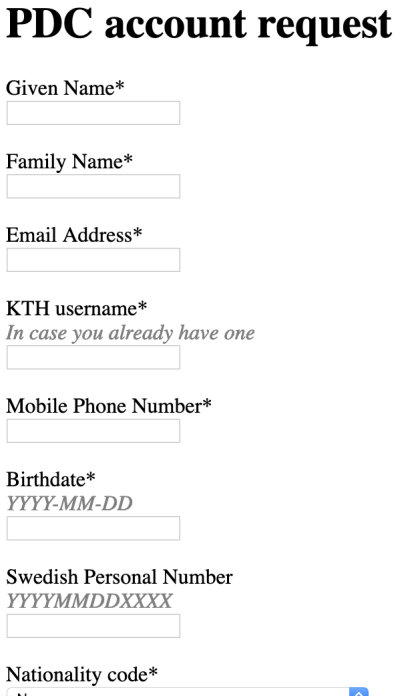
# Hands-on:
# AMD GPU on Dardel supercomputer

# Connect to Dardel

If not yet done, to apply for a PDC user account, you need to fill out the form at:

https://pdc-web.eecs.kth.se/accounts/

For this hands-on session, you will be using project account ‘edu23.summer’ for job allocation



**PDC account request**

Given Name*

Family Name*

Email Address*

KTH username*
*In case you already have one*

Mobile Phone Number*

Birthdate*
*YYYY-MM-DD*

Swedish Personal Number
*YYYYMMDDXXXX*

Nationality code*

# Connect to Dardel - Kerberos

Before connecting to Dardel, the local environment of your laptop must be configured.

Detailed instructions can be found on https://www.pdc.kth.se/support/documents/login/configuration.html.

•If you are using **Mac,** you need to follow a special set of instructions here: https://www.pdc.kth.se/support/documents/login/mac_login.html.

•If you are using **Windows**, we recommend using the WSL2 to use a fully-fledged Ubuntu: https://www.pdc.kth.se/support/documents/login/windows_login.html#wsl-approach.


To configure Kerberos on your local machine, you need to do the following steps:

1) Create .ssh folder if it does not already exist in your home folder.

2) Create a file called krb5.conf in .ssh with the following content

# Connect to Dardel - SSH

1. See https://www.pdc.kth.se/support/documents/login/configuration.html
2. Create a file in .ssh called config with the following content

```
# Hosts we want to authenticate to with Kerberos
Host *.kth.se *.kth.se.
# User authentication based on GSSAPI is allowed
GSSAPIAuthentication yes
# Key exchange based on GSSAPI may be used for server authentication
GSSAPIKeyExchange yes
# Hosts to which we want to delegate credentials. Try to limit this to
# hosts you trust, and were you really have use for forwarded tickets.
Host *.csc.kth.se *.csc.kth.se. *.nada.kth.se *.nada.kth.se. *.pdc.kth.se *.pdc.kth.se.
# Forward (delegate) credentials (tickets) to the server.
GSSAPIDelegateCredentials yes
# Prefer GSSAPI key exchange
PreferredAuthentications gssapi-keyex,gssapi-with-mic
# All other hosts
Host *
```

