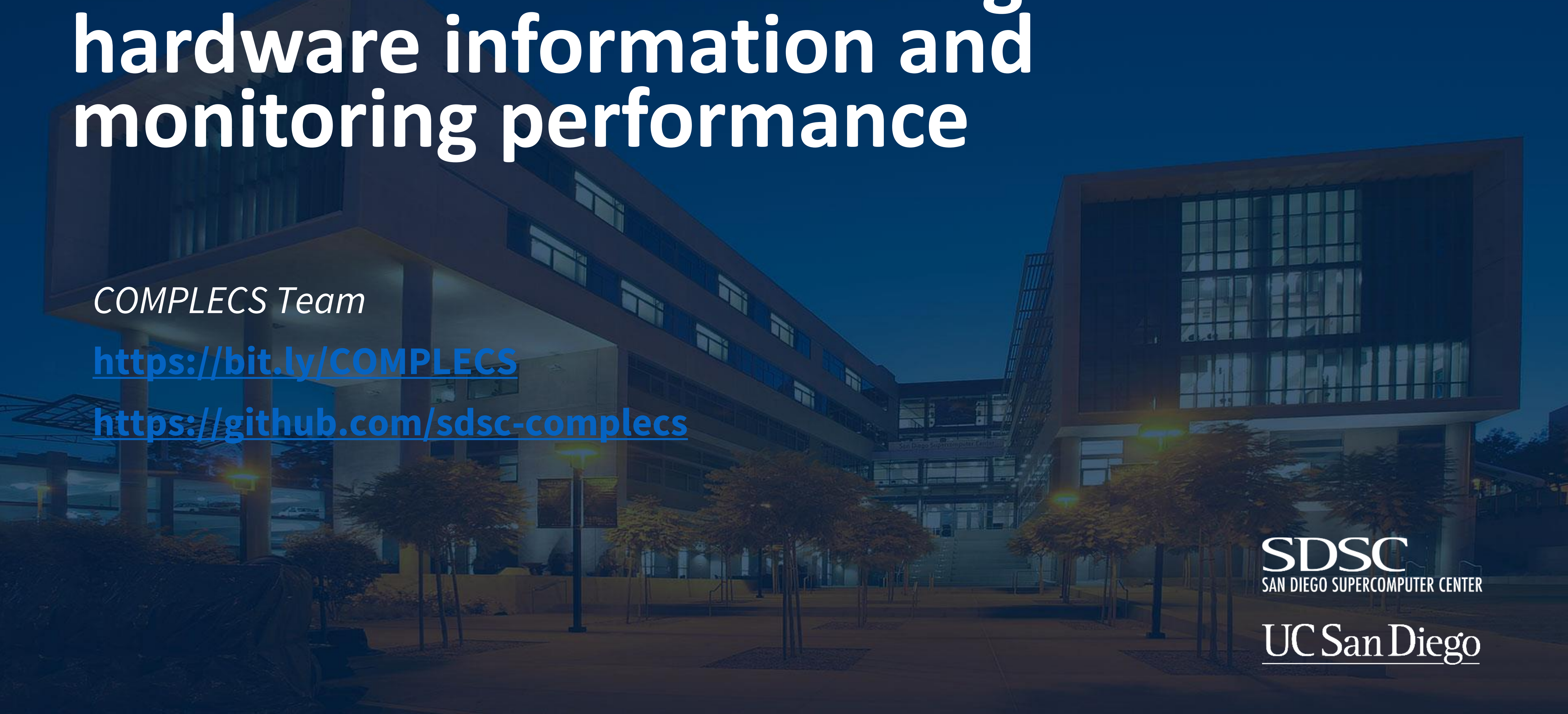
HPC Hardware : Obtaining hardware information and monitoring performance



COMPLECS Team

https://bit.ly/COMPLECS

https://github.com/sdsc-complecs

SDSC
SAN DIEGO SUPERCOMPUTER CENTER

UC San Diego

About COMPLECS

COMPLECS (COMPrehensive Learning for end-users to Effectively utilize CyberinfraStructure) is a new SDSC program where training will cover non-programming skills needed to effectively use supercomputers. Topics include parallel computing concepts, Linux tools and bash scripting, security, batch computing, how to get help, data management and interactive computing.

COMPLECS is supported by NSF award 2320934.

Table of Contents

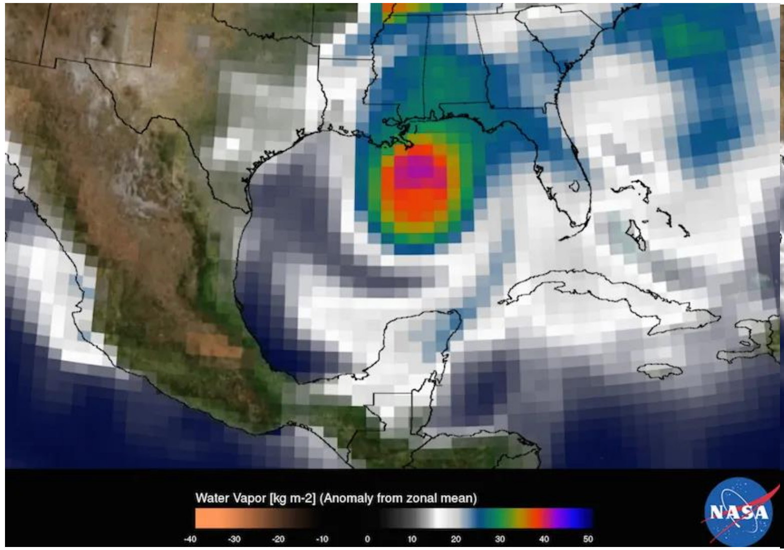
- What makes up an HPC system, and how is each associated to your work
- Hardware information
  - OS, Kernel
  - CPU (lscpu, /proc/cpuinfo)
  - GPU (……, nvida-smi)
  - Memory (/proc/meminfo)
  - Cache
  - SCSI
  - File Systems (df, free, lfs, …)
  - Network
- Hardware monitoring
  - top, htop, atop tools
  - mpstat
  - sar (System Activity Report)
  - Free
  - Ps
- Job Monitoring
  - seff, sacct

