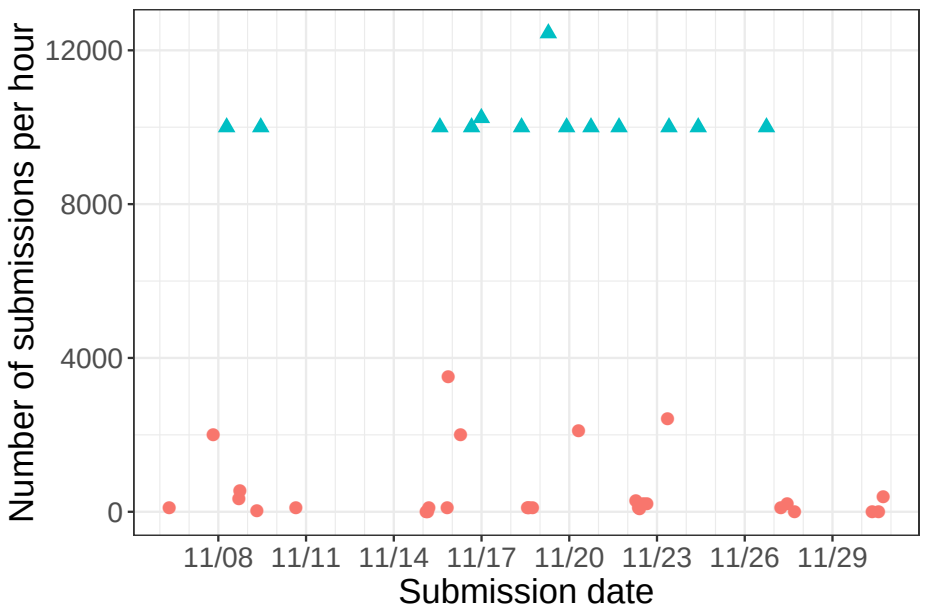

- And also share-related priorities and stringent quotas

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Redefinition of the Scheduling Queues

Queue name	CPU Time	Time	Memory	File Size	Cores
mc-long	48h	58h	3.6G	30G	33,568
mc-huge	72h	86h	8G	30G	9,040
mc-longlasting	202h	226h	3G	30G	19,800
long	48h	58h	4G	30G	33,568
huge	72h	86h	10G	110G	10,418
longlasting	168h	192h	4G	30G	3,931

- Sequential vs. Multi-core
  - But Multi-core = Grid $\rightsquigarrow$ even higher priority
- Walltime not considered at all
- No "Resource pools"

