OAK RIDGE National Laboratory

Introduction to Job Submission on Summit

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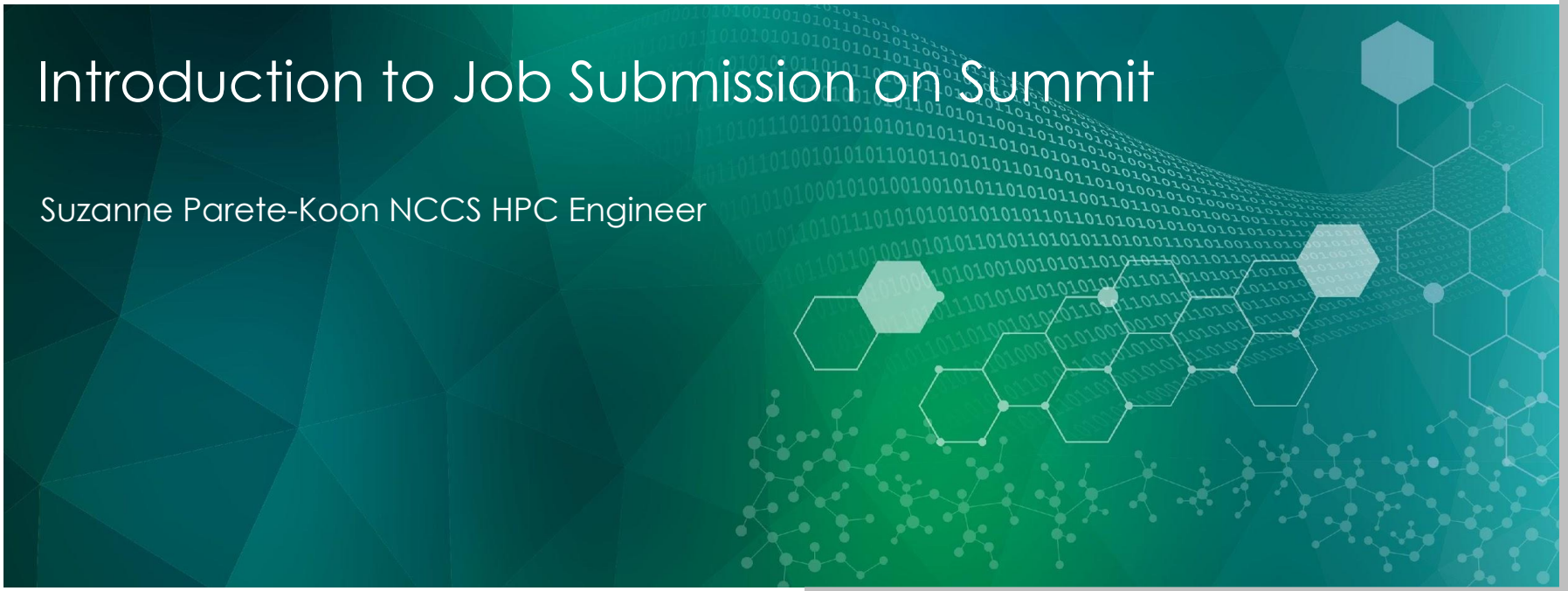

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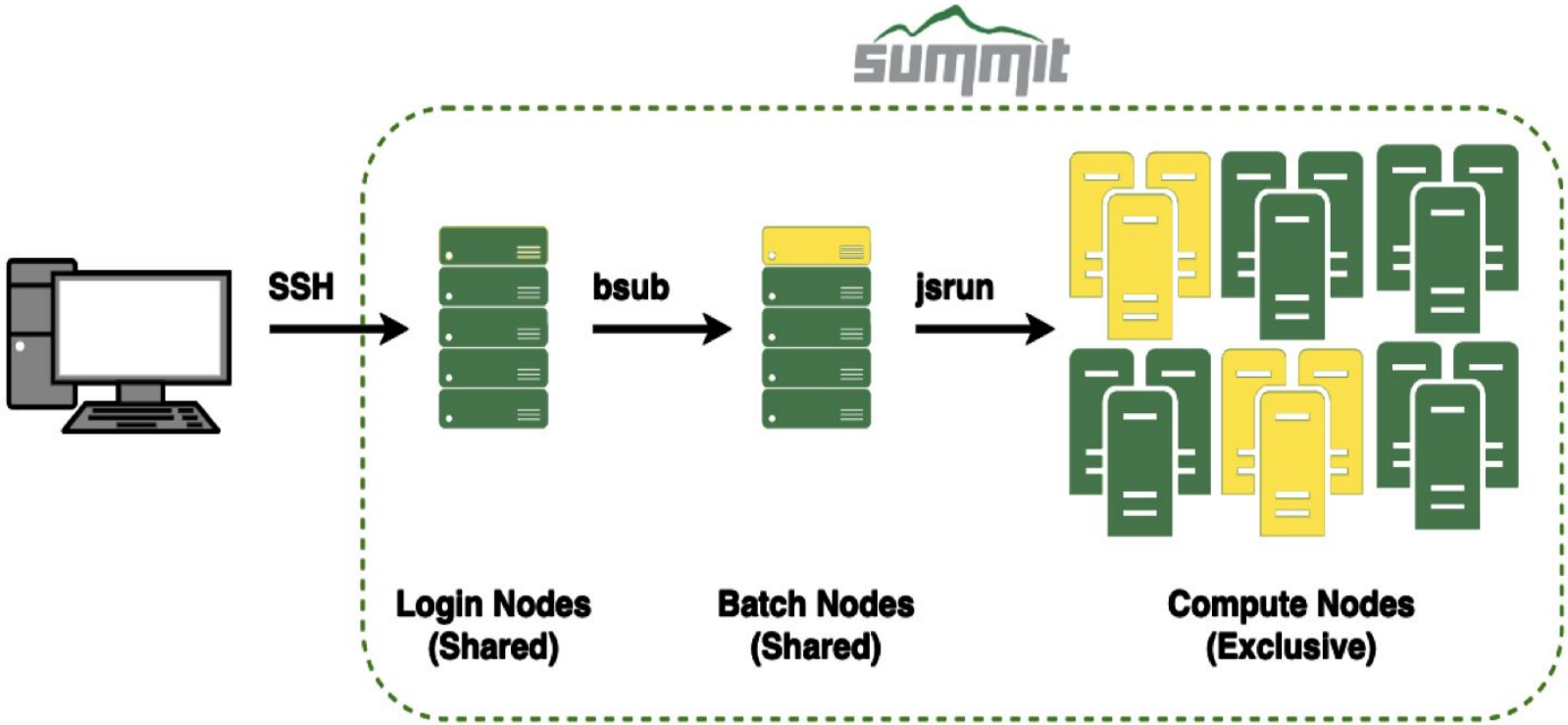
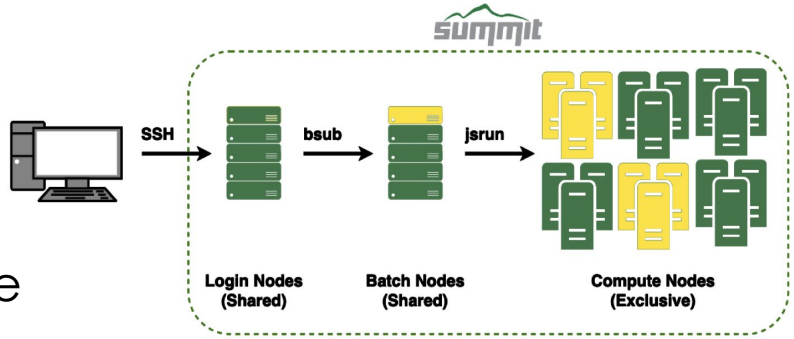
summit
IBM