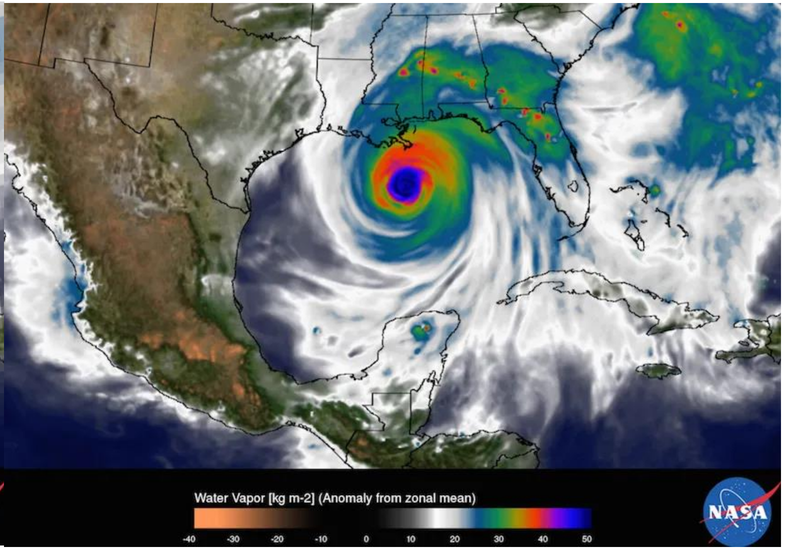
Agenda

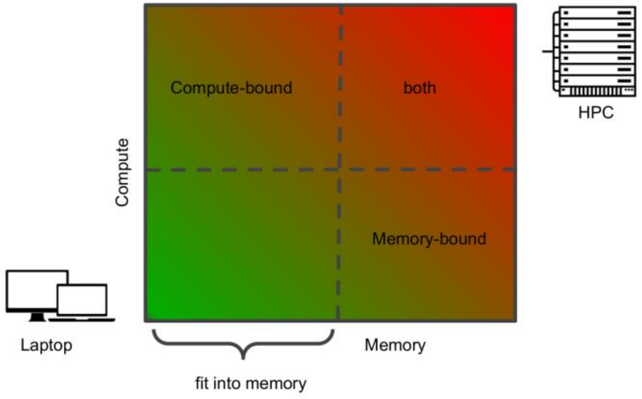
- Identify the Hardware components of HPC systems
- Understand why they matter to you
- Get information about your system
- Use some common tools to :
  - Monitor HPC resources
  - Monitor HPC Jobs on resources

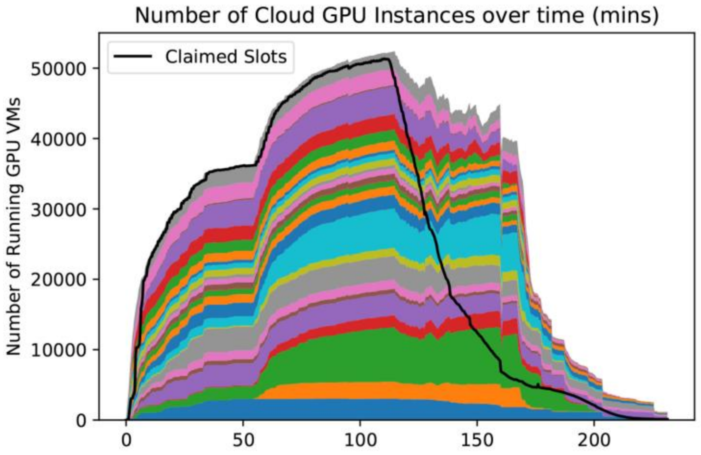
Introduction: High-Performance Computing (HPC)

High-performance computing (HPC) uses supercomputers and computer clusters to solve advanced computation problems.









Key advantages of leveraging HPC for your research:

- **Speed** - Solve a problem more quickly
- **Scale** - Solve a larger, more complex problem
- **Throughput** - Solve many (simple) problems more quickly

Finding OS and kernel information

- uname (unix name) – prints system information
    - uname [OPTION]...
- Use uname to get information on the Linux kernel

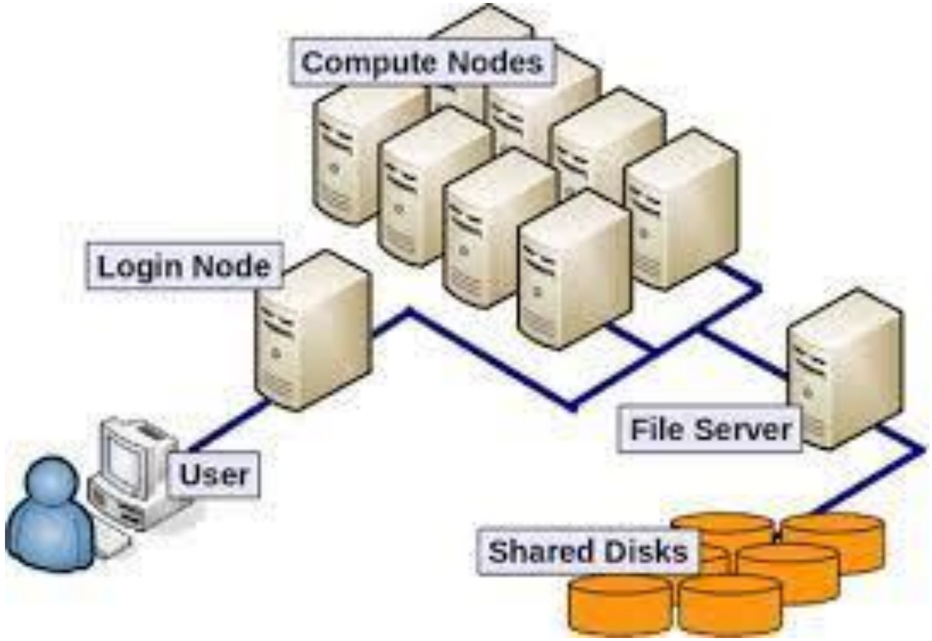
```
@login02]$ uname -a
Linux login02 4.18.0-477.15.1.el8_8.x86_64 #1 SMP Wed Jun 28 15:04:18
UTC 2023 x86_64 x86_64 x86_64 GNU/Linux
```

- Look in /etc/centos-release to get the Linux distribution (will vary by Linux distro)

```
@login02]$ cat /etc/centos-release
Rocky Linux release 8.8 (Green Obsidian)
```

Overview of Compute Nodes

- Nodes
  - Processors and accelerators
  - Sockets
  - Memory
  - Attached devices
- Networking
  - Interconnect
- Software and tools
- Storage

