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slurm

workload manager

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Workload Management & Slurm

Presented by CSCNSI

What is Workload Management?

- We need a way to easily put our many compute nodes to use
- We need a tool that can match work that needs to be done with resources that are available
- It needs to be smart enough to
  - Start multi-node jobs
  - Schedule jobs from a long list of waiting tasks according to policy
  - Know what resources are available
  - Know what jobs to send to what hardware
  - Know how to start a job on our hardware
- And generally a lot of other things, like keeping track of accounting information, etc.

Scheduling vs. Resource Management

Scheduler

- The “Brain” of the system
- Single, centralized daemon
- Obtains job and node data from Resource Manager
- Prioritizes jobs
- Decides:
  - What jobs will run
  - Where they will run
  - When they will run

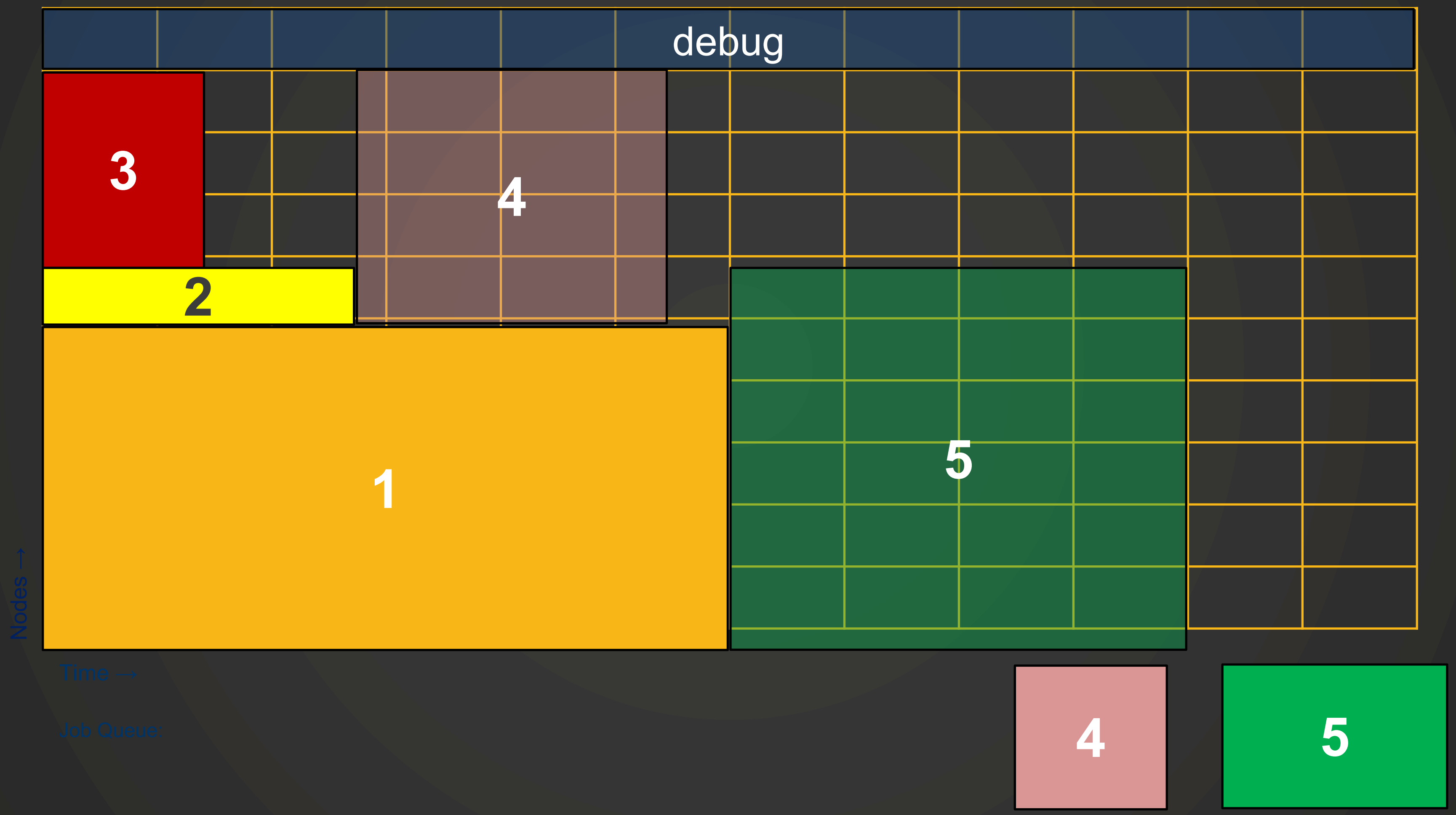
Resource Manager

- The “Worker” of the system
- Server daemon plus per-node client daemons
- Gathers node information (CPUs, memory, disk, load)
- Answers queries for this information
- Spawns jobs when told to
- Can add/remove resources

