Multicore

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On behalf of the WLCG Multicore Task Force
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Layout

- WLCG Task Force
- Scheduling Problem
- CMS&ATLAS models
- Initial observations
- Keeping the slots alive
- Range of options
- Dynamic partitioning
- Dynamic scheduling
- Site status
- Conclusions

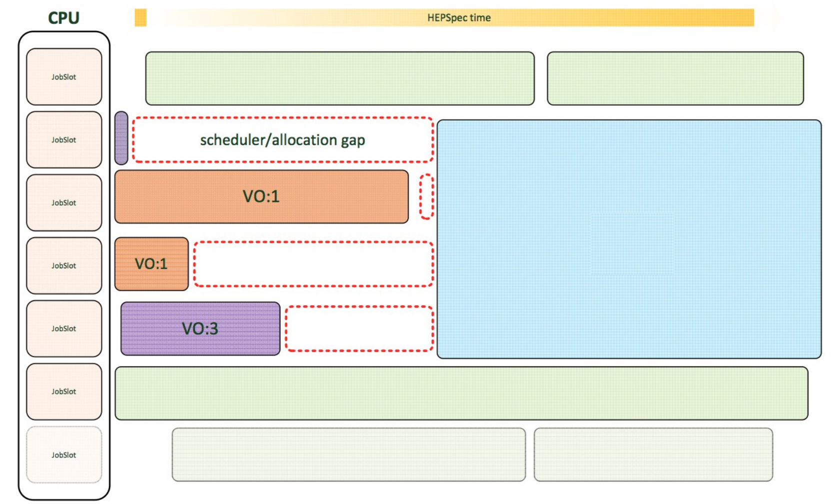
WLCG Task Force

- Running multicore a long standing problem in WLCG
  - 2 experiments (different philosophies)
  - 170 sites different sizes
    - 5 batch systems + versioning
    - 3 CE flavours
    - Other supported VOs
- The objective of the WLCG Task Force is to
  - Find a set of easy to implement recommendations to schedule multicore without waisting resources
    - Batch system capability, experiments approach
  - Get the sites to run multicore

Scheduling problem

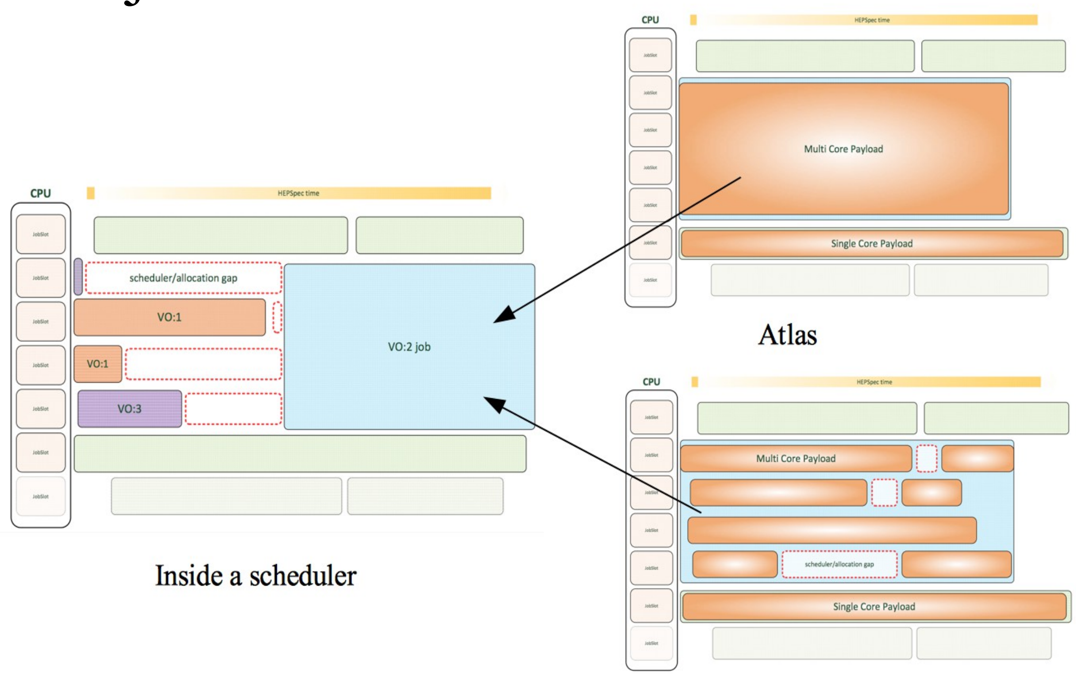
- Key problem: in order for a multicore job to start in a non-dedicated environment the machine needs to be sufficiently drained.
  - Creating a multicore slot:
    - Prevent single core jobs from taking freed resources
    - draining = idle CPUs!
  - Higher priority single core arrives and occupies slots
    - Wasted draining!