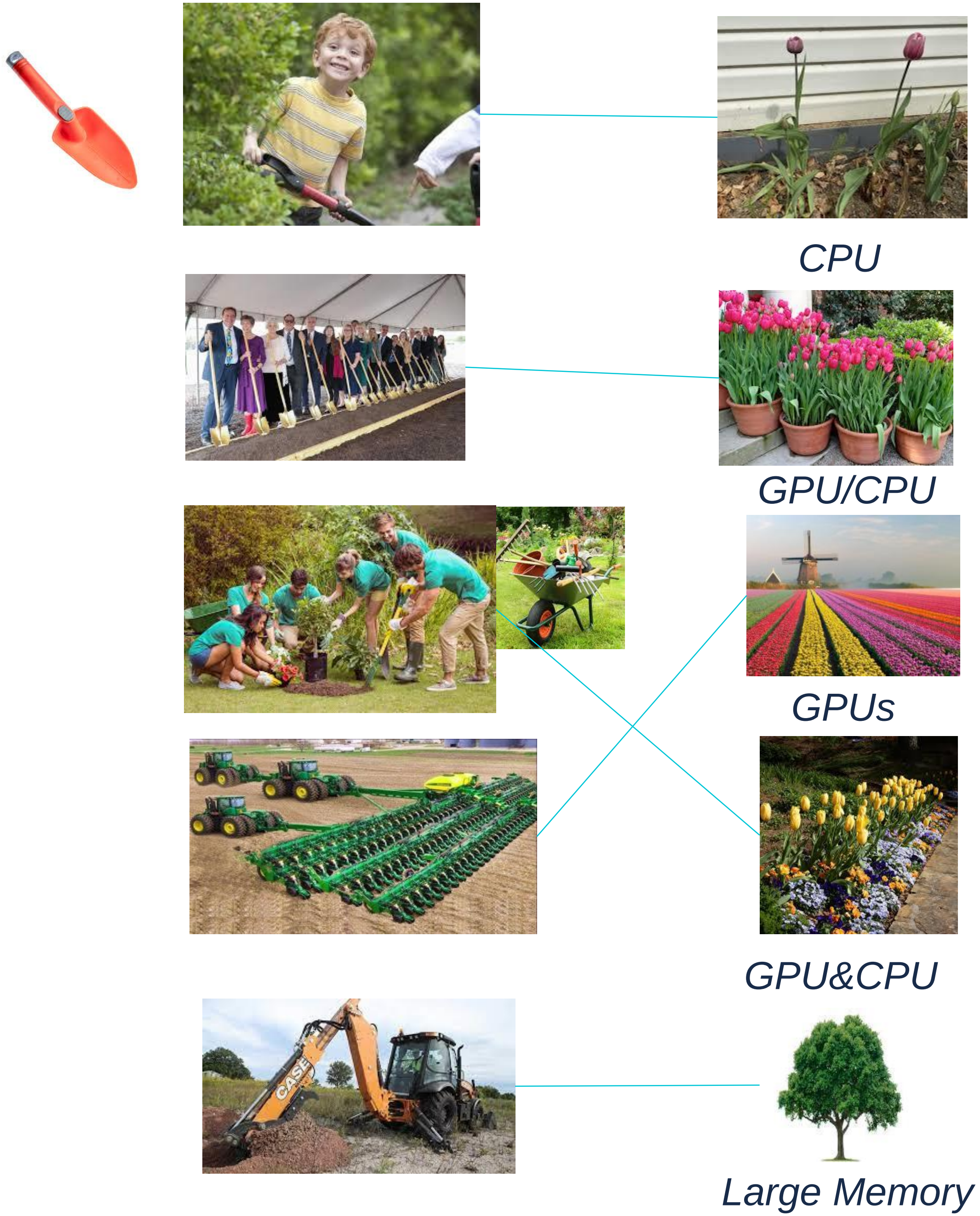


Getting hardware information – why do I care?

- Reporting
  - You may be asked to report details of your hardware in a manuscript, presentation, proposal or request for computer time
- Access
  - Resource Selection
    - Based on available resources will you job be able to run?
    - Estimating performance relative to another system. *All else being equal*, jobs will run at least as fast on hardware with
      - Faster CPU clock speeds
      - Larger caches
      - Faster local drives
- Identifying/Addressing system behavior
  - Job Compilation
  - Tune application for hardware
  - Efficient utilization
    - Save money and resources

Using the correct tool

- Myth 1: A supercomputer will improve code performance
- Myth 2: Requesting more hardware will reduce time to solution and improve efficiency
- HPC applications need to be explicitly programmed to take advantage of the hardware



Obtaining hardware information

- User Guide
- Linux tools for collecting architecture information
  - **lscpu**
  - **/proc/ file system – Various Linux kernel statistics**
    - pseudo-filesystems (/proc /sys)

Processor specifications: lscpu

On Linux systems, the **lscpu** command lists key processor information

- Number of processors (sockets)
- Processor type or model
- Nominal clock speed
- Number of cores per processor
- Cache sizes
- Instruction set architecture
- NUMA nodes

Processor specifications: (lscpu) *Expanse* compute node

```
Architecture:          x86_64
CPU op-mode(s):        32-bit, 64-bit
Byte Order:            Little Endian
CPU(s):                128
On-line CPU(s) list:   0-127
Thread(s) per core:    1
Core(s) per socket:    64
Socket(s):             2
NUMA node(s):          8
Vendor ID:             AuthenticAMD
CPU family:            23
Model:                 49
Model name:            AMD EPYC 7742 64-Core Processor
Stepping:              0
CPU MHz:               3257.493
BogoMIPS:              4491.71
Virtualization:        AMD-V
L1d cache:             32K
L1i cache:             32K
L2 cache:              512K
L3 cache:              16384K
```

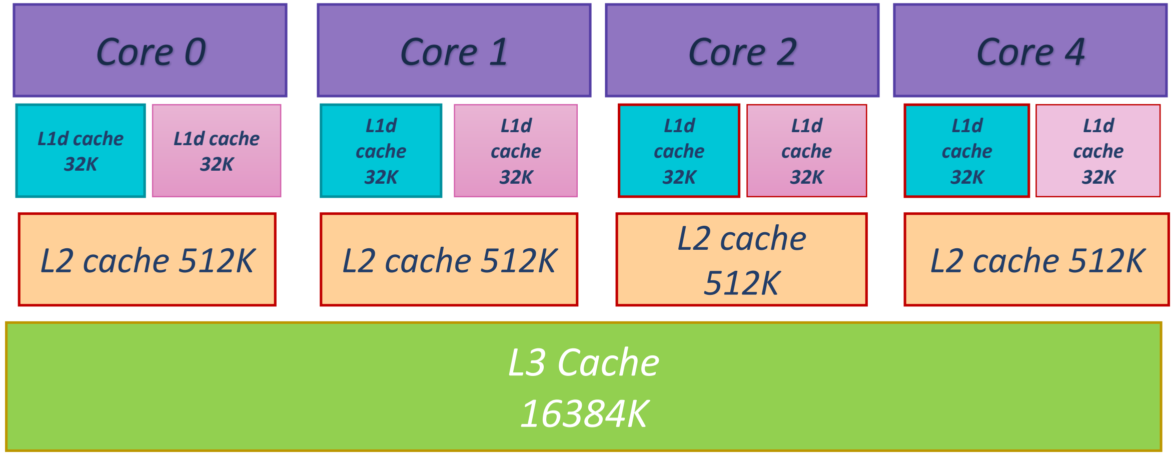
```
NUMA node0 CPU(s):     0-15
NUMA node1 CPU(s):     16-31
NUMA node2 CPU(s):     32-47
NUMA node3 CPU(s):     48-63
NUMA node4 CPU(s):     64-79
NUMA node5 CPU(s):     80-95
NUMA node6 CPU(s):     96-111
NUMA node7 CPU(s):     112-127
Flags:                 fpu vme de pse tsc msr pae mce
cx8 apic sep mtrr pge mca cmov pat pse36 clflush mmx
fxsr sse sse2 ht syscall nx mmxext fxsr_opt pdpe1gb
rdtscp lm constant_tsc rep_good nopl xtopology
nonstop_tsc cpuid extd_apicid aperfmperf pni
pclmulqdq monitor ssse3 fma cx16 sse4_1 sse4_2
x2apic movbe popcnt aes xsave avx f16c rdrand
lahf_lm cmp_legacy svm extapic cr8_legacy abm sse4a
misalignsse 3dnowprefetch osvw ibs skinit wdt tce
topoext perfctr_core perfctr_nb bpext perfctr_llc
mwaitx cpb cat_l3 cdp_l3 hw_pstate sme ssbd mba sev
ibrs ibpb stibp vmmcall fsgsbase bmi1 avx2 smep bmi2
cqm rdt_a rdseed adx smap clflushopt clwb sha_ni
xsaveopt xsavec xgetbv1 xsaves cqm_llc cqm_occup_llc
cqm_mbm_total cqm_mbm_local clzero irperf xsaveerptr
wbnoinvd arat npt lbrv svm_lock nrip_save tsc_scale
vmcb_clean flushbyasid decodeas
```

https://git.kernel.org/cgit/linux/kernel/git/stable/linux-stable.git/tree/arch/x86/include/asm/cpufeatures.h