2. Set the correct permission on the file

```
$ chmod 644 ~/.ssh/config
```

3. Connect

```
$ ssh YourUsername@dardel.pdc.kth.se
```

# A Supercomputer

Kerberos
+ `ssh`

Login Node

Login Node

slurm workload manager

slurm workload manager

Comp. Node

Comp. Node

Comp. Node

Comp. Node

Comp. Node

Comp. Node

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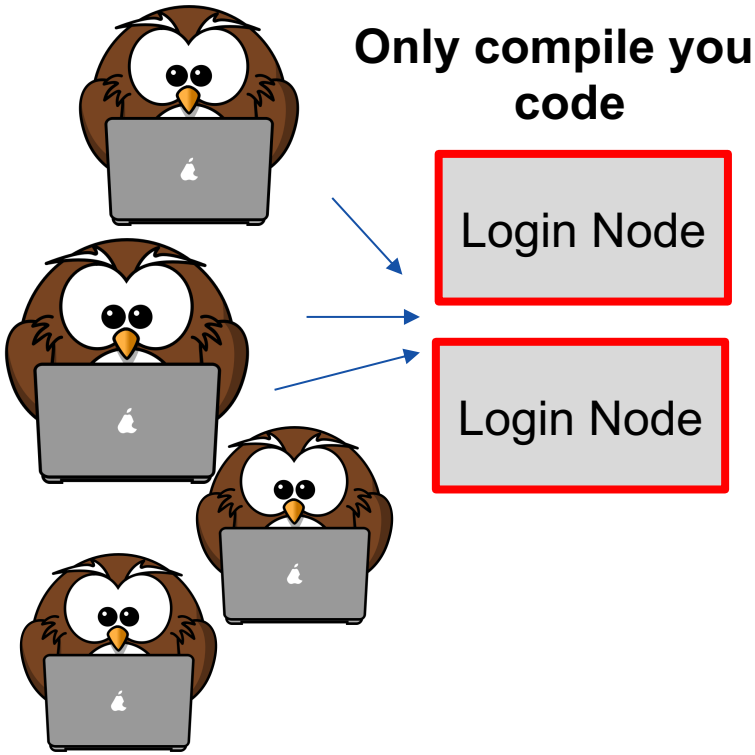
Comp. Node

# Do not run your simulation on the Login Node!




- When connecting to a supercomputer, you are connecting to the **login node**.
- Login nodes are **shared nodes across all users**.
- You can use the `top` command to check who is connected to the login node.
- Use the login nodes only for compiling your code.
  - **Never use the login nodes for running your executable**
  - We use the scheduler slurm to launch the executable on the computing nodes

## Use Slurm to Launch Your Simulation on Computing Nodes

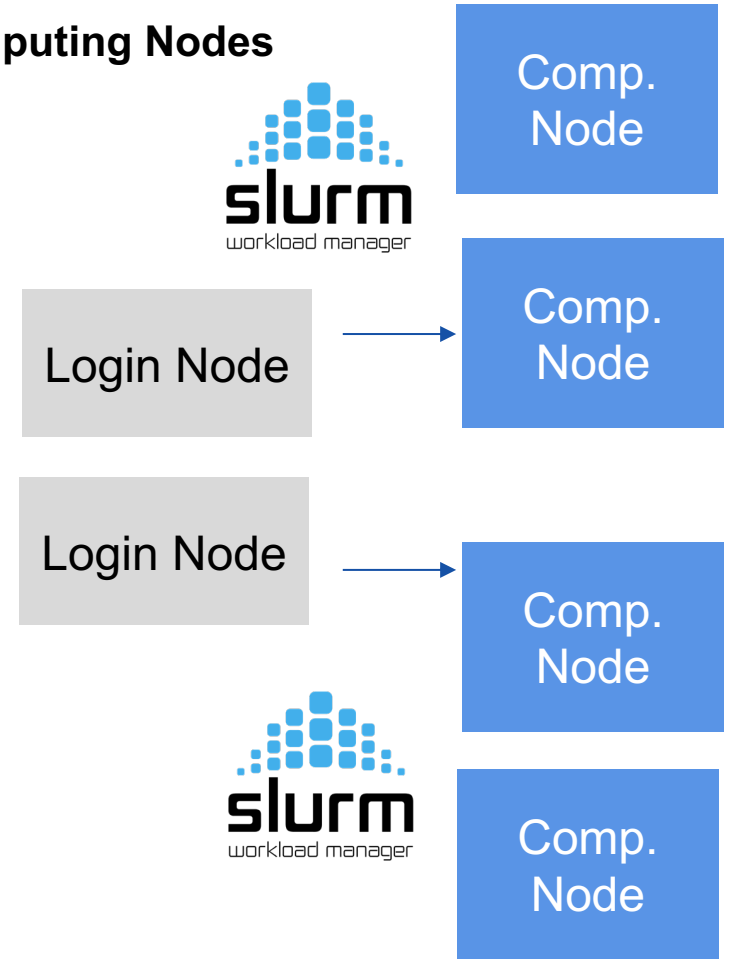
- Slurm allows us to launch our simulation on the computing nodes
- Two ways:
  - **Interactive mode:** ask for a resource, and as soon it becomes available, we can launch your simulations interactively

```
$ salloc --nodes=1 -t 00:30:00 -A edu23.summer -p shared --ntasks-per-node=1 --cpus-per-task=1
```

```
$ salloc --nodes=1 -t 00:30:00 -A edu23.summer -p gpu --ntasks-per-node=1 --cpus-per-task=1
```

```
$ srun -n 1 ./hello.out
```