Jsrun is the job launcher for Summit



bsub -Submit a Job to LSF



- bsub allocates 1 batch node plus the number of requested compute nodes.

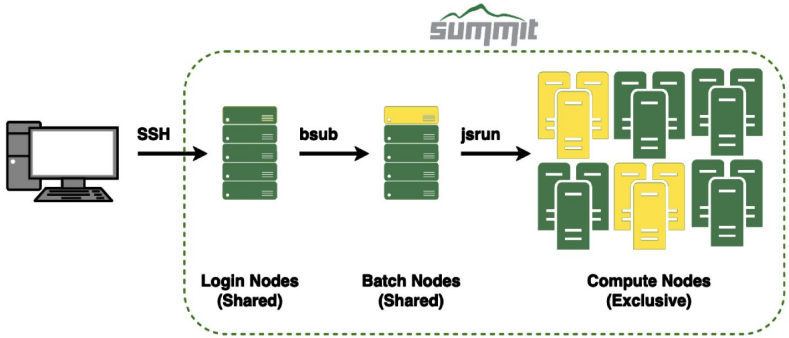
bsub -alloc_flags defines allocation-wide configurations

- Applied to every compute node
  - CPU Simultaneous Multithreading Level (smt)
  - GPU Multi-Process Service (gpumps)
  - Burst Buffer (nvme)
  - Others (spectral, maximizegpfs,...)
- Multiple options require quoting, space separated
  - #BSUB -alloc_flags "gpumps smt1 nvme"

Jsrun is the job launcher for Summit

```
#!/bin/bash
#BSUB -P STF007
#BSUB -J myLSFjob
#BSUB -o out.%J
#BSUB -e err.%J
#BSUB -W 30
#BSUB -nnodes 1
#BSUB -alloc_flags nvme

hostname
jsrun -n1 hostname
hostname
```



batch1
g24n10
batch1

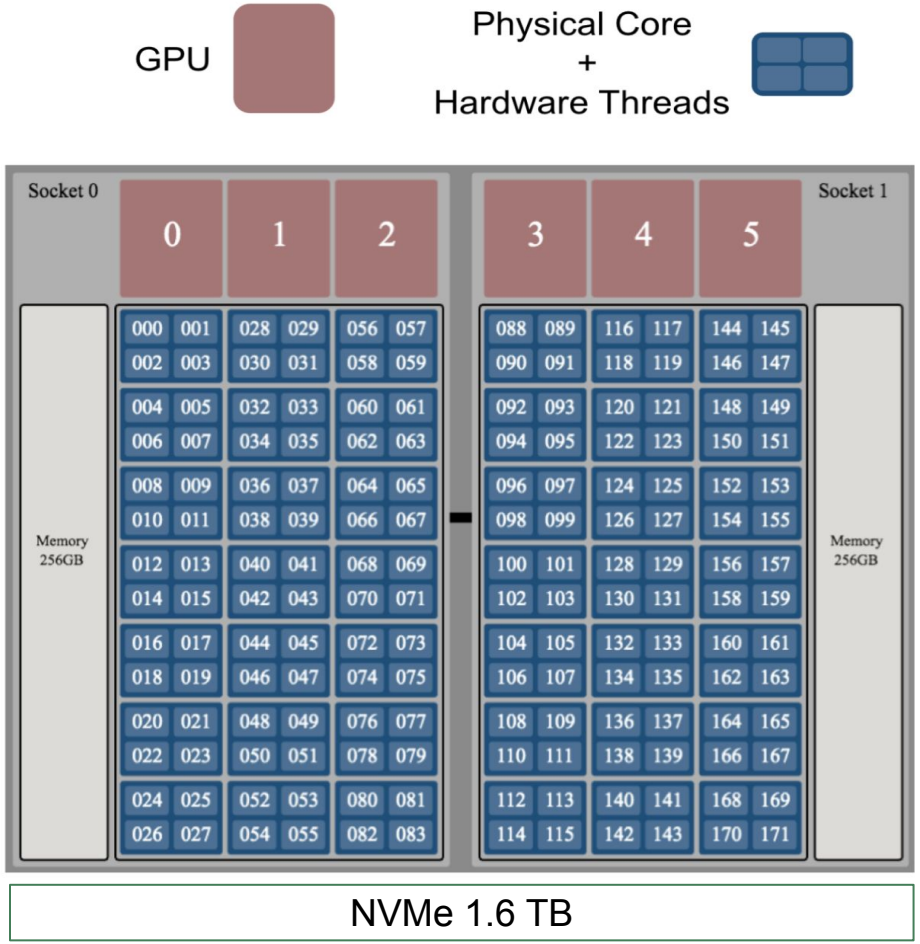
```
[suzanne@login3.summit ~]$ bsub batchScript.lsf
Job <1849558> is submitted to default queue <batch>.
[suzanne@login3.summit ~]$
```