Processor specifications: (lscpu) *Expanse* compute node

```
@exp-9-55 ~]$  lscpu -e
CPU NODE SOCKET CORE L1d:L1i:L2:L3   ONLINE
0    0     0      0    0:0:0:0         yes
1    0     0      1    1:1:1:0         yes
2    0     0      2    2:2:2:0         yes
3    0     0      3    3:3:3:0         yes
4    0     0      4    4:4:4:1         yes
5    0     0      5    5:5:5:1         yes
6    0     0      6    6:6:6:1         yes
7    0     0      7    7:7:7:1         yes
8    0     0      8    8:8:8:2         yes
9    0     0      9    9:9:9:2         yes
10   0     0      10   10:10:10:2      yes
11   0     0      11   11:11:11:2      yes
12   0     0      12   12:12:12:3      yes
13   0     0      13   13:13:13:3      yes
14   0     0      14   14:14:14:3      yes
15   0     0      15   15:15:15:3      yes
16   1     0      16   16:16:16:4      yes
17   1     0      17   17:17:17:4      yes
18   1     0      18   18:18:18:4      yes
19   1     0      19   19:19:19:4      yes
20   1     0      20   20:20:20:5      yes
.    .     .      ..   ..:..”..:..     …
```

- CPU : CPU Index
- Node: NUMA node
- Socket: Index of physical socket to which the cpu belongs
- Core: Index of physical core
- L1d:L1i:L2:L3: Index of L1 Data Cache, L1 Instruction Cache, Index of L2 cache, Index of L3 cache.
    - Indicates that Expanse has 128 L1d, L1i, L2 caches, once for each physical core
    - And 32 L3 Caches shared by 4 CPUs



Simultaneous multithreading (SMT) / hyperthreading

```
Thread(s) per core:  1
```

Simultaneous multithreading, abbreviated as SMT, is the process of a CPU splitting each of its physical cores into virtual cores, which are known as threads. This is done in order to increase performance and allow each core to run two instruction streams at once.

Intel branded this process as hyper-threading, but hyper-threading is the same thing as simultaneous multithreading. For example, AMD CPUs with four cores use simultaneous multithreading to provide eight threads, and most Intel CPUs with two cores use hyper-threading to provide four threads.

https://www.tomshardware.com/reviews/simultaneous-multithreading-definition,5762.html

SDSC does not enable hyperthreading on its systems. When hyperthreading is enabled, core count will appear to be doubled.

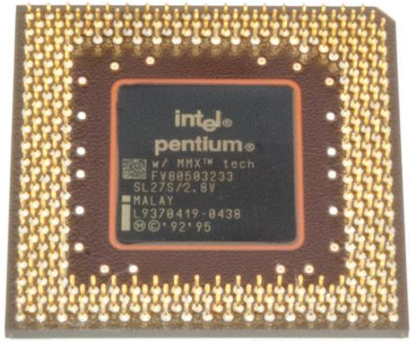
Advanced Vector Extensions (AVX, AVX2, AVX512)

```
Flags:              fpu vme de avx tsc msr pae mce cx8 apic sep mtrr … avx2 mca …
```

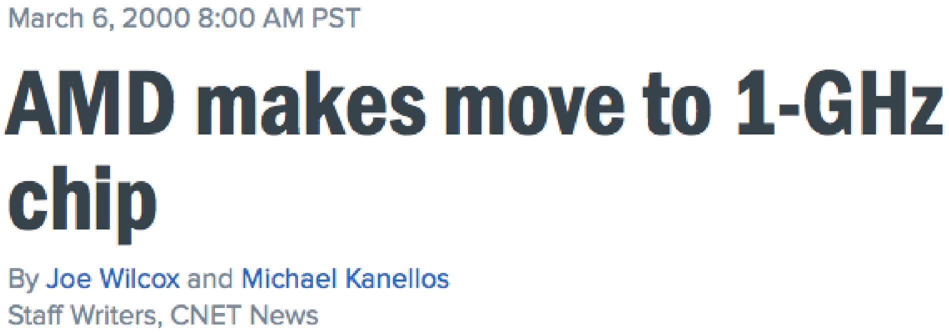
The Advanced Vector Extensions (AVX) are an extension to the x86 microprocessor architecture that allows a compute core to perform up to 8 floating point operations per cycle. Previous limit was 4/core/cycle

- AVX2 improves this to 16 Flops/cycle/core (Comet, Expanse)
- AVX512 further improves to 32 Flops/cycle/core (Intel ≥ Skylake)

These were developed partially in response to challenges in increasing CPU clock speeds



http://www.computerhope.com



March 6, 2000 8:00 AM PST

AMD makes move to 1-GHz chip

By Joe Wilcox and Michael Kanellos
Staff Writers, CNET News

Advanced Vector Extensions (AVX, AVX2, AVX512)

- Can theoretically obtain a 2x speedup when going from a non-AVX processor to an AVX capable processor (all else being equal)
  - And another 2x from AVX to AVX2
  - And another 2x from AVX2 to AVX512

- But don’t get too excited (or worried that *Expanse* doesn’t have AVX512)
  - It’s difficult enough to make good use of AVX and even harder to make good use of AVX2 or AVX512.
  - Need long loops with vectorizable content. Memory bandwidth not keeping up with gains in computing power.
  - On Skylake, clock speed scaled down when executing AVX512 instructions

