CSCS
Centro Svizzero di Calcolo Scientifico
Swiss National Supercomputing Centre

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

MC jobs with SLURM at CSCS

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Miguel Gila, CSCS

miguel.gila@cscs.ch

grid@cscs.ch

CSCS-LCG2

- **Swiss Tier-2 for ATLAS, CMS and LHCb**

- **Currently providing ~27kHS06**
  - ~2.7k jobs running at all times
  - ~1k jobs in queue avg. / seen max of ~4k

- **Running SLURM 2.6.2 since October 2013**

- **Multiple node configuration**
  - 10x AMD Interlagos (32 core) *– to be decommissioned*
  - 67x Intel Sandy Bridge (32 core)
  - 16x Intel Ivy Bridge (40 core)

  - HT enabled => one job slot per "core"
  - Using Infiniband QDR/FDR + shared filesystem (GPFS) => MPI possible (but not configured)

MC jobs

- Running ATLAS MC jobs since Jan 2014
  - First job started on 2014-01-01T18:35:40
- EMI-3 ARC and CREAM CEs configured, but MC jobs landing only on ARC
- We make no distinction between jobs: MC and SC run under the same users, partitions and conditions ➔ this makes fair-share calculations easier and more accurate
  - ATLAS, CMS and LHCb (+ops, hone, dteam) allowed to run MC jobs
- ATLAS is the only VO running MC
  - So far completed ~6800 ATLAS jobs (1.6% of ATLAS)
  - In terms of CPU time, MC jobs account for 259.066h (18.5% of ATLAS)

The middleware

- **Initial issues with the middleware:**
  - ARC-CE would reserve 8x cores per job (=64 instead of 8)
  - CREAM-CE would simply ignore MC jobs

- **Modified the submission scripts by hand for SLURM and MC** (thanks to ICM's initial port)
  - ARC: *submit-SLURM-job*
  - CREAM: *slurm_submit.sh* + *slurm_local_submit_attributes.sh*

- **Problems now solved,** anything **newer** than the following versions should support MC without issues:
  - emi-cream-ce-1.2.2-2.el6.noarch
  - nordugrid-arc-3.0.3-1.el6.x86_64

- **Currently ATLAS MC jobs only land on ARC-CE**

SLURM configuration

- **SLURM supports multicore jobs by default**

slurm.conf

```
SelectType=select/cons_res              # consumable resources
SelectTypeParameters=CR_CPU_Memory      # consumable resources are CPU and MEM
SchedulerType=sched/backfill            # backfill is enabled

MaxTasksPerNode=40                      # Max is 128tasks per node, but for WLCG we want ~one per CPU

NodeName=DEFAULT        RealMemory=64359  CPUs=32 State=UNKNOWN    # keep it simple: no Sockets, SocketsPerBoard…
NodeName=wn[80-95]      RealMemory=128894 CPUs=40 State=UNKNOWN    # just number of CPUs = job slots

PartitionName=DEFAULT Nodes=wn[01-48],wn50,wn[52-95] Default=YES Priority=10     DefMemPerCPU=2000 Shared=NO
PartitionName=atlas   Priority=10   MaxTime=96:00:00 AllowGroups=atlas,nordugrid MaxMemPerCPU=4000 Default=NO
```

- **One partition (queue) per VO** (atlas uses 2, atlas + atlashimem)
  – All nodes belong to all partitions

- **Testing is easy:**

```
$ srun -N1 --ntasks-per-node=2 -p other hostname
```

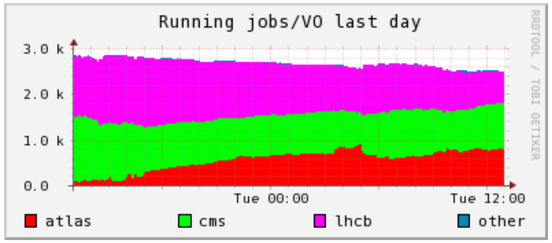
```
$ cat simple_script.jdl
[
SMPgranularity = 2;
#WholeNodes = True;
#HostNumber = 1;
#CpuNumber = 2;
Executable="simple_script.sh";
InputSandbox = {"simple_script.sh"};
StdOutput = "stdout.out";
StdError = "stderr.out";
OutputSandbox = {"stdout.out", "stderr.out"};
OutputSandboxBaseDestURI = "gsiftp://localhost";
]
```

