

Scheduling Basic Jobs

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Slides & Exercises

https://github.com/ResearchComputing/hpc_fundamentals_micro_credential

- In “scheduling_jobs” directory



Learning Objectives

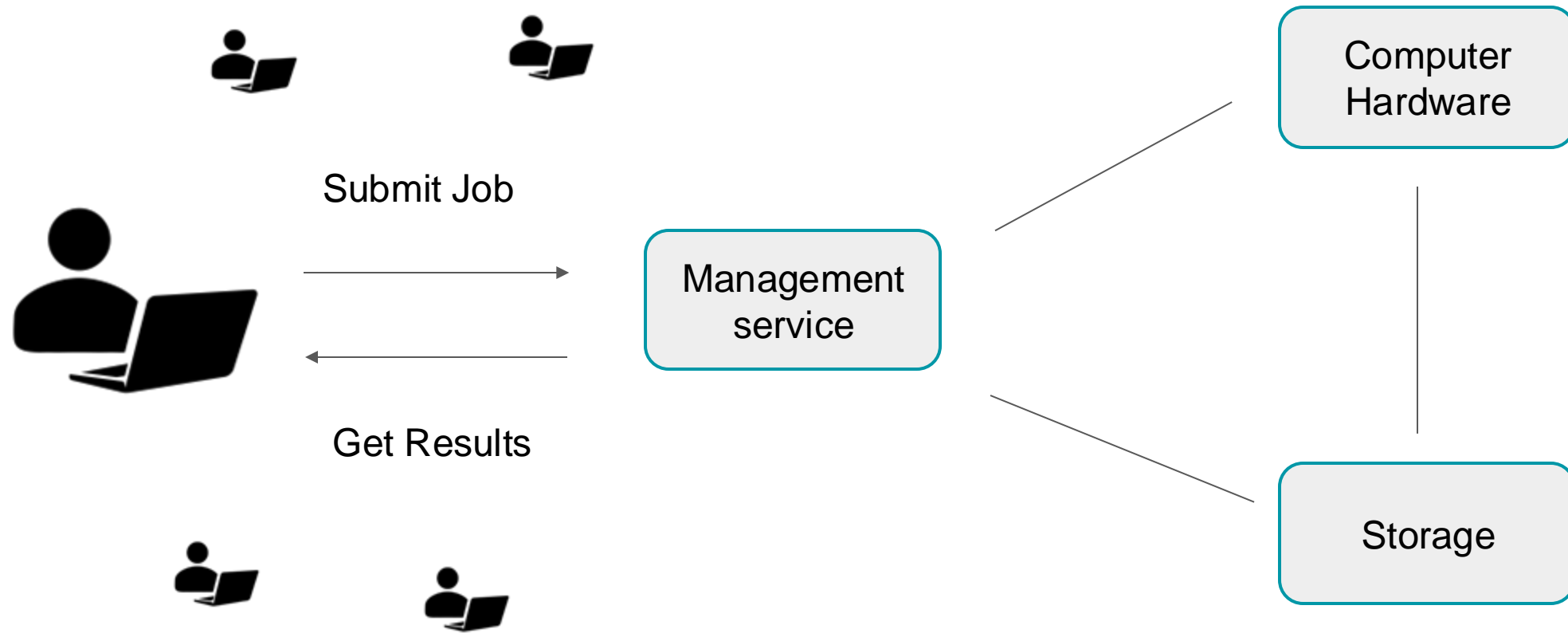
- Obtain a clear overview of job submission on an HPC system
- Learn about submitting both a batch and an interactive job to Alpine using the terminal

Session Overview

- General overview of Job submission
- Introduction to batch jobs
 - Submission of a batch job
- Checking/monitoring jobs
- Utilizing software in a job
- Introduction to interactive jobs

Remember, when you login to the HPC system you are put on a login node. You need to then gain access to a compute node to run software.