err.1849558 out.1849558

https://docs.olcf.ornl.gov/systems/summit_user_guide.html#batch-scripts

Summit Node

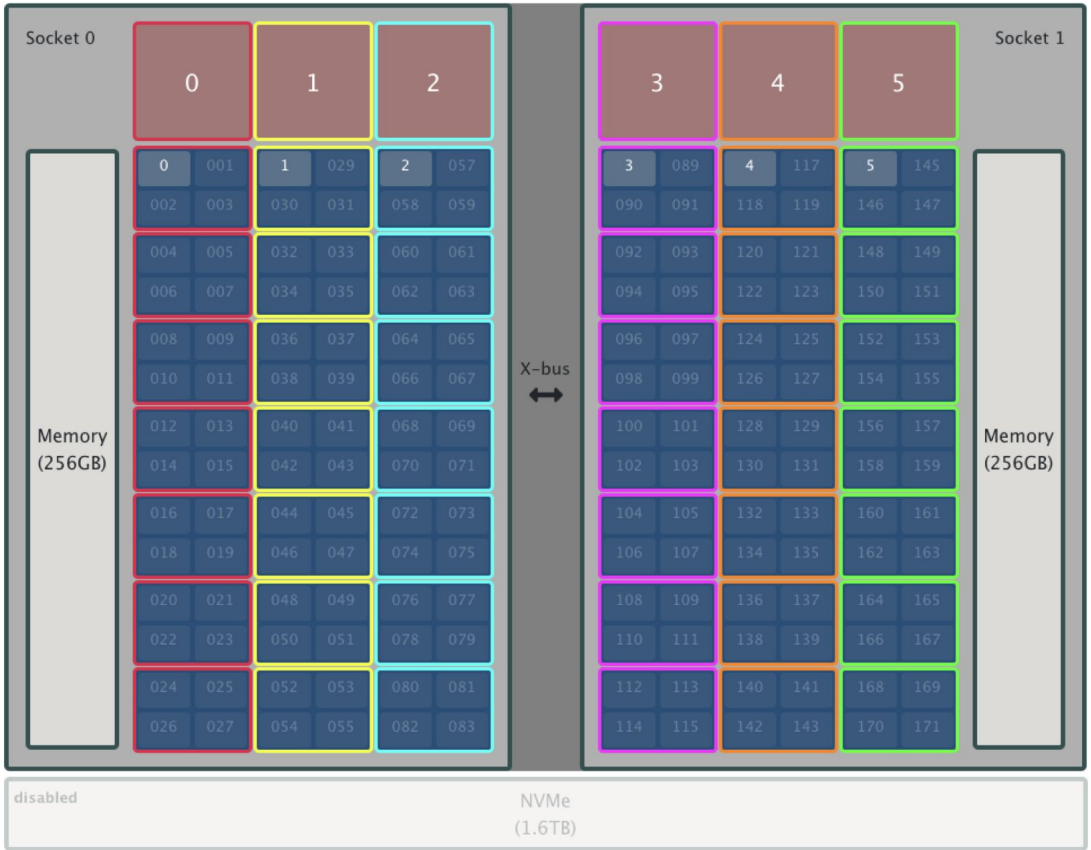
- IBM Power System AC922 Compute Node
- 2 Sockets
  - 3 NVIDIA V100 GPUs
  - 21 usable cores
    - {1, 2, 4}-way Multithreading (SMT)
  - 256 GB DDR4 RAM
- 1.6 TB NVMe (Burst Buffer)
- Exclusive access during job
- X-bus(64GB/s)



Resource Sets

jsrun [-n #resource sets] [tasks, threads, and GPUs in each resource set] program [program args]

jsrun -n6 -c7 -a1, -g1 ./a.out



Resource Sets

jsrun [-n #resource sets] [tasks, threads, and GPUs in each resource set] program [program args]

- Used to shape the compute node to your application by grouping
  - Physical cores
  - GPUs
  - RAM
- Must contain 1 or more physical cores and 0 or more GPUs
- Allow for multiple job steps on a single node (Adv.)
- Highly flexible with Explicit Resource Files (Adv.)

- Not as scary as they seem

jsrun -n6 -c7 -a1, -g1 ./a.out

Resource Sets

jsrun [-n #resource sets] [tasks, threads, and GPUs in each resource set] program [program args]

Some limitations

- A resource set may span sockets, but *cannot* span nodes
  - Creating resource sets within sockets can avoid cross-socket communication
- Memory access requires a physical core or GPU on its host socket
- Resource Sets are homogeneous by default
  - Heterogeneous resourcesets possible with ERF (Adv.)

jsrun -n6 -c7 -a1, -g1 ./a.out

Designing a Resource Set

jsrun [-n #resource sets] [tasks, threads, and GPUs in each resource set] program [program args]

Flags			
Long	**Short**	**Description**	**Default Value**
`--nrs`	`-n`	Number of resource sets	All available physical cores
`--tasks_per_rs`	`-a`	Number of MPI tasks (ranks) per resource set	Not set by default, instead total tasks (-p) set
`--cpu_per_rs`	`-c`	Number of CPUs (cores) per resource set.	1
`--gpu_per_rs`	`-g`	Number of GPUs per resource set	0
`--bind`	`-b`	Binding of tasks within a resource set. Can be none, rs, or packed:#	packed:1
`--rs_per_host`	`-r`	Number of resource sets per host	No default
`--latency_priority`	`-l`	Latency Priority. Controls layout priorities. Can currently be cpu-cpu or gpu-cpu	gpu-cpu,cpu-mem,cpu-cpu
`--launch_distribution`	`-d`	How tasks are started on resource sets	packed

Designing a Resource Set

jsrun [-n #resource sets] [tasks, threads, and GPUs in each resource set] program [program args]

1. Understand how the code expects the node to appear
   - How many tasks/threads per GPU?
   - Does each task expect to see a single GPU?
   - Do multiple tasks expect to share a GPU (gpumps)?
   - Is the code written to internally manage task to GPU workloads based on the number of available cores and GPUs?
2. Create Resource Sets containing the needed GPU to task binding
   - Describe a resource set that meets the requirements above. If the code is written for one GPU per task, consider a resource set with just one GPU
3. Decide on the number of Resource Sets needed
   - After understanding task, thread, and GPU requirements, scale the number of Resource Sets (and number of nodes) as needed.