HPC System Architecture: Conceptual Model

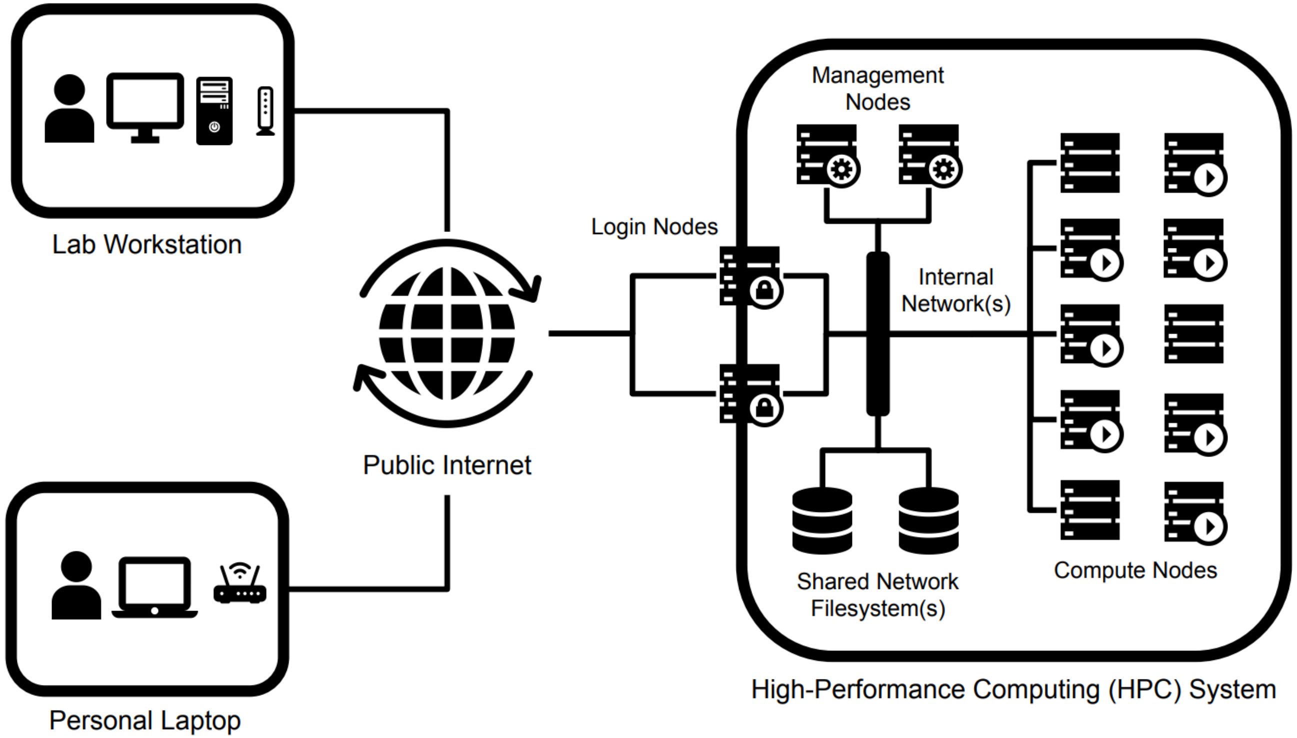
Login node(s): Provide remote access to an HPC system; use only for simple tasks such as editing files, limited data transfers to and from the system, and batch job submission

Compute nodes: Run computational workloads: simulations, data analysis and visualization

Data Mover nodes: Dedicated and configured specifically for transferring data

Internal Network(s): Provide high-bandwidth, low-latency communication between computes nodes ; access to shared (parallel) filesystems; system management

Shared Network Filesystem(s): Provide input/output (I/O) access to data storage systems from any compute node



Management node(s): Run core system services such as cluster management software, system monitoring software, *batch job scheduler*, etc

CPU vs. GPU

- CPU (Central Processing Unit)
- large and broad instruction sets
- managing every input and output of a computer
- Use RAM

- GPU
- More gpus
- Use VRAM
- https://www.heavy.ai/technical-glossary/cpu-vs-gpu

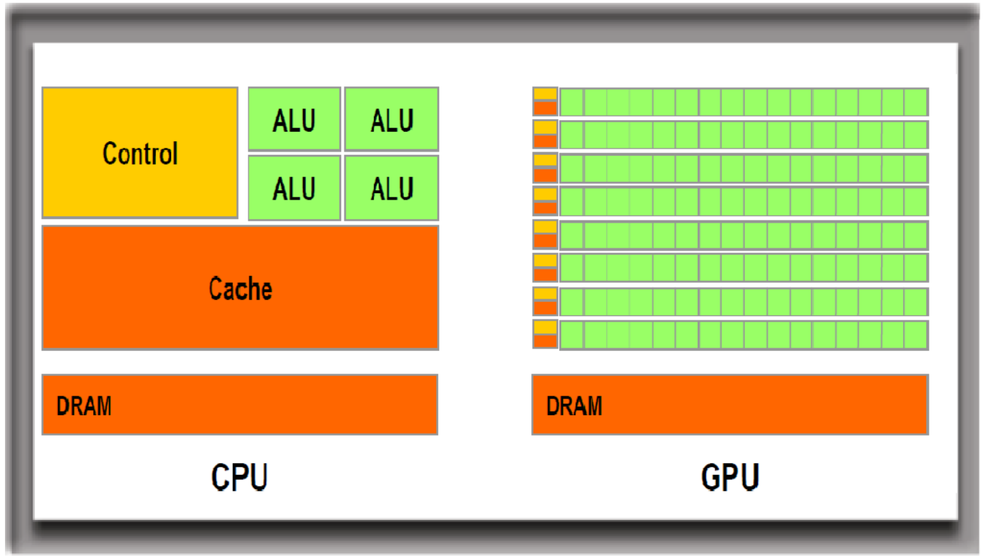


Image from NVIDIA

Processor Specifications: (lscpu) Expanse gpu node

```
Architecture:          x86_64
CPU op-mode(s):        32-bit, 64-bit
Byte Order:            Little Endian
CPU(s):                40
On-line CPU(s) list: 0-39
Thread(s) per core:  1
Core(s) per socket:  20
Socket(s):             2
NUMA node(s):          2
Vendor ID:             GenuineIntel
CPU family:            6
Model:                 85
Model name:            Intel(R) Xeon(R) Gold 6248 CPU
@ 2.50GHz
Stepping:              7
CPU MHz:               1719.434
CPU max MHz:           3900.0000
CPU min MHz:           1000.0000
BogoMIPS:              5000.00
L1d cache:             32K
L1i cache:             32K
L2 cache:              1024K
L3 cache:              28160K
```

```
•   NUMA node0 CPU(s):
    0,2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,32,34,36,3
    8
•   NUMA node1 CPU(s):
    1,3,5,7,9,11,13,15,17,19,21,23,25,27,29,31,33,35,37,3
    9
•   Flags:                 fpu vme de pse tsc msr pae mce
    cx8 apic sep mtrr pge mca cmov pat pse36 clflush dts
    acpi mmx fxsr sse sse2 ss ht tm pbe syscall nx
    pdpe1gb rdtscp lm constant_tsc art arch_perfmon pebs
    bts rep_good nopl xtopology nonstop_tsc cpuid
    aperfmperf pni pclmulqdq dtes64 monitor ds_cpl smx
    est tm2 ssse3 sdbg fma cx16 xtpr pdcm pcid dca sse4_1
    sse4_2 x2apic movbe popcnt tsc_deadline_timer aes
    xsave avx f16c rdrand lahf_lm abm 3dnowprefetch
    cpuid_fault epb cat_l3 cdp_l3 invpcid_single
    intel_ppin ssbd mba ibrs ibpb stibp ibrs_enhanced
    fsgsbase tsc_adjust bmi1 avx2 smep bmi2 erms invpcid
    cqm mpx rdt_a avx512f avx512dq rdseed adx smap
    clflushopt clwb intel_pt avx512cd avx512bw avx512vl
    xsaveopt xsavec xgetbv1 xsaves cqm_llc cqm_occup_llc
    cqm_mbm_total cqm_mbm_local dtherm ida arat pln pts
    pku ospke avx512_vnni md_clear flush_l1d
    arch_capabilities
```

Node information: (gpu) lscpu -e

```
[nickel@exp-7-59 ~]$ lscpu -e
CPU NODE SOCKET CORE L1d:L1i:L2:L3 ONLINE MAXMHZ    MINMHZ
0   0    0      0    0:0:0:0       yes    3900.0000 1000.0000
1   1    1      1    1:1:1:1       yes    3900.0000 1000.0000
2   0    0      2    2:2:2:0       yes    3900.0000 1000.0000
3   1    1      3    3:3:3:1       yes    3900.0000 1000.0000
4   0    0      4    4:4:4:0       yes    3900.0000 1000.0000
5   1    1      5    5:5:5:1       yes    3900.0000 1000.0000
6   0    0      6    6:6:6:0       yes    3900.0000 1000.0000
7   1    1      7    7:7:7:1       yes    3900.0000 1000.0000
8   0    0      8    8:8:8:0       yes    3900.0000 1000.0000
9   1    1      9    9:9:9:1       yes    3900.0000 1000.0000
10  0    0      10   10:10:10:0    yes    3900.0000 1000.0000
11  1    1      11   11:11:11:1    yes    3900.0000 1000.0000
12  0    0      12   12:12:12:0    yes    3900.0000 1000.0000
13  1    1      13   13:13:13:1    yes    3900.0000 1000.0000
```

Getting GPU information

If you’re using GPU nodes, you can use nvidia-smi (NVIDIA System Management Interface program) to get GPU information (type, count, etc.)