- Key Problems:
  - Create mcore slots
  - Conserve mcore slots
  - Reduce draining vs ability to run mcore effectively



Experiments submission

- CMS move the scheduling within the pilot
  - Predictability
  - Shared sites still have single core to handle
- ATLAS: mcore and score in parallel with 1 payload per pilot and let the scheduler do the job.
  - Entropy
  - Predictability still helps
    - Backfilling not an option yet



Inside a scheduler

Atlas

CMS

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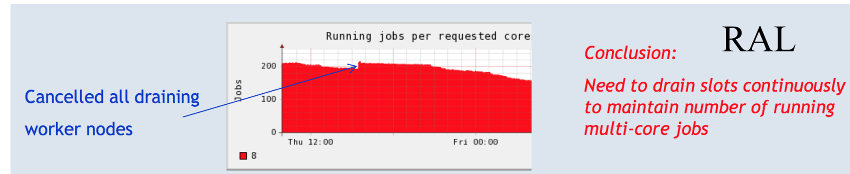
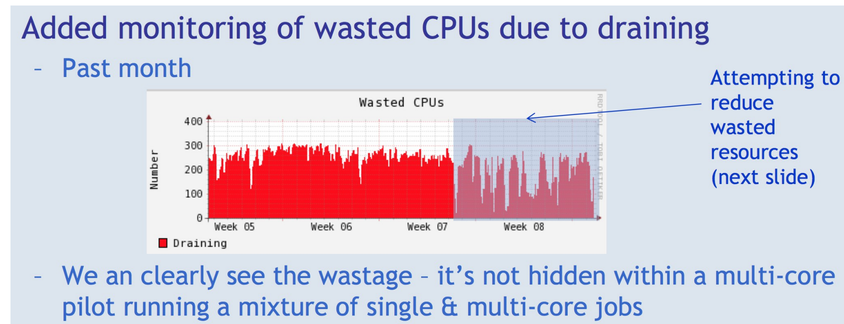
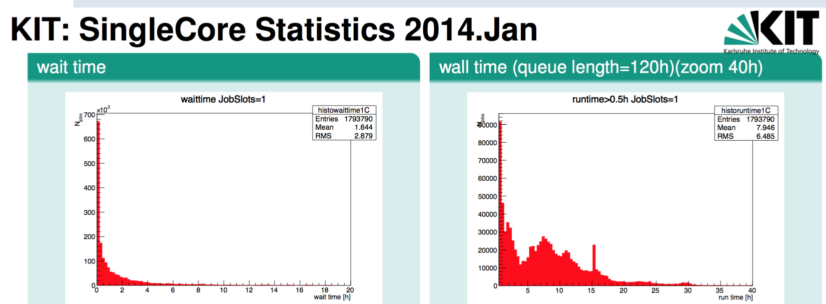
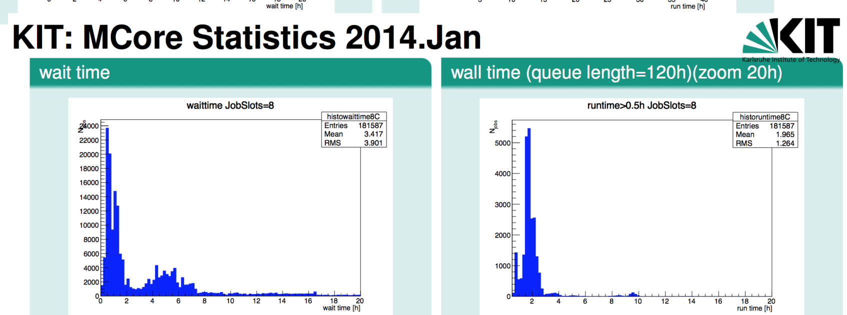
Early observations