Examples

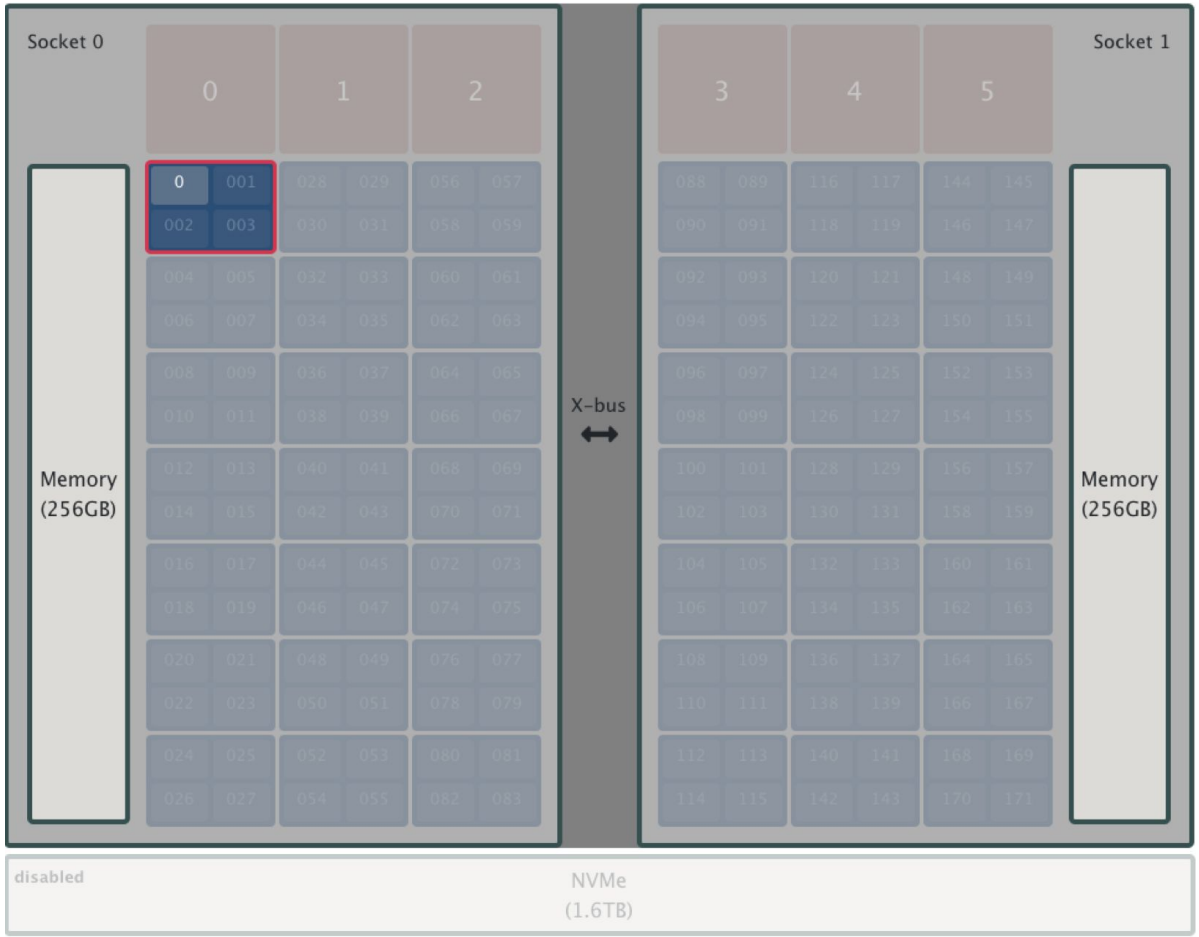
jsrun -n1

- By default you get one core with one task.
- This is the same as

jsrun -n1 -c1 -a1

- Better not to rely on defaults

Let's add a GPU . . .



Examples

jsrun -n1 -c1 -a1 -g1

- -g flag specifies the number of GPUs per resource set.
- How many of these sets can we fit on the node?

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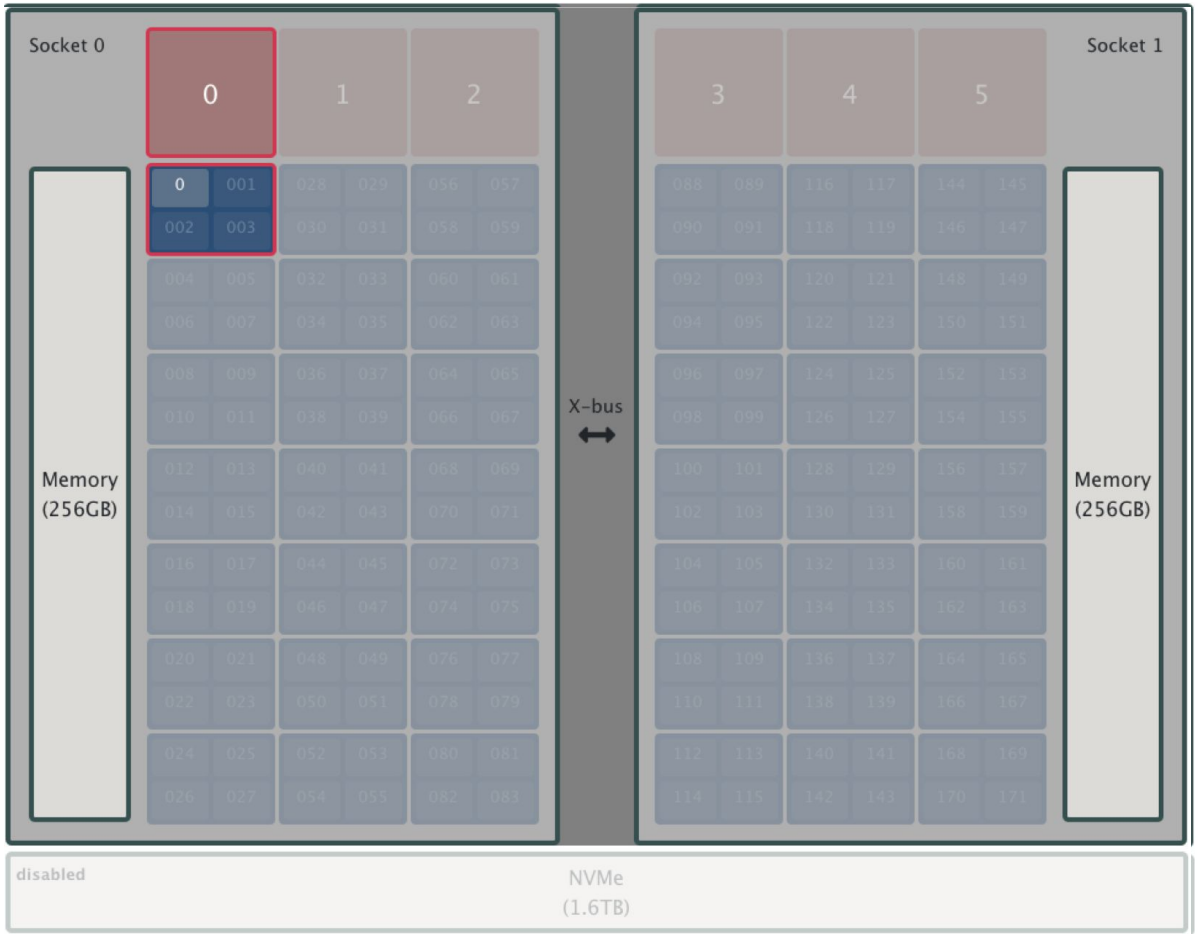