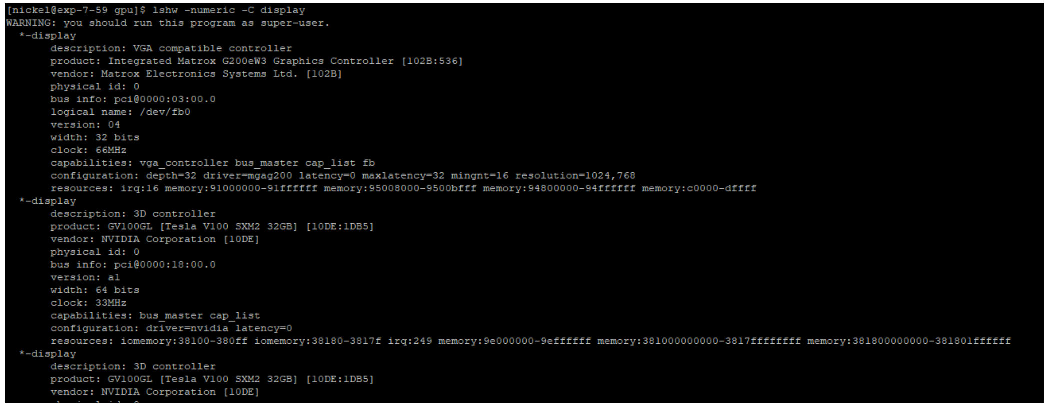
When running in gpu-shared partition, will only see the GPUs you had requested (typically one)

```
 $ nvidia-smi
Mon Aug  2 10:16:29 2021
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 460.32.03    Driver Version: 460.32.03    CUDA Version: 11.2     |
|-------------------------------+----------------------+----------------------+
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|                               |                      |               MIG M. |
|===============================+======================+======================|
|   0  Tesla V100-SXM2...  On   | 00000000:18:00.0 Off |                    0 |
| N/A   40C    P0    67W / 300W |      0MiB / 32510MiB |      0%      Default |
|                               |                      |                  N/A |
+-------------------------------+----------------------+----------------------+

+-----------------------------------------------------------------------------+
| Processes:                                                                  |
|  GPU   GI   CI        PID   Type   Process name                  GPU Memory |
|        ID   ID                                                   Usage      |
|=============================================================================|
|  No running processes found                                                 |
+-----------------------------------------------------------------------------+
```

Processor specifications: (lspci) *Expanse* gpu node

- A graphics processing unit (**GPU**), also occasionally called visual processing unit (**VPU**)
- lspci: information about PCI buses in the system and devices connected to them
  - grep –E “VGA|3D”
- lshw: List hardware
  - –numeric –C display (or video)

```
 lspci | grep -E "VGA|3D"
03:00.0 VGA compatible controller: Matrox
Electronics Systems Ltd. Integrated Matrox G200eW3
Graphics Controller (rev 04)
18:00.0 3D controller: NVIDIA Corporation GV100GL
[Tesla V100 SXM2 32GB] (rev a1)
3b:00.0 3D controller: NVIDIA Corporation GV100GL
[Tesla V100 SXM2 32GB] (rev a1)
86:00.0 3D controller: NVIDIA Corporation GV100GL
[Tesla V100 SXM2 32GB] (rev a1)
af:00.0 3D controller: NVIDIA Corporation GV100GL
[Tesla V100 SXM2 32GB] (rev a1)
```



```
[nickel@exp-7-59 gpu]$ lshw -numeric -C display
WARNING: you should run this program as super-user.
  *-display
       description: VGA compatible controller
       product: Integrated Matrox G200eW3 Graphics Controller [102B:536]
       vendor: Matrox Electronics Systems Ltd. [102B]
       physical id: 0
       bus info: pci@0000:03:00.0
       logical name: /dev/fb0
       version: 04
       width: 32 bits
       clock: 66MHz
       capabilities: vga_controller bus_master cap_list fb
       configuration: depth=32 driver=mgag200 latency=0 maxlatency=32 mingnt=16 resolution=1024,768
       resources: irq:16 memory:91000000-91ffffff memory:95008000-9500bfff memory:94800000-94ffffff memory:c0000-dffff
  *-display
       description: 3D controller
       product: GV100GL [Tesla V100 SXM2 32GB] [10DE:1DB5]
       vendor: NVIDIA Corporation [10DE]
       physical id: 0
       bus info: pci@0000:18:00.0
       version: a1
       width: 64 bits
       clock: 33MHz
       capabilities: bus_master cap_list
       configuration: driver=nvidia latency=0
       resources: iomemory:38100-380ff iomemory:38180-3817f irq:249 memory:9e000000-9effffff memory:381000000000-3817ffffffff memory:381800000000-381801ffffff
  *-display
       description: 3D controller
       product: GV100GL [Tesla V100 SXM2 32GB] [10DE:1DB5]
       vendor: NVIDIA Corporation [10DE]
```

A brief aside on pseudo-files

Up to this point, we’ve been using the term pseudo-file without defining what it is. Recall that in the UNIX/Linux world, ev/proc and /sys are just interfaces to the Linux kernel data structures in a convenient and familiar file system format

everything is treated as a file (files, directories, devices, etc.)

```
$ ls -ld /proc
dr-xr-xr-x 2258 root root 0 Jul 28 09:27 /proc
[sinkovit@login01 ~]$ ls -ld /proc/cpuinfo
-r--r--r-- 1 root root 0 Jul 28 16:56 /proc/cpuinfo

$ head /proc/cpuinfo
processor  : 0
vendor_id  : AuthenticAMD
cpu family : 23
Model.     : 49
model name : AMD EPYC 7742 64-Core Processor
stepping   : 0
microcode  : 0x8301038
```

Processor specifications: /proc/cpuinfo

On Linux systems, the **/proc/cpuinfo** pseudo-file contains pretty much the same information that you get from lscpu, but with a few differences

- Information is listed per core
- Access to instantaneous clock speeds
- Bugs detected / addressed
  see discussion: https://unix.stackexchange.com/questions/456425/what-does-the-bugs-section-of-proc-cpuinfo-actually-show
- Microcode, TLB size , power management, cache line flush sizes and other low-level details that you probably don’t need to know about