- Multicore require continuous draining of slots
  - Reduce the number of draining slots at the time
- Longer waiting times for multicore jobs
  - Sometimes not running for days
- Short jobs (<6h)
  - disruptive because they don't exploit the slots freed.
- Long jobs (>24h)
  - Disruptive at shared sites
- Bursty submission most disruptive. Waste of CPU affected by submission patterns.
  - Disruptive whatever the solution









Keep the mcore slots alive

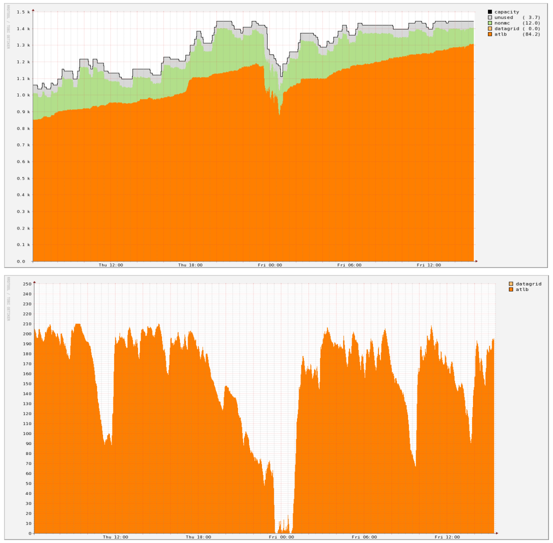
- Mixture of entropy and predictability
  - Experiments:
    - Continuous and stable supply of multicore jobs
    - Agreed common slot size at each site (default 8)
    - Avoid bursty submission patterns, which force the system to continue and re-adjust the level of draining
    - Avoid too short jobs or too long at non-dedicated sites
  - Sites
    - Allocate multicore jobs to multicore slots
      - Instead of single core jobs disrupting the drain process.
    - Rank/prioritise multicore over single core
    - Limit the number of slots that can be drained at the time

Range of options

- Treated in the TF
    1. Dynamic partitioning (Torque/LSF)
    2. Dynamic scheduling preferential mcore treatment and adaptable N of drained slots (HTcondor)
    3. Dynamic scheduling capacity to limit N of drained slots (SGE)
- Some other sites
    1. Static partitioning
        - Some dedicated sites with inflexible BS still use this.
    2. Dynamic scheduling preferential mcore treatment
        - No way to limit the number of draining slots
    3. Dynamic scheduling with no adjustments
        - All the problems described and no benefits at all!!

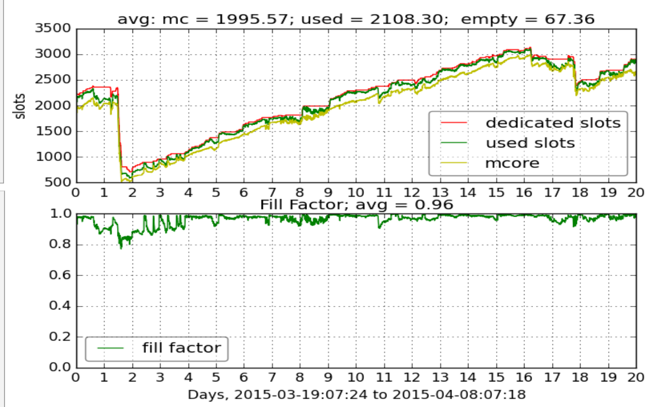
Dynamic Partitioning
(Torque/LSF)

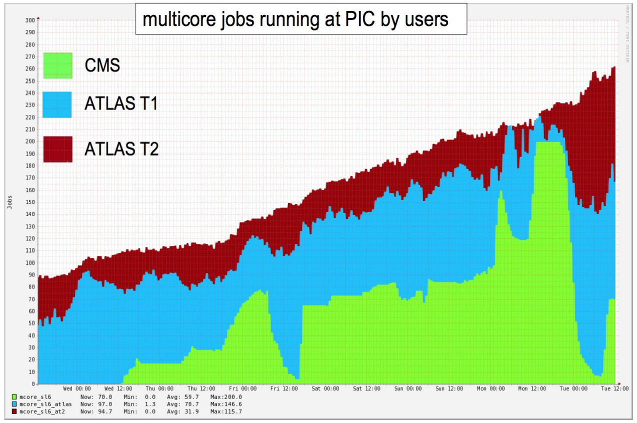
- Separate pools : avoid other higher priority jobs taking 1 of the 8 slots and destroy the ‘mc slot’
- Floating pool boundary w/ policies for filling and draining the tank:
  - Avoid too many empty slots during filling
  - Avoid empty slots if supply of mc jobs consistently dries up
- Protect against short stops