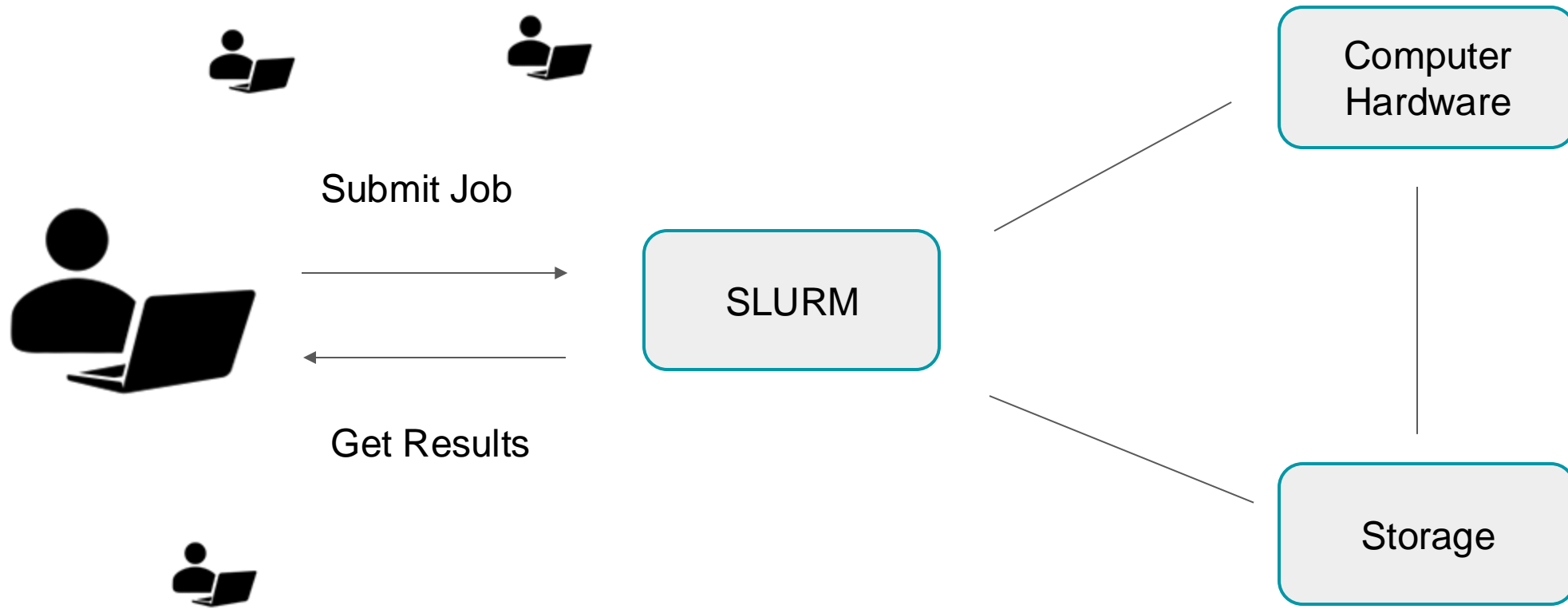
General Overview of Job Submission



Introduction to Jobs

- Because our clusters are shared resources with many users trying to utilize available compute with their applications, we need a system to divide compute in a simple and fair system
- SLURM
 - **S**imple **L**inux **U**tility for **R**esource **M**anagement
- Through SLURM, users can grab allotments of compute resources called Jobs
- 2 Types of Jobs
 - **Batch Jobs**
 - **Interactive Jobs**

General Overview of Job Submission



Job directives

- Directives are special flags that specify what type of HPC resources you would like to use
 - “I want to run on 1 CPU for 1 hour”
- Used for both interactive and batch jobs
- Can be specified via the command line or in a job script
- All directives shown are specific to SLURM

Common directives

- **Partition – A collection of compute nodes**
 - `--partition=<partition_name>`
- **Quality of service (QoS) – System defined constraints for a job (more on this later!)**
 - `--qos=<qos>`
- **Allocation – Account to “charge to”**
 - `--account=<account_name>`
- **Number of nodes to run on**
 - `--nodes=<nodes>`
- **Number of cores to run on**
 - `--ntasks=<number-of-tasks>`

Common directives

- **Wall time** – How long you want to run on these resources
 - `--time=<wall time>`
- **Job name**
 - `--job-name=<jobname>`
- **Output** – Where all output that would be written to the terminal should go
 - `--output=<name>`
- **Send an email when events happen in the job**
 - `--mail-type=<type>`
- **Email address to send updates to**
 - `--mail-user=<user>`

Alpine Partitions

- Partitions are a collection of compute nodes e.g. computers with common characteristics

Partition	Description	# of nodes	RAM/core (GB)	cores/node	GPUs/node
amilan	General Compute Node: AMD Milan	376	3.75	32,48,64	0
ami100	GPU Node: 3x AMD MI100	8	3.75	64	3
aa100	GPU Node: 3x Nvidia A100	12	3.75	64	3
amem	High-memory node	24	21.5	48,64	0

Alpine Testing Partitions

- For many of the partitions we have testing partitions that provide quicker access to resources.

Note: there are restrictions on the amount of resources you can request. These restrictions can be found in our documentation.