Processor specifications: /proc/cpuinfo

```
$ grep 'cpu MHz' /proc/cpuinfo  | head -5
cpu MHz         : 3325.325
cpu MHz         : 2239.263
cpu MHz         : 3374.887
cpu MHz         : 2360.551
cpu MHz         : 2393.493
```

```
--- selected output ---
microcode        : 0x8301038
bugs             : sysret_ss_attrs spectre_v1 spectre_v2 spec_store_bypass
TLB size         : 3072 4K pages
clflush size     : 64
cache_alignment  : 64
address sizes    : 43 bits physical, 48 bits virtual
power management : ts ttp tm hwpstate cpb eff_freq_ro [13] [14]
```

Getting memory information: /proc/meminfo

On Linux machines, the /proc/meminfo pseudo-file lists key memory specs. More information than you probably want, but at least one bit of useful data

Regular Memory Node

```
MemTotal:         263698228 kB (total physical memory)
MemFree:          251035032 kB
MemAvailable:     250623760 kB
Buffers:             12824 kB
Cached:            3126364 kB
SwapCached:              0 kB
Active:            1301564 kB (good approx used memory)
Inactive:          2990668 kB
Active(anon):      1240284 kB
Inactive(anon):    2890076 kB
Active(file):        61280 kB
Inactive(file):     100592 kB
Unevictable:             0 kB
Mlocked:                 0 kB
SwapTotal:               0 kB
SwapFree:                0 kB
Dirty:                  32 kB
Writeback:               0 kB
AnonPages:         1151660 kB
```

Large Memory Node

```
MemTotal:        2113365024 kB
MemFree:         2003813192 kB
MemAvailable:    2003837576 kB
Buffers:            1816060 kB
Cached:             3765288 kB
SwapCached:           19588 kB
Active:            18699308 kB
Inactive:          74523312 kB
Active(anon):      15751904 kB
Inactive(anon):    73244676 kB
Active(file):       2947404 kB
Inactive(file):     1278636 kB
Unevictable:           3072 kB
Mlocked:                  0 kB
SwapTotal:         16759804 kB
SwapFree:          15768188 kB
Dirty:                    0 kB
Writeback:                0 kB
AnonPages:         57923904 kB
Mapped:             1313932 kB
Shmem:              1355308 kB
```

GPU Node

```
MemTotal:         394817856 kB
MemFree:          390316552 kB
MemAvailable:     389003936 kB
Buffers:               8244 kB
Cached:             1028748 kB
SwapCached:               0 kB
Active:              176572 kB
Inactive:           2139400 kB
Active(anon):          2308 kB
Inactive(anon):     1410160 kB
Active(file):        174264 kB
Inactive(file):      729240 kB
Unevictable:           3072 kB
Mlocked:                  0 kB
SwapTotal:                0 kB
SwapFree:                 0 kB
Dirty:                 3256 kB
Writeback:                0 kB
AnonPages:          1280240 kB
Mapped:              741024 kB
Shmem:               133256 kB
```

For more details, see http://www.redhat.com/advice/tips/meminfo.html

Finding Cache Information

On Linux systems, can obtain cache properties through the /sys pseudo filesystem. Details may vary slightly by O/S version and vendor, but basic information should be consistent. Goes deeper into cache properties than lscpu

```
$ pwd
/sys/devices/system/cpu

$ ls
cpu0   cpu17  cpu25  cpu33  cpu41  cpu5   cpu58  cpu9         offline
cpu1   cpu18  cpu26  cpu34  cpu42  cpu50  cpu59  cpufreq      online
cpu10  cpu19  cpu27  cpu35  cpu43  cpu51  cpu6   cpuidle      possible
cpu11  cpu2   cpu28  cpu36  cpu44  cpu52  cpu60  hotplug      power
...

$ cd cpu0/cache
$ ls
index0  index1  index2  index3  power  uevent

$ cd index0
$ ls
coherency_line_size  physical_line_partition  size
id                   power                    type
level                shared_cpu_list          uevent
number_of_sets       shared_cpu_map           ways_of_associativity
```

Finding SCSI device information

SCSI (Small Computer System Interface) is a common interface for mounting peripheral, such as hard drives and SSDs. The lsscsi or /proc/scsi/scsi file command will provide info on SCSI devices.

```
$ lsscsi
[3:0:0:0]    disk    ATA      SSDSC2KB480G8R   DL67  /dev/sda
[N:0:0:1]    disk    Dell Express Flash NVMe P4510 1TB SFF__1  /dev/nvme0n1
```

Dell 1TB PCIe
NVMe Read

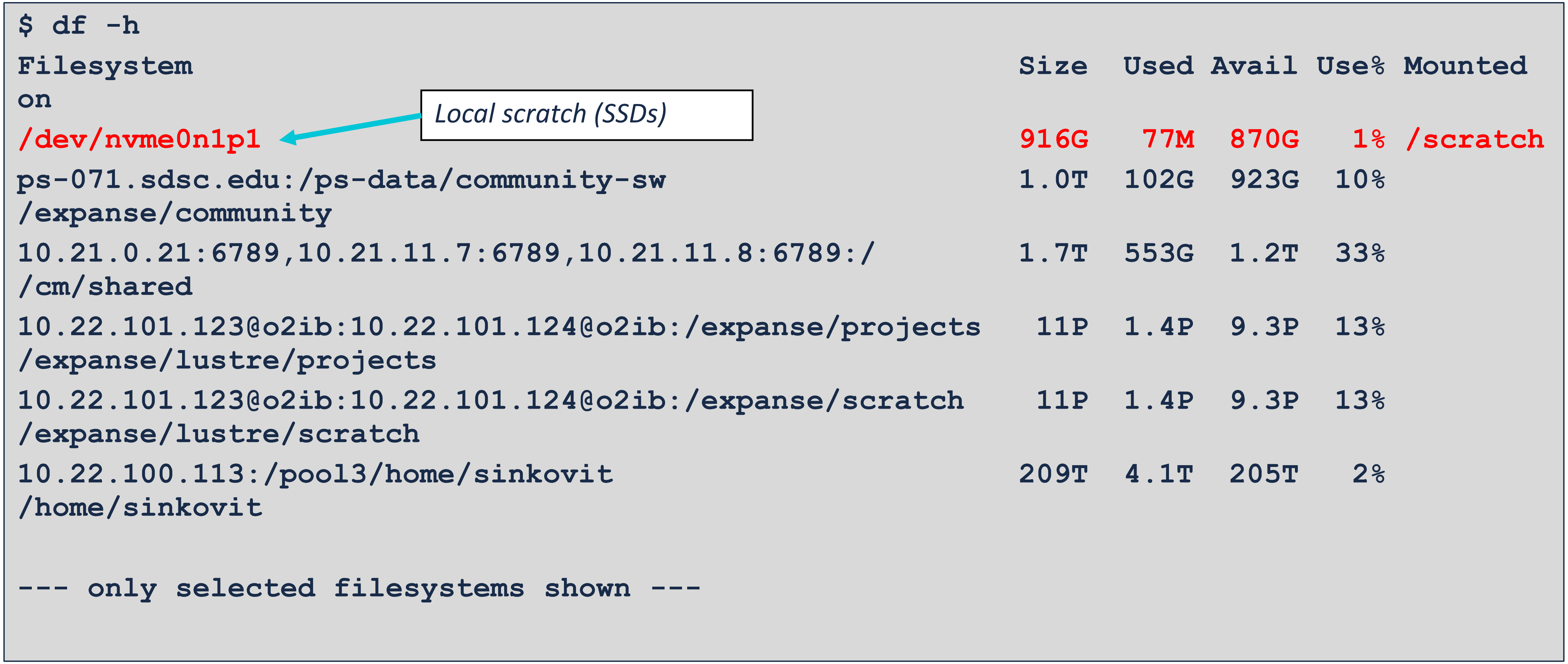
File system information

- Pseudo filesystems
  - /proc/filesystem
  - /proc/mounts & /etc/mtab
- Linux commands
  - df – disk free
  - du – disk usage
- File sytem specific commands
  - lfs – lustre file system