Examples

jsrun -n6 -c1 -a1 -g1

- How would this scale to two or more nodes?

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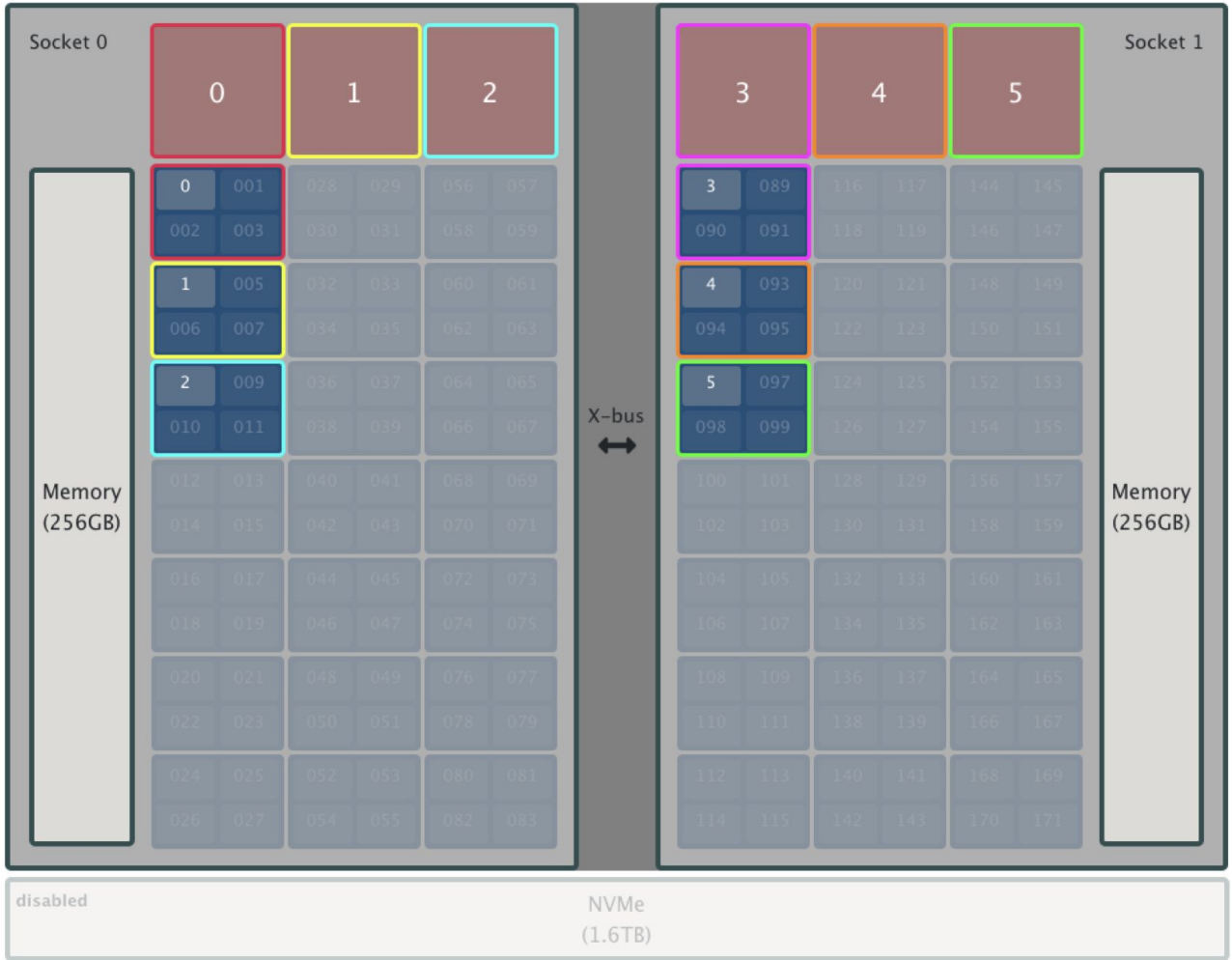