Partition	Description	# of nodes	RAM/core (GB)	cores/node	GPUs/node
atesting	General Compute Node: AMD Milan	2	3.75	64	0
acompile	General Compute Node: AMD Milan	4	3.75	64	0
atesting_mi100	GPU Node: 3x AMD MI100	1	3.75	64	3
atesting_a100	GPU Node: 3x Nvidia A100	1	3.75	64	6 MIG instances



Quality of Service (QoS)

- Quality of Service specifies additional constraints for a job
 - On Alpine, QoS can be used to run long jobs, specify testing partitions, and select high-memory nodes

QoS	Description	Max wall time	Max jobs/user	Max nodes/user
normal	Default QoS	24 H	1000	128
long	For jobs needing longer wall times	7 D	200	20
mem	High-memory jobs	7 D	n/a	12
testing	For jobs submitted to testing partitions	1 H	1	n/a
compile	For jobs submitted to compile partition	12 H	1	n/a

Batch Jobs

- **Batch Jobs** are jobs you submit to the scheduler that are run later without supervision
 - By far the most common job on Alpine
 - Requires a job script
- A job script is simply a script that includes **SLURM directives** (resource specifics) ahead of any commands.

Anatomy of a job script

- It's just a bash script with SLURM specific directives!

```
#!/bin/bash
```

```
## Directives
```

```
#SBATCH --<option>=<value>
```

```
## Software
```

```
module load <software>
```

```
## User scripting
```

```
<command>
```



Directives in a job script

```
#SBATCH --<option>=<value>
```

Example job script

```
#!/bin/bash

## Directives
#SBATCH --ntasks=1           # Number of requested tasks/cores
#SBATCH --time=0:01:00       # Max run time
#SBATCH --partition=amilan    # Specify Alpine CPU node
#SBATCH --output=test_%j.out  # Rename standard output file

## Software
module purge                  # Purge all existing modules

## User commands
echo "This is a test of user $USER"
```

Submitting a Job script

- Once a job script has been constructed you must submit it to the HPC system using SLURM
 - Done using `sbatch`
- If we created the job script “my_first_job.sh” then we would submit it as follows:

```
sbatch /path/to/my_first_job.sh
```

Job output

- Once a job completes its execution, the standard output of the script will be redirected to an output file.
 - Great for debugging!
 - Could be different from output generated by your application
 - File is created in directory job was run unless specified in your `--output` directive.
 - If the directive `--output` is not provided, then a generic file name will be used (slurm_XXXXXX.out).

Checking your jobs

- **squeue**: Monitor your jobs status **in queue and while running**:
 - By default, shows all jobs in queue can specify using:

```
$ squeue -u <username>  
$ squeue -p <partition>
```

- **sacct**: Check back on usage statistics of **previous Jobs**
 - By default, only checks all jobs from the start of the current day can specify using:

```
$ sacct -u <username>  
$ sacct --start=MM/DD/YY -u <username>  
$ sacct -j <job-id>
```

Checking your jobs

- Another method of checking details of your job while running is with `scontrol`
 - Advanced command usually used by system administrators, but you can use it too!

```
$ scontrol show job <job number>
```

- To check the percentage of CPU and memory usage of a job **after it completes**, use `seff`

```
$ module load slurmttools  
$ seff <job number>
```

Software and Jobs

- Okay so running a job is easy, but how do I run a job with my software?
- We can utilize all the software we discussed in the previous talk in the job script!
- Any non-GUI related commands you would run from the command line can be put in your job script!
 - If you would like to use GUI applications, you will need X11 forwarding and an interactive job

Software job script example

```
#!/bin/bash

## Directives
#SBATCH --ntasks=1                # Number of requested tasks/cores
#SBATCH --time=0:01:00            # Max run time
#SBATCH --partition=amilan        # Specify Alpine CPU node
#SBATCH --output=test_%j.out      # Rename standard output file

## Software
module purge                      # Purge all existing modules
module load anaconda              # Load Anaconda
conda activate <my-conda-environment> # Activate CONDA environment

## Run Python script
python my_cool_script.py
```



Interactive jobs

- Interactive jobs are used to gain access to a compute node in real time
 - Great for testing and debugging!
- Interactive jobs can be subject to normal wait times!
- We can get access to a compute node interactively with `sinteractive`
- We also have a specialized command called `acompile` that provides you with an interactive session
 - Access to quick resources
 - Limit of 4 CPUs for up to 12 hours

Running an interactive job

- Here we will run a Python script using an interactive job
- First request resources:

```
$ sinteractive --partition=acompile -qos=compile --time=00:10:00
```

- When the job starts you will be put on a compute node and you can execute your commands:

```
$ module load anaconda  
$ python my_very_cool_script.py
```

- To quit:

```
$ exit
```

Interactive GUI job

- If you have software that has a Graphical User Interface (GUI) it is sometimes possible to display that GUI on your local machine.
 - This is done using X11 forwarding
 - This GUI may be laggy if you are on a compute node or if your connection is unstable
 - See our documentation: <https://curc.readthedocs.io/en/latest/running-jobs/interactive-jobs.html#interactive-gui-applications>

Note: you can also use our Open OnDemand “Core Desktop” application to display a GUI. This tends to be more stable than X11 forwarding.

Thank you!