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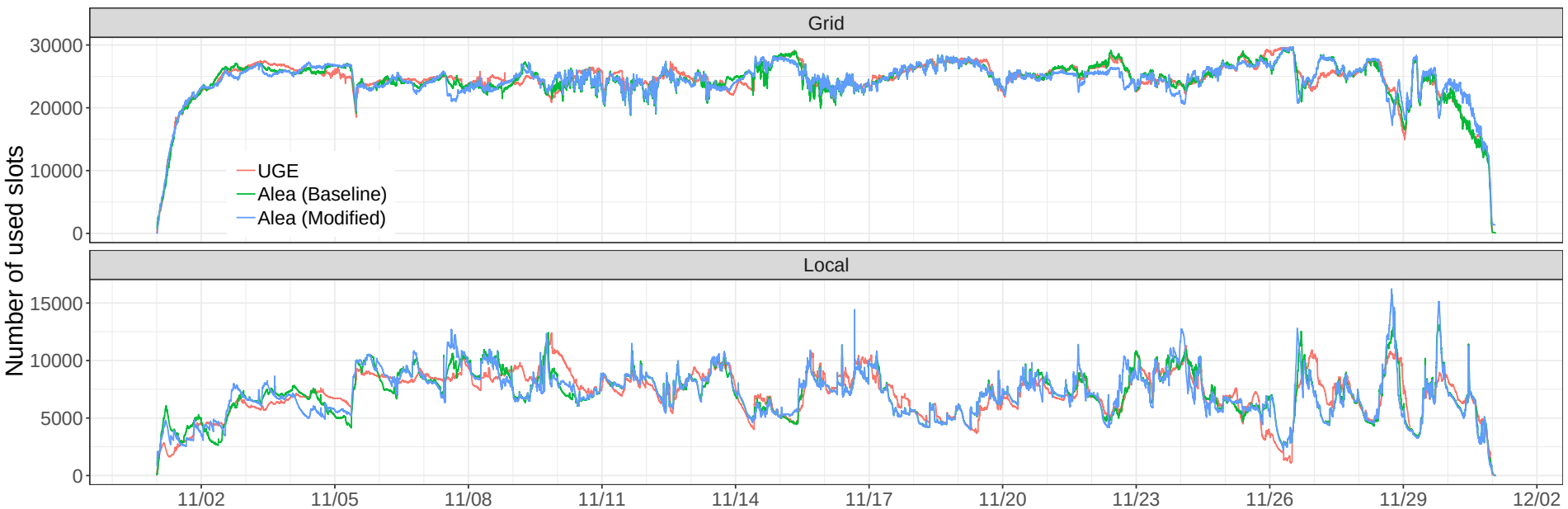
Queue name	CPU Time	Time	Memory	File Size	Cores
local-short	6h	7h	4G	30G	20,000
local-medium	24h	28h	4G	30G	15,000
local-long	48h	58h	4G	30G	10,000
grid	48h	58h	3.6G	30G	25,000
huge	72h	86h	10G	110G	10,000
longlasting	202h	226h	3G	30G	5,000

Quota Relaxation

- Existing large quota $\rightsquigarrow$ Harmless jobs
- Classify local jobs according to the fraction of resources they can use
  - 0-5%
  - 5-10%
  - 10+%
- Conservative relaxation
  - 0-5% $\rightsquigarrow$ increase by 5%
  - 5-10% $\rightsquigarrow$ increase by 10%
  - 10+% $\rightsquigarrow$ increase by 20%
- Extreme relaxation
  - 0-5% $\rightsquigarrow$ increase by 100%
  - 5-10% $\rightsquigarrow$ increase by 200%
  - 10+% $\rightsquigarrow$ increase by 300%

Simulation Results

- Replay the entire workload in simulation
- Rely on the Alea job scheduling simulator
  - Models the algorithms, queues, quotas, ...
- Have to first check that the simulation captures the main trends of the original schedule $\rightsquigarrow$ Baseline version



Simulation Results

Redefinition of the scheduling queues

Workload	Scenario	Average	Percentiles 50th	75th	90th	Maximum
Grid	Baseline	1h 10m	0s	8m 18s	1h 18m	15d 21h 54m
	Modified	1h 45m	0s	14m	2h 2m	14d 4h 33m
Local	Baseline	2h 3m	4m 30s	1h 40m	6h 40m	11d 21h 41m
	Modified	1h 58m	8s	1h 10m	6h 20m	4d 19h 6m

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Quota Relaxation

Workload	Scenario	Average	Percentiles 50th	75th	90th	Maximum
Grid	Conservative	1h 53m	0s	16m	2h 21m	13d 15h 21m
	Extreme	1h 57m	4s	17m 41s	2h 47m	14d 4h 41m
Local	Conservative	1h 39m	2s	45m 40s	5h 8m	3d 16h 58m
	Extreme	1h 14m	1s	21m 55s	2h 30m	3d 23h 11m

Conclusion

- Batch systems are complex
  - Many configuration parameters
- Have to know understand your workload
- Study different options
  - Redefine queues
  - Leverage job duration
  - Relax quotas
- Leverage simulation to assess the impact of modifications
  - It's a production system, disruption is forbidden

Thank you for your attention

Questions?