  - **Batch mode:** put your simulation into a queue



# AMD GPU – Exercise 1

Query your AMD GPU on the Dardel supercomputer

- Request a job in the GPU partition in interactive mode

```
$ salloc --nodes=1 -t 00:30:00 -A edu23.summer -p gpu --ntasks-per-node=1 --cpus-per-task=1
```

- Run the *rocm-smi* command

```
> srun -n 1 rocm-smi
======================= ROCm System Management Interface =======================
================================== Concise Info ==================================
GPU  Temp   AvgPwr  SCLK    MCLK     Fan  Perf  PwrCap  VRAM%  GPU%
0    27.0c  91.0W   800Mhz  1600Mhz  0%   auto  560.0W    0%   0%
1    28.0c  N/A     800Mhz  1600Mhz  0%   auto  0.0W      0%   0%
```

**Question**: how many GPUs do you see?

# AMD GPU – Exercise 2

- Compile a simple HIP code
- Go to the folder ./1_helloWorld

```
> ls
HelloWorld.cpp Makefile
```

- Compile the code with

```
1_helloWorld> make
hipcc --offload-arch=gfx90a   -c -o HelloWorld.o HelloWorld.cpp
hipcc HelloWorld.o -o HelloWorld
```

- Run on AMD GPU in interactive mode

**Question**: what the output string do you see?

# AMD GPU – Exercise 3

- Compile a simple 1D vectorAdd HIP code
- Go to the folder ./2_vectorAdd

```
2_vectorAdd > ls
Makefile  vectoradd_hip.cpp
```

- Compile the code with

```
2_vectorAdd> make
hipcc --offload-arch=gfx90a   -c -o vectoradd_hip.o vectoradd_hip.cpp
hipcc vectoradd_hip.o -o vectoradd_hip.exe
```

- Run on AMD GPU in interactive mode

**Question**: what output message do you see?

# Convert a CUDA code into HIP code

**Hipify** our vectorAdd.cu example in yesterday's hands-on exercise

- Ensure rocm/5.3.3 module is loaded

```
/3_hipify> module load rocm/5.3.3
```

- Call hipify script

```
/3_hipify> hipify-perl -print-stats vectorAdd.cu > vectorAdd.cpp

[HIPIFY] info: file 'vectorAdd.cu' statisitics:
  CONVERTED refs count: 14
  TOTAL lines of code: 100
  WARNINGS: 0
[HIPIFY] info: CONVERTED refs by names:
  cudaDeviceSynchronize => hipDeviceSynchronize: 1
  cudaFree => hipFree: 3
  cudaMalloc => hipMalloc: 3
  cudaMemcpy => hipMemcpy: 3
  cudaMemcpyDeviceToHost => hipMemcpyDeviceToHost: 1
```

# Convert a CUDA code into HIP code

- Compile your hipified code

```
> hipcc --offload-arch=gfx90a -o vectoradd vectorAdd.cpp
```

- Run on AMD GPU in interactive mode

```
> srun -n 1 ./vectoradd 8192
The input length is 8192
valid
```

# Reduction Operation

The example HIP code takes a user input array length N and sum up their values

- Compile the code using hipcc

```
4_reduction> make
hipcc -std=c++11 -O3 --offload-arch=gfx90a -o reduction reduction.cpp
```

- Run on AMD GPU in interactive mode

```
/4_reduction> srun -n 1 ./reduction
Usage: ./reduction num_of_elems
using default value: 52428800
ARRAYSIZE: 52428800
Array size: 200 MB
The average performance of reduction is 374.525 GBytes/sec
VERIFICATION: result is CORRECT
```

# Reduction Operation – Compare different kernels

Use the run.sh batch script to test reduction of different array length

```
4_reduction> bash run.sh
./reduction 1024*1024*4
ARRAYSIZE: 1024
Array size: 0.00390625 MB
The average performance of reduction is 0.0488957 GBytes/sec
VERIFICATION: result is CORRECT

./reduction 8388608
ARRAYSIZE: 8388608
Array size: 32 MB
The average performance of reduction is 83.1296 GBytes/sec
VERIFICATION: result is CORRECT
```

# Reduction Operation – Exercise

Switch between the three reduction kernels,
*atomic_reduction_kernel(),*

*atomic_reduction_kernel2(),*

*atomic_reduction_kernel3()*

- What performance difference do you observe in them?
- Try with different input length N

# Reduction Operation – Exercise

For an array of length N:

- How many atomic operations are used in `atomic_reduction_kernel()` ?

# Q & A