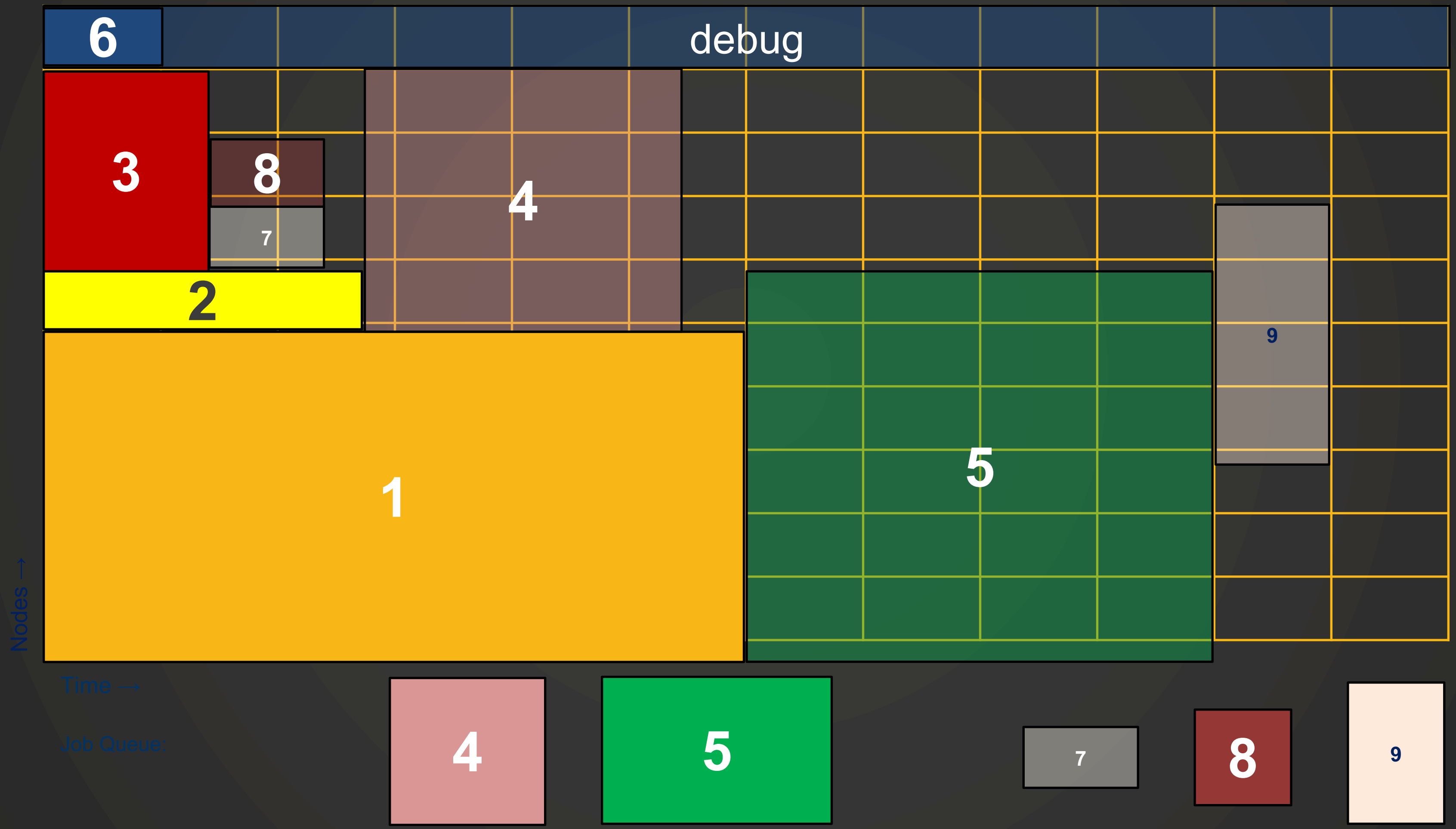
Scheduling Cycle

- Job Ordering
  - Calculate job priorities and sort job list by priority
  - Start all jobs which can start
  - Make reservations for next 1024 jobs
  - Use backfill policy to sort remaining jobs (1024)
- Job Placement (for each job being started)
  - Filter list of all nodes based on requirements
  - Filter list of nodes based on eligibility
  - Sort final node list based on node allocation policy
  - Start job on top n nodes

Scheduling Example – Iteration #1



Scheduling Example – Iteration #2 (backfill)