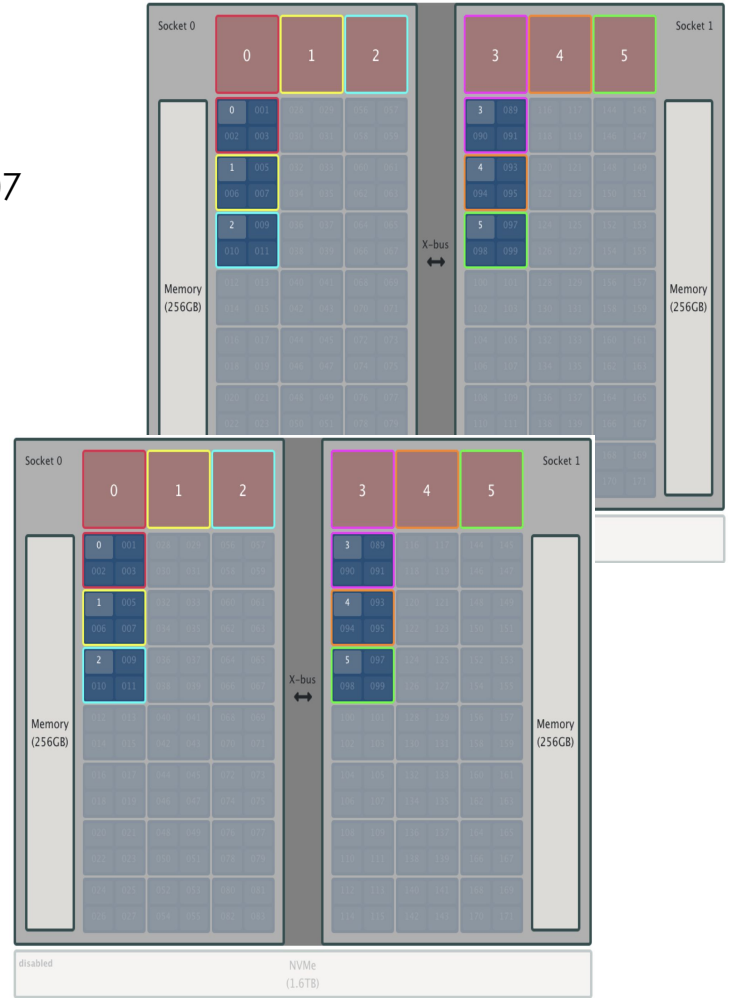
Examples: Multiple Nodes

jsrun -n12 -c1 -a1 -g1

- -n will be the number of nodes you reserved multiplied by the number of resource sets on one node.
- If your resources sets don't fill both sockets, jsrun may not map the resources set as you expect when you expand to multiple nodes.
- Let's talk about that and threads next.

h37n07

h37n08



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Examples : Threading

jsrun -n1 -c7 -a1 -EOMP_NUM_THREADS=7 -g1

- **-EOMP_NUM_THREADS=#** lets you set the number of openMP threads per task.
- Could also do export OMP_NUM_THREADS=7 just before the jsrun command.
- All 7 threads are clustered on the same core!
- How do we fix this?

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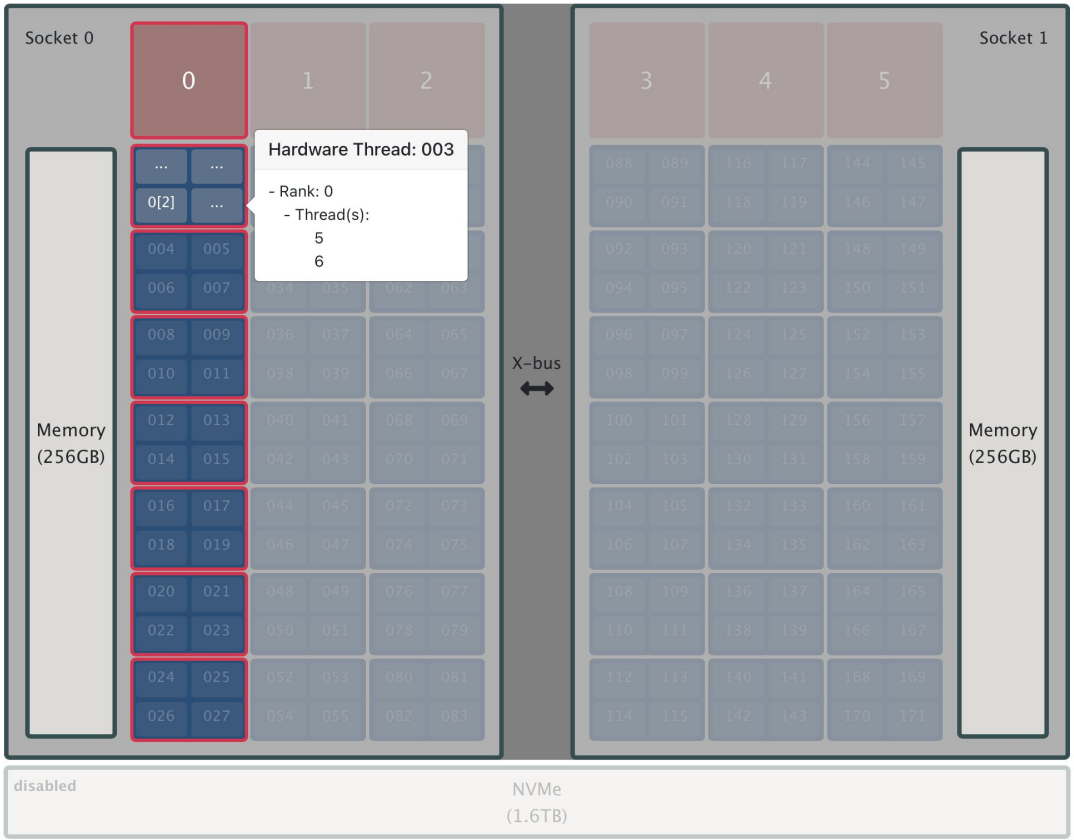
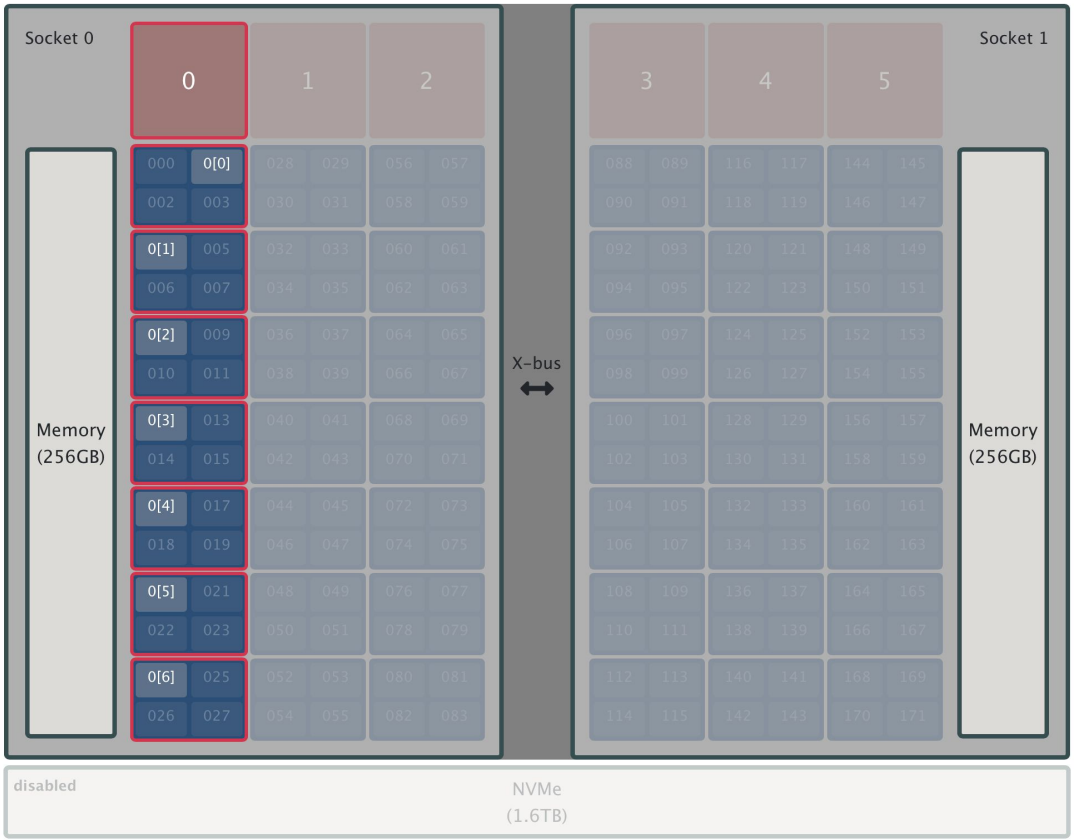