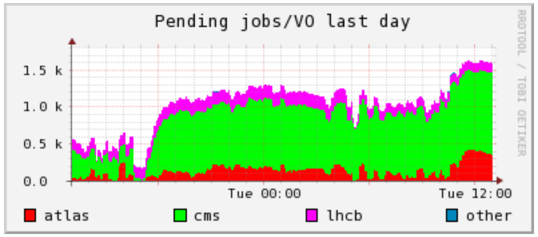
SLURM configuration

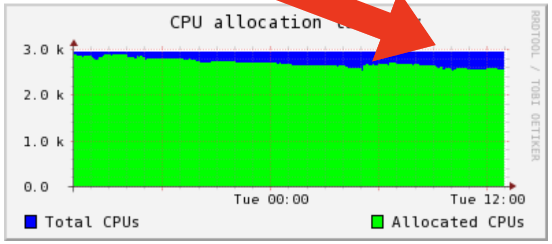
- **No implicit limit on the number of cores that can be requested by jobs.**
  - The CE needs to limit it to < # cores in a system
  - Nowadays 8 seems a safe assumption

- **Backfilling enabled,** but not very useful as jobs don't request time constraints ➔ they get the max configured and SLURM can't plan ahead
  - Avg. queue time ATLAS SC: 2h:32m:44s
  - Avg. queue time ATLAS MC: 11h:59m:39s

SLURM is draining nodes to make room for MC jobs ➔ node utilization goes down







Our evaluation

- **The good:**
  - Extremely easy to deploy: minimal or no changes on the scheduler configuration are required
  - Fair-share calculations take into account total number of cores per job
  - Middleware seems to be prepared for SLURM + MC jobs
- **The bad:**
  - Backfilling would work better if jobs would actually use time limits
  - Not a lot of scripts available to parse accounting DB ➔ a lot of work in-house to plot statistics (http://wiki.chipp.ch/twiki/bin/view/LCGTier2/PhoenixMonOverview)
- **The ugly:**
  - Some versions of SLURM have serious bugs (i.e. 2.6.2 would crash when reserving cores instead of full nodes ➔ ops is affected!!)

Questions?

Thank you for your attention.