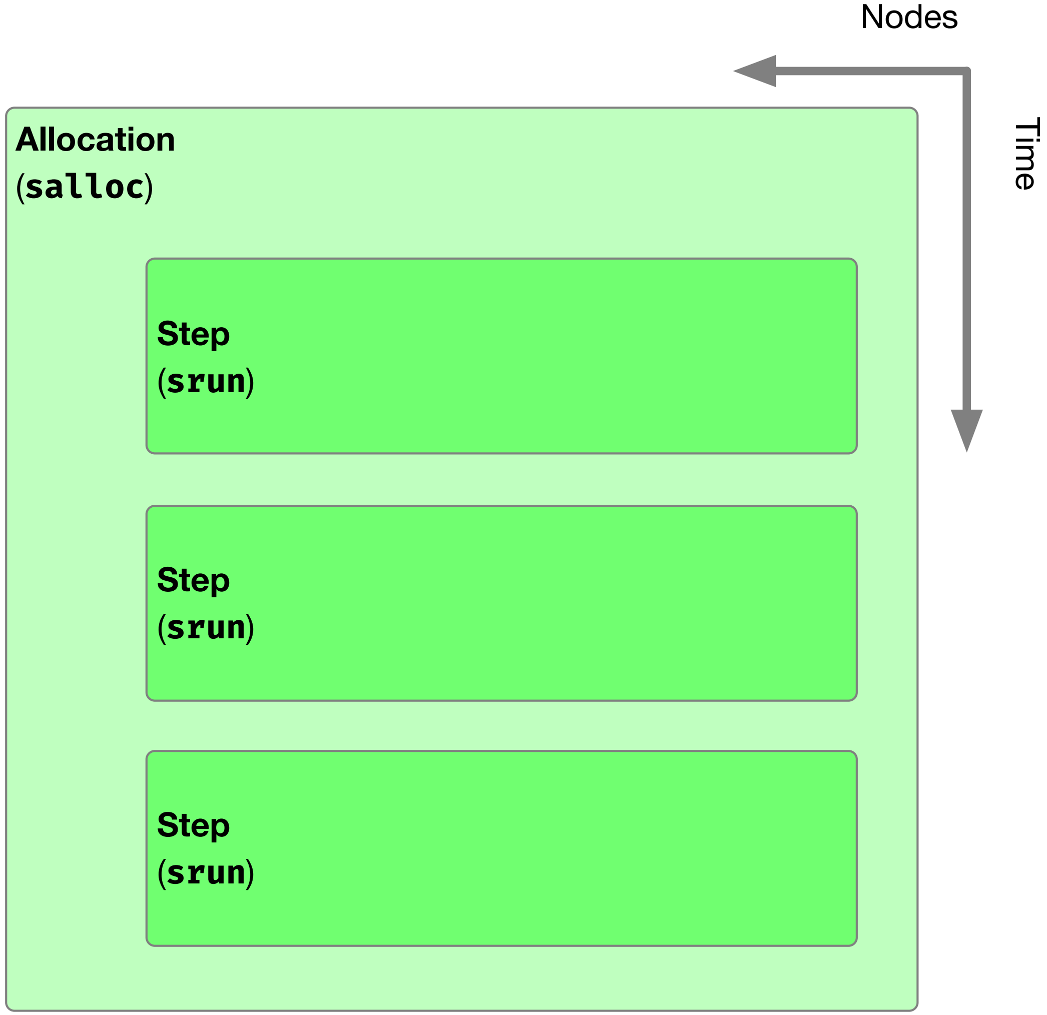


What is Slurm?

- Slurm is a Workload Manager for HPC workloads
- Originally "*Simple Linux Utility for Resource Management*"
  - Was spelled SLURM
- Since it now is also a scheduler, was rebranded *Slurm* (not an acronym)
- Originally written at LLNL
- Now commercially developed & supported by SchedMD
- Used on more than half of the top 10 of the top500

Structure of a Slurm job

- A job needs an “allocation”
  - Specifies needed resources
    - Memory
    - Nodes/CPUs
    - …
  - Specifies a max time
- Within an allocation multiple steps can execute
  - Steps, in total, must fit within allocation



Slurm interactive job

- An allocation is made with the **`salloc`** command
- An allocation is bound to a process
- **`srun`** started within that process create a step
- The job ends when the allocation process ends

```
[fe] $ salloc –n1 /bin/bash
salloc: Granted job allocation 423
[fe] $ srun --pty /bin/bash
[n01] $ ./do_work
[n01] $ exit
[fe] $ srun –pty ./do_more_work
(runs on n01)
[fe] $ exit
salloc: Relinquishing job allocation
423
[fe] $
```

Slurm batch job

- Jobs can be specified as a pre-defined script
- Special *#SBATCH* lines provide Slurm parameters
- Can submit multiples of the same task
  - Or can submit arrays of the same job, keyed by the *$SLURM_ARRAY_TASK_ID*
- Submitted with:
  - *sbatch <script>*

```
#!/bin/bash
#
#SBATCH --job-name=test_emb_arr
#SBATCH --output=res_emb_arr.txt
#SBATCH --ntasks=1
#SBATCH --time=10:00
#SBATCH --mem-per-cpu=100 #
#SBATCH --array=1-8
srun ./my_program.exe \
   $SLURM_ARRAY_TASK_ID
```

Common Slurm commands

Start an allocation	**salloc**
Run a step in an allocation	**srun**
Submit a batch script	**sbatch**
View the queue	**squeue**
Stop a running job	**scancel**
Attach to I/O of current task	**sattach**
View the cluster status	**sinfo**
View job accounting data	**sacct**
Control Slurm	**scontrol**

All of the commands have extensive options. See `man <slurm_command>`

Questions?