Nikhef

CNAF

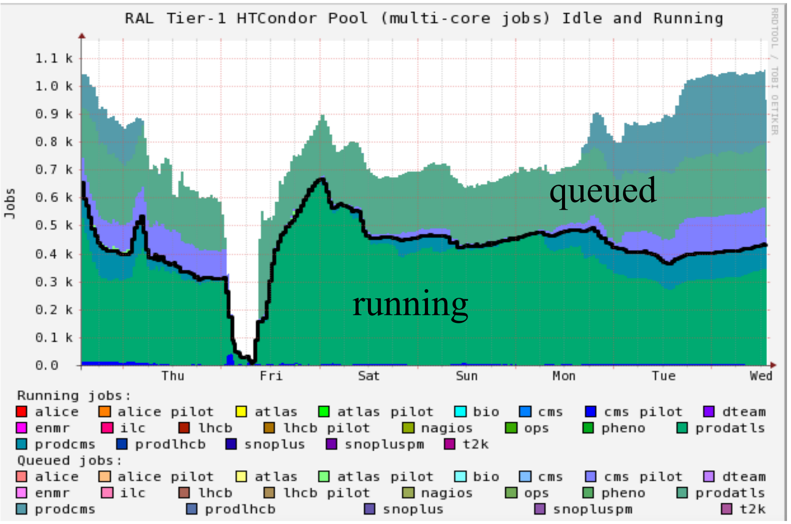


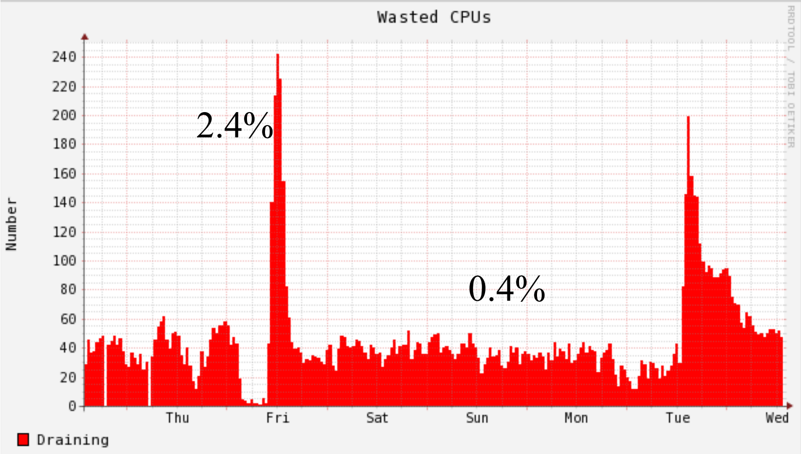


PIC

Dynamic scheduling
(HTcondor)

- GROUP_SORT_EXPR to evaluate mcore before score
- Enabled defrag daemon
  - Pick WN in order of how many 8-slots can be freed
  - WNs can run both score and mcore at the same time
- Cron to adjust number of drained slots to workload
  - Adjust condor config DEFRAG_MAX_CONCURRENT_DRAINING