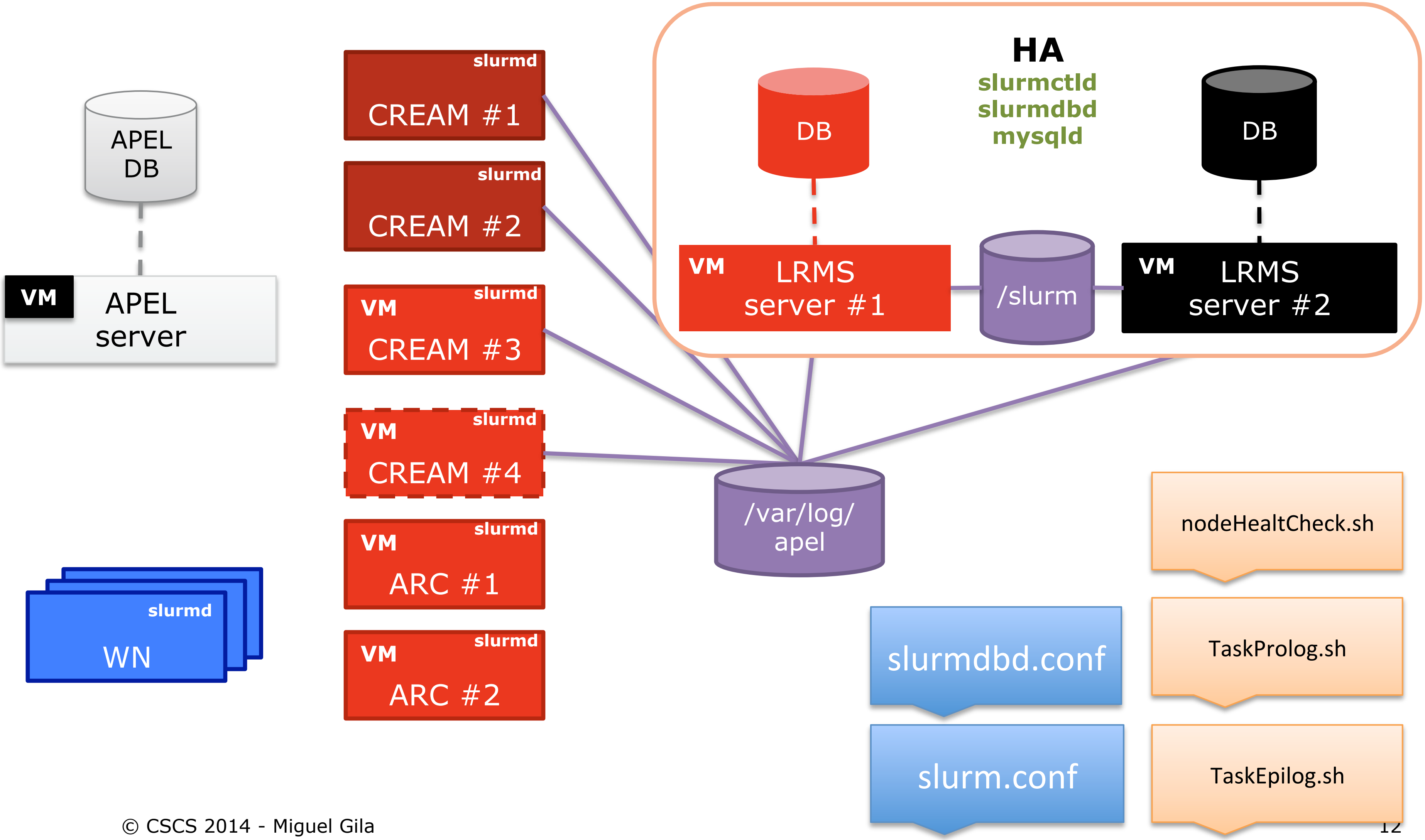
Backup slides

SLURM processes

- **slurmd:**
  - runs on the clients (WN, ARC and CREAM)
- **slurmctld:**
  - it is the scheduler itself
  - runs on the control nodes (can be HA)
- **slurmdbd:**
  - it connects slurmctld and the accounting DB
  - runs on any node (usually control nodes, can be HA)

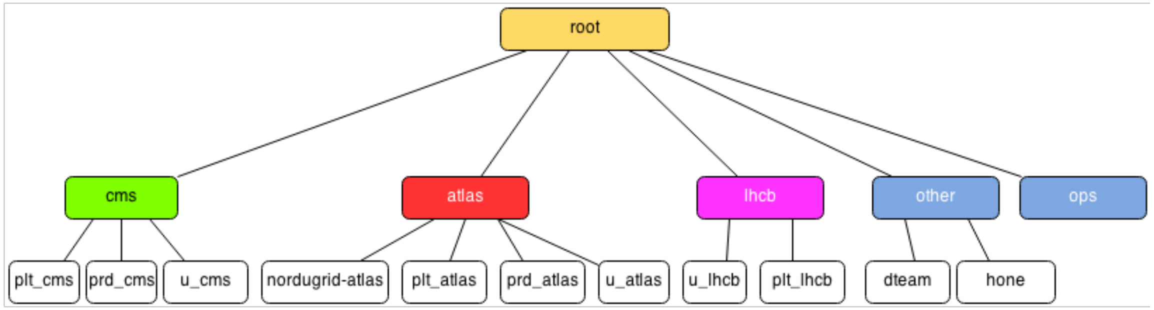
- **mysqld:**
  - runs anywhere (can be HA)

Our setup


APEL
DB
VM
APEL
server
slurmd
WN
slurmd
CREAM #1
slurmd
CREAM #2
slurmd
VM
CREAM #3
slurmd
VM
CREAM #4
slurmd
VM
ARC #1
slurmd
VM
ARC #2
HA
slurmctld
slurmdbd
mysqld
DB
DB
VM
LRMS
server #1
/slurm
VM
LRMS
server #2
/var/log/
apel
nodeHealtCheck.sh
TaskProlog.sh
TaskEpilog.sh
slurmdbd.conf
slurm.conf

Configuration details

- **7 partitions** (atlas, atlashimem, other, ops, lcgadmin, cms, lhcb)
- **All nodes are in all partitions/queues**
- **1 reservation for priority_jobs**
  - OPS + VO *sgm users
  - 2 nodes fully reserved (because of bug on slurm 2.6.2)
- TaskProlog.sh and TaskEpilog.sh empty
- nodeHealthCheck.sh runs on all nodes every 3 minutes and checks for basic system health. It drains the node if not all checks are successful
- Both SLURM control daemon nodes need to share /slurm for consistency
- Hierarchical accounting configuration



slurm.conf

```
ControlMachine=slurm1
BackupController=slurm2
[…]
SlurmdSpoolDir=/tmp/slurmd
TaskProlog=/etc/slurm/TaskProlog.sh
TaskEpilog=/etc/slurm/TaskEpilog.sh
AuthType=auth/munge
SchedulerType=sched/backfill
SelectType=select/cons_res
SelectTypeParameters=CR_CPU_Memory
TaskPlugin=task/none
ProctrackType=proctrack/linuxproc
DefaultStorageType=slurmdbd
AccountingStorageType=accounting_storage/slurmdbd
JobAcctGatherType=jobacct_gather/linux
JobCompType=jobcomp/script
JobCompLoc=/usr/share/apel/slurm_acc.sh
AccountingStorageEnforce=limits
HealthCheckInterval=180
HealthCheckProgram=/etc/slurm/nodeHealthCheck.sh
[…]
```

```
[…]
PriorityType=priority/multifactor
PriorityDecayHalfLife=07-12
PriorityFavorSmall=YES
PriorityMaxAge=4-0
PriorityWeightAge=1000
PriorityWeightFairshare=5000
PriorityWeightJobSize=1000
PriorityWeightPartition=10000
PriorityWeightQOS=1000
FastSchedule=1
PreemptType=preempt/none
[…]
```