Examples: Threading -brs

jsrun -n1 -c7 -a1 -EOMP_NUM_THREADS=7 -g1 -brs

- -b controls the thread binding options are packed:#, rs, none
- allows you to set the number of physical cores available to an MPI task
- -b rs binds the threads to fill the available cores. In the resource set
- How would I do this over 2 nodes?



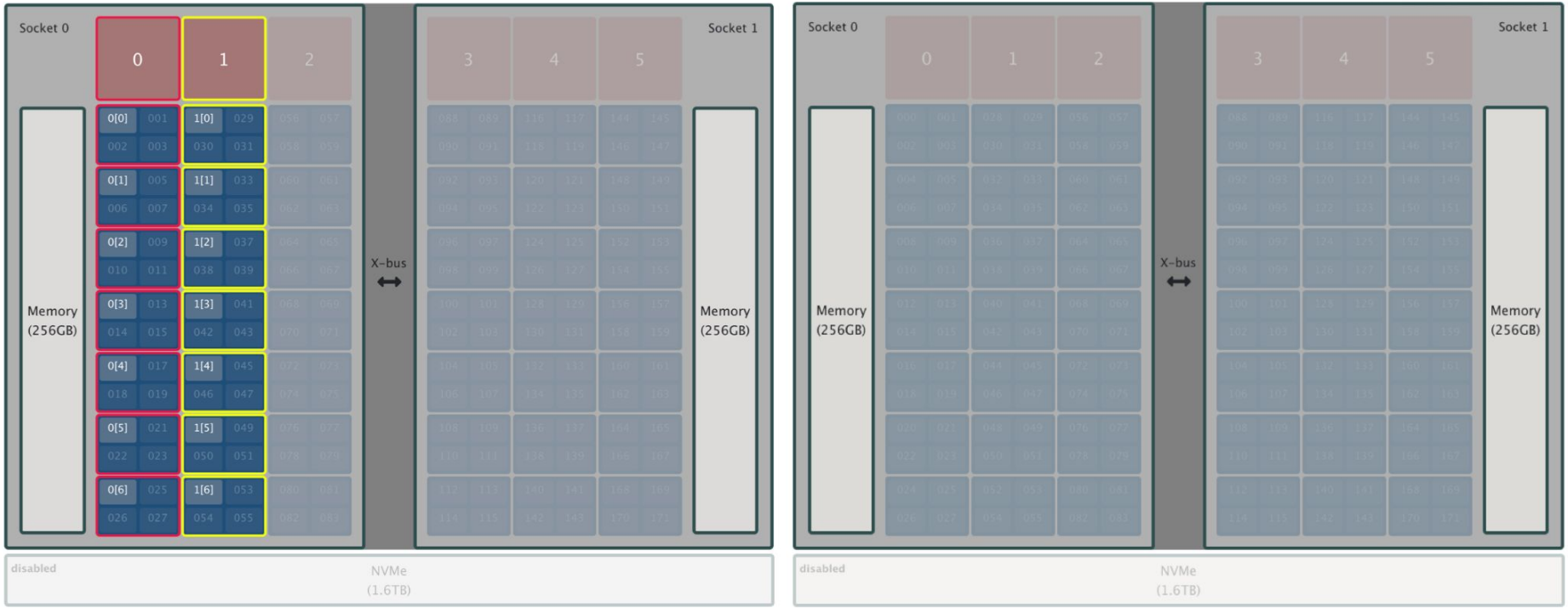
Examples: Threading multiple nodes

```
jsrun -n2 c7 -a1 -EOMP_NUM_THREADS=7 -g1 -brs
```

Examples: Threading multiple nodes

!Wast of Allocation!