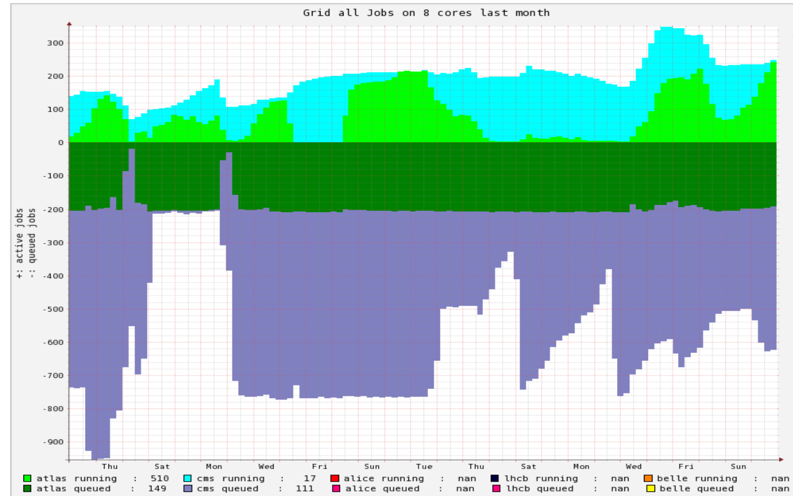


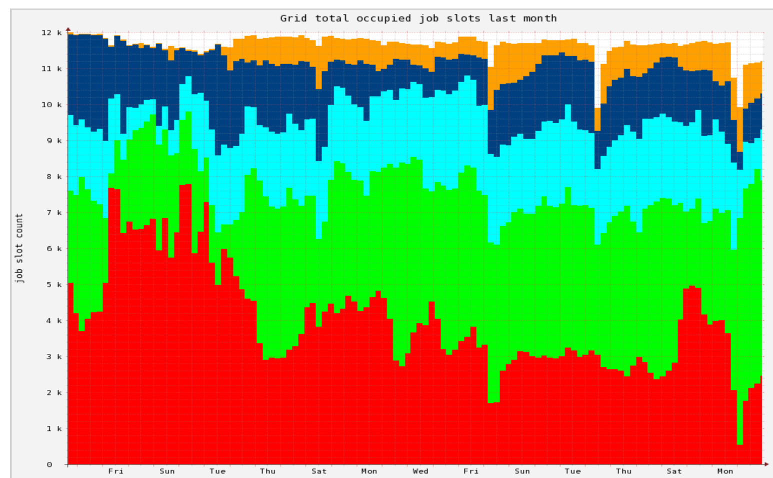


RAL

Dynamic Scheduling
(SGE)

- Goal: minimize waste of resources by limiting draining
  - Create a PE (Parallel Environment)
  - Max number of jobs that can be considered for draining
    - max_reservation_set
      - ~10=0.5-1% degradation
      - ~20=1-1.5% degradation
  - -R y option to enable reservations
  - Relies on experiments to rank/prioritize their workload
    - No extra queue
    - No partitions
    - WNs can run score and mcore





FZK

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Passing Parameters

- Backfilling is the traditional BS way to minimize waste
  - Requires jobs to pass the walltime at submission
  - Work ongoing on passing parameters to the BS in the TF
    - Concerning only ATLAS for now
    - Not only walltime but also memory
      - cgroups required to handle memory properly
      - Not all BS integrated with cgroups
        - Torque, SoGE, UGE <8.3.1, LSF<9.1.1
      - https://twiki.cern.ch/twiki/bin/view/LCG/BSPassingParameters

Sites status

- 85% of ATLAS sites have MCORE enabled
  - Still going through optimization
  - Reached 40% of resources, 50% slots in March.
- CMS priority for 2015 is multicore prompt data reconstruction which requires T0 plus 50% of T1 CPU resources.
  - All CMS T1s support multicore and target of 50% of T1 CPUSs has been achieved.
  - T2s still on voluntary basis

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Conclusions

- Quite few people put a lot of work and some creativity in solving this long standing problem both on the sites part and the experiments.
- There is still ongoing work
  - Looking at related high memory jobs scheduling
  - Passing parameters to the batch system
- Infrastructure to make it work is there
  - Infact it is currently already working
    - Needs fine tuning

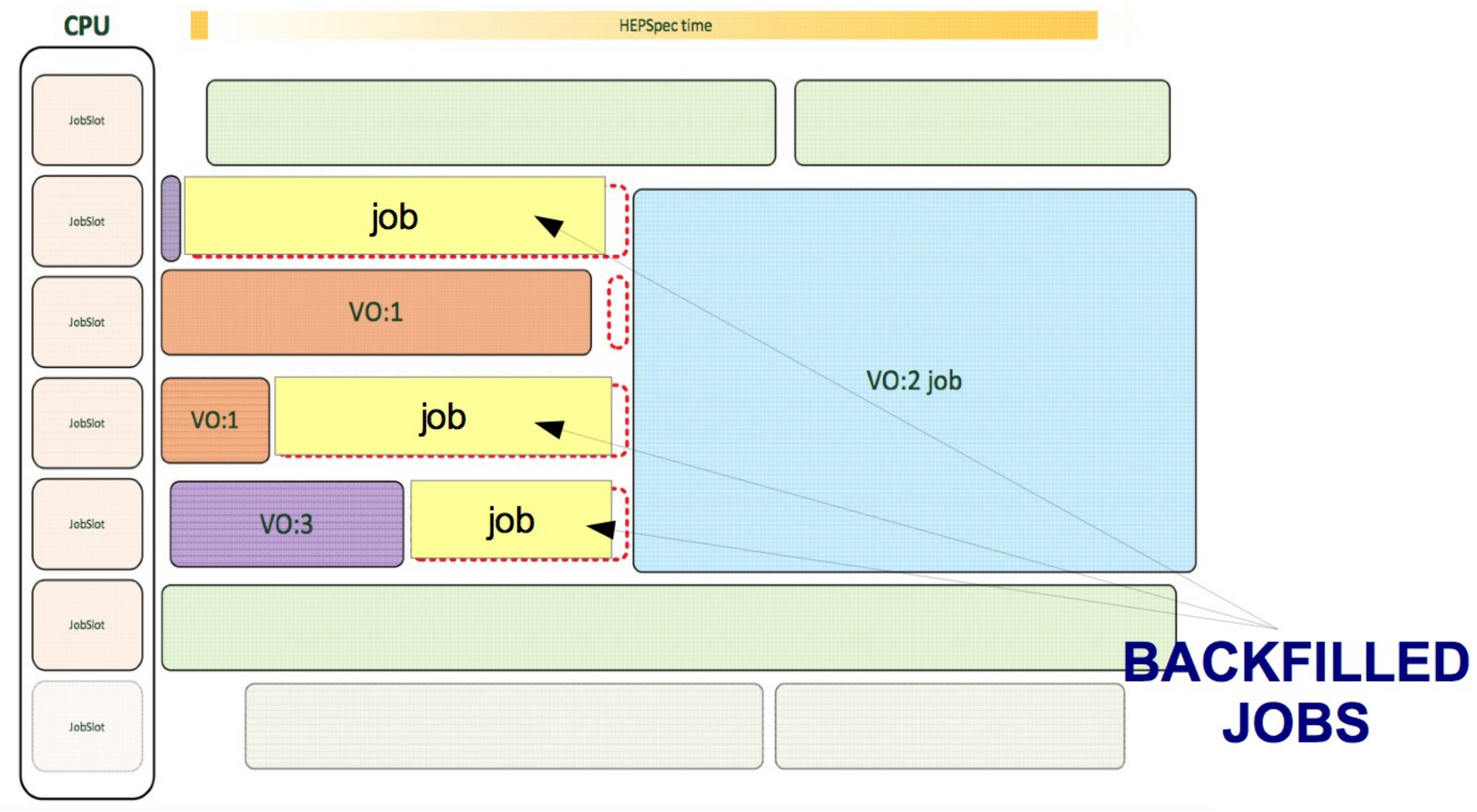
Backup slides

Backfilling

- Jobs of lower priority are allowed to utilize the reserved resources only if their prospective job end (i.e. the declared wallclock usage) is before the start of the reservation
  - Successful backfilling relies on two concepts
    - Entropy: there should be a distribution of jobs resources requests in order to increase the likelihood of finding the right "piece" to fill each temporary hole in draining WNs
    - Predictability: job running times estimates, so that the scheduler can make a decision on whether it should run this job in that hole or not.

Functionality	Torque/Maui	SLURM	HTCondor	USGE/OSGE	Son of GE	LSF
Efficient Backfilling	tunable	tunable	not out-of-the-box, but similar behaviour can probably be configured	yes	yes	yes

Backfilling



Reasons why there is no walltime (yet)

- Inherent to the jobs themselves, as the instantaneous luminosity and pile-up determine the complexity of events and thus the job running time.
  - This is different for analysis, MC production and data reconstruction/reprocessing.
  - There are mitigating tools in both experiments
- Variance in CPU power for WNs distributed across the grid and also within sites.
  - This may not be so much of a problem if the actual difference between the fastest and slowest machines at a given site is not larger than 15-20%.
- The most used CE type it require a standardization of the scripts to pass parameters to the batch system.
  - The TF has taken this on board