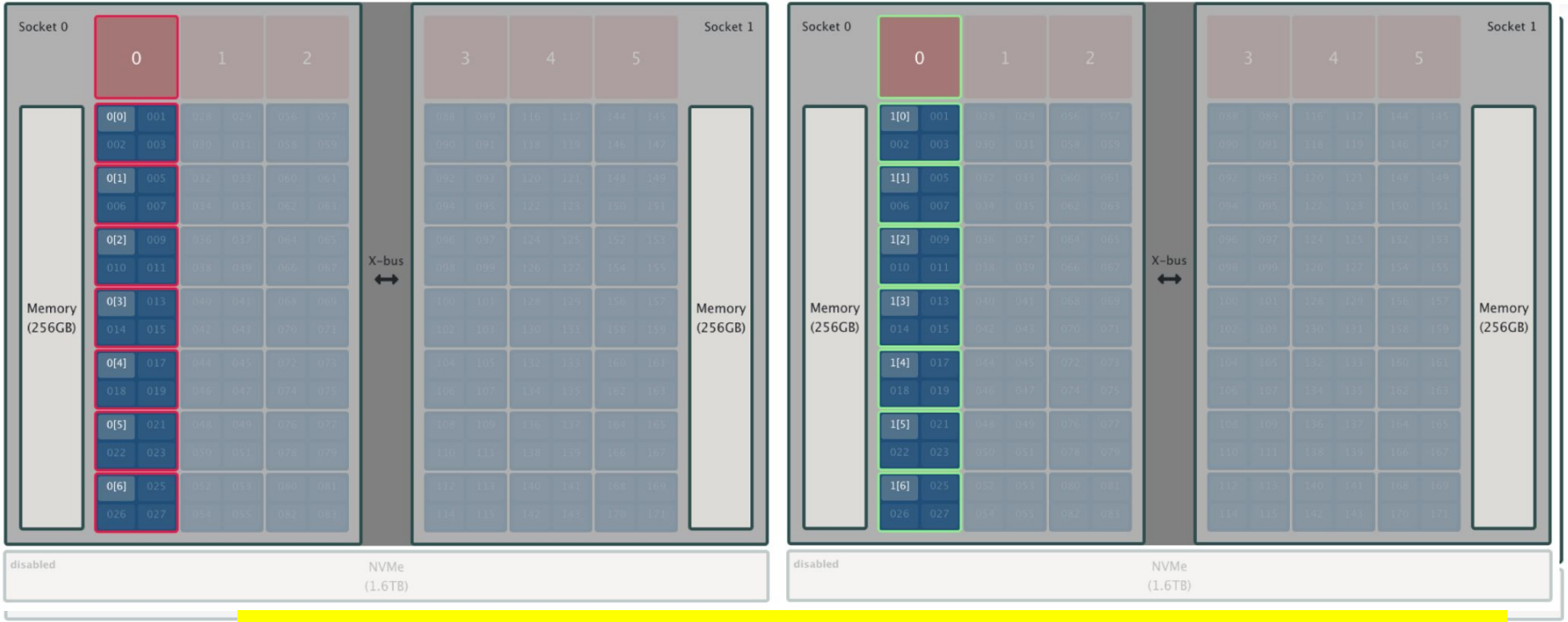
```
jsrun -n2 c7 -a1 -EOMP_NUM_THREADS=7 -g1 -brs
```



Examples: Threading multiple nodes

But this still might be a waste of allocation.

```
jsrun -n2 -r1 -c7 -a1 -EOMP_NUM_THREADS=7 -g1 -brs
```



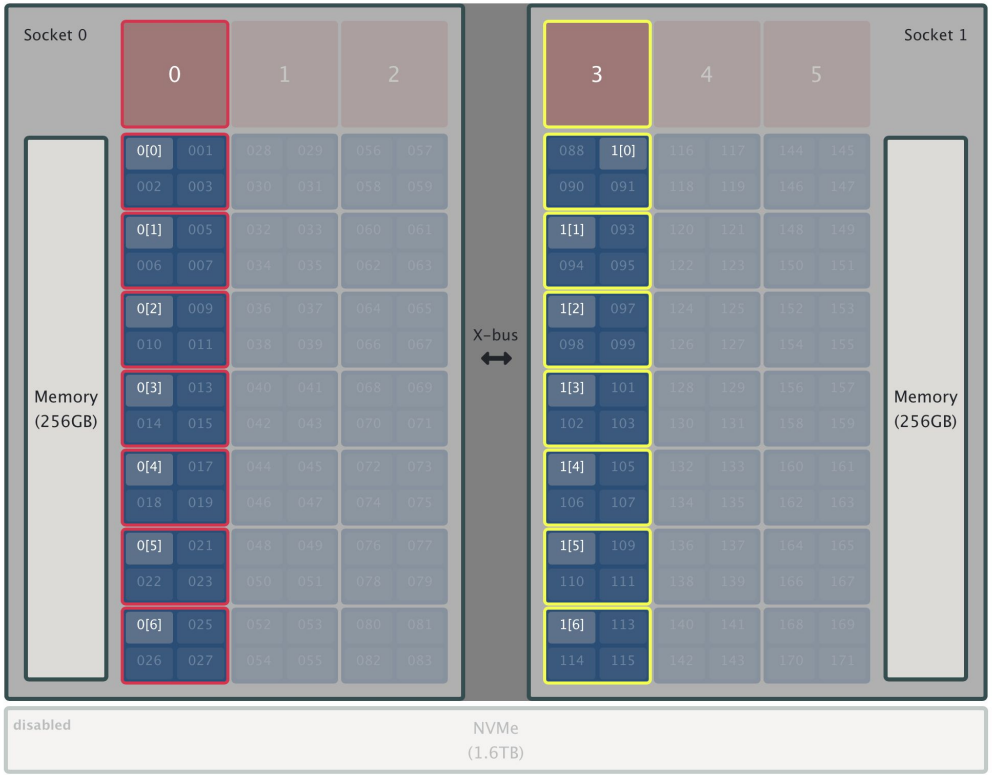
Remember you must have a core or GPU reserved on each socket to get access to that socket's memory,so what you see above does not give each resource set 512 GB, but rather only 265 GB.

Examples: Threading multiple nodes

If you used -n 4, you'd get two nodes that look like this.

```
jsrun -n2 --rs_per_socket 1 -c7 -a1 -EOMP_NUM_THREADS=7 -g1
-brs
```

- Setting the resource sets per socket to 1 gives you one set on each socket, each able to get full access to that node's 265 GB of RAM.
- This gives you a more efficient use of allocation than the configuration on the previous slide.



Resources

- OLCF user docs for running jobs: https://docs.olcf.ornl.gov/systems/summit_user_guide.html#running-jobs
  - Covers main jsrun options with examples of each.
  - Also options for monitoring your jobs.
- man jsrun
  - This has the complete descriptions of all Jsrun options and advice about how combinations of those options will be interpreted
- Job-step-viewer
  - Demo: https://jobstepviewer.olcf.ornl.gov
  - How To: https://docs.olcf.ornl.gov/systems/summit_user_guide.html#job-step-viewer
- **New User Quick Start guide: https://docs.olcf.ornl.gov/quickstart/index.html**
  - Has slides and recordings of past jsrun trainings (and many other new user topics)
  - Hands on exercises with answers for jsrun

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Hands-On

New User Quick Start

Direct your browser to https://docs.olcf.ornl.gov/quickstart/index.html

Login to summit.
$ ssh your_user_name@summit.olcf.ornl.gov

(PIN followed by your RSA token code.)

- git clone https://github.com/olcf/NewUserQuickStart.git
  - cd NewUserQuickStart
- Do Basic Workflow to learn about Batch scripts and job submission
  - $ cd hands-on/Basic_Workflow/
- Do Jsrun basics to practice what you have learned in this lecture.
  - cd hands-on/jsrun_Job_Launcher/

I'll go to the repo now and walk you through the exercises . . .