/proc/filesystem and /etc/mtab

- /proc/filesystem
  - lists file system types currently supported by the kernel
- /etc/mtab
  - List currently mounted filesystems

df command: Information on filesystem usage



```
$ df -h
Filesystem                                          Size   Used Avail Use% Mounted
on
/dev/nvme0n1p1                                      916G    77M  870G   1% /scratch
ps-071.sdsc.edu:/ps-data/community-sw               1.0T   102G  923G  10%
/expanse/community
10.21.0.21:6789,10.21.11.7:6789,10.21.11.8:6789:/   1.7T   553G  1.2T  33%
/cm/shared
10.22.101.123@o2ib:10.22.101.124@o2ib:/expanse/projects  11P   1.4P  9.3P  13%
/expanse/lustre/projects
10.22.101.123@o2ib:10.22.101.124@o2ib:/expanse/scratch   11P   1.4P  9.3P  13%
/expanse/lustre/scratch
10.22.100.113:/pool3/home/sinkovit                  209T   4.1T  205T   2%
/home/sinkovit


--- only selected filesystems shown ---
```

Local scratch (SSDs)

df command: information on filesystem usage

```
$ df -h
Filesystem                                              Size   Used  Avail  Use% Mounted
on
/dev/nvme0n1p1                                          916G    77M   870G    1% /scratch
ps-071.sdsc.edu:/ps-data/community-sw                   1.0T   102G   923G   10%
/expanse/community
10.21.0.21:6789,10.21.11.7:6789,10.21.11.8:6789:/       1.7T   553G   1.2T   33%
/cm/shared
10.22.101.123@o2ib:10.22.101.124@o2ib:/expanse/projects  11P   1.4P   9.3P   13%
/expanse/lustre/projects
10.22.101.123@o2ib:10.22.101.124@o2ib:/expanse/scratch   11P   1.4P   9.3P   13%
/expanse/lustre/scratch
10.22.100.113:/pool3/home/sinkovit                      209T   4.1T   205T    2%
/home/sinkovit


--- only selected filesystems shown ---
```

Community and SDSC maintained software stacks

df command: Information on filesystem usage

```
$ df -h
Filesystem                                                 Size  Used Avail Use% Mounted
on
/dev/nvme0n1p1                                             916G   77M  870G   1% /scratch
ps-071.sdsc.edu:/ps-data/community-sw                      1.0T  102G  923G  10%
/expanse/community
10.21.0.21:6789,10.21.11.7:6789,10.21.11.8:6789:/          1.7T  553G  1.2T  33%
/cm/shared
10.22.101.123@o2ib:10.22.101.124@o2ib:/expanse/projects     11P  1.4P  9.3P  13%
/expanse/lustre/projects
10.22.101.123@o2ib:10.22.101.124@o2ib:/expanse/scratch      11P  1.4P  9.3P  13%
/expanse/lustre/scratch
10.22.100.113:/pool3/home/sinkovit                         209T  4.1T  205T   2%
/home/sinkovit


--- only selected filesystems shown ---
```

Lustre scratch and project filesystems

df Command: Information on filesystem usage

```
$ df -h
Filesystem                                          Size  Used Avail Use% Mounted on
/dev/nvme0n1p1                                      916G   77M  870G   1% /scratch
ps-071.sdsc.edu:/ps-data/community-sw               1.0T  102G  923G  10%
/expanse/community
10.21.0.21:6789,10.21.11.7:6789,10.21.11.8:6789:/   1.7T  553G  1.2T  33% /cm/shared
10.22.101.123@o2ib:10.22.101.124@o2ib:/expanse/projects  11P  1.4P  9.3P  13%
/expanse/lustre/projects
10.22.101.123@o2ib:10.22.101.124@o2ib:/expanse/scratch   11P  1.4P  9.3P  13%
/expanse/lustre/scratch
10.22.100.113:/pool3/home/username                  209T  4.1T  205T   2% /home/username

--- only selected filesystems shown ---
```

Home filesystem

du command

- Disk usage
- --time : the time of the last modification to any file in the directory or subdirectory that you run it against
- -s: summary
- -h: “human readable”
- -a: lists the sizes of all files and directories in the given file path

Networking/interconnects

- Ethernet
- 10GbE
- Infiniband

Finding Network Information

The ip command (/sbin/ip) is normally used by sys admins, but regular users can use it to learn about networking information

```
$ /sbin/ip link
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN mode DEFAULT
group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
2: eno1: <BROADCAST,MULTICAST> mtu 1500 qdisc noop state DOWN mode DEFAULT group
default qlen 1000
    link/ether 6c:2b:59:bb:61:24 brd ff:ff:ff:ff:ff:ff
3: eno33: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 9000 qdisc mq state UP mode DEFAULT
group default qlen 1000
    link/ether 1c:34:da:62:a8:50 brd ff:ff:ff:ff:ff:ff
4: eno34: <BROADCAST,MULTICAST> mtu 1500 qdisc noop state DOWN mode DEFAULT group
default qlen 1000
    link/ether 1c:34:da:62:a8:51 brd ff:ff:ff:ff:ff:ff
5: ib0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 4092 qdisc mq state UP mode DEFAULT
group default qlen 256
    link/infiniband 20:00:11:07:fe:80:00:00:00:00:00:00:1c:34:da:03:00:5d:53:90 brd
00:ff:ff:ff:ff:12:40:1b:ff:ff:00:00:00:00:00:00:ff:ff:ff:ff
6: eno33.450@eno33: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 9000 qdisc noqueue state
UP mode DEFAULT group default qlen 1000
    link/ether 1c:34:da:62:a8:50 brd ff:ff:ff:ff:ff:ff
```

Prefix	Network Type
en	Ethernet
ib	InfiniBand
sl	Serial line IP
wl	WLAN (wireless local area network
ww	WWAN (wireless wide are network

Monitoring Resource Utilization

- Tools
  - top, htop, atop : display Linux processes
  - mpstat : display processors related statistic
  - sar : display system activity report
  - free: display memory statics
  - ps: display active processes
  - nvidia-smi: display gpu activity and statistic
- seff (slurm efficiency) after job is complete

top, htop, atop

- Used to analyze the load of a server running Linux
  - **top** - a standard utility, installed in all Linux versions by default
  - **htop** - easier to use than top, interactive
  - **atop** – easier then top, interactive, allows logging

Using the Linux top utility

The top utility is found on all Linux systems and provides a high-level view of running processes. Does not give any information at the source code level (profiling), but can still be very useful for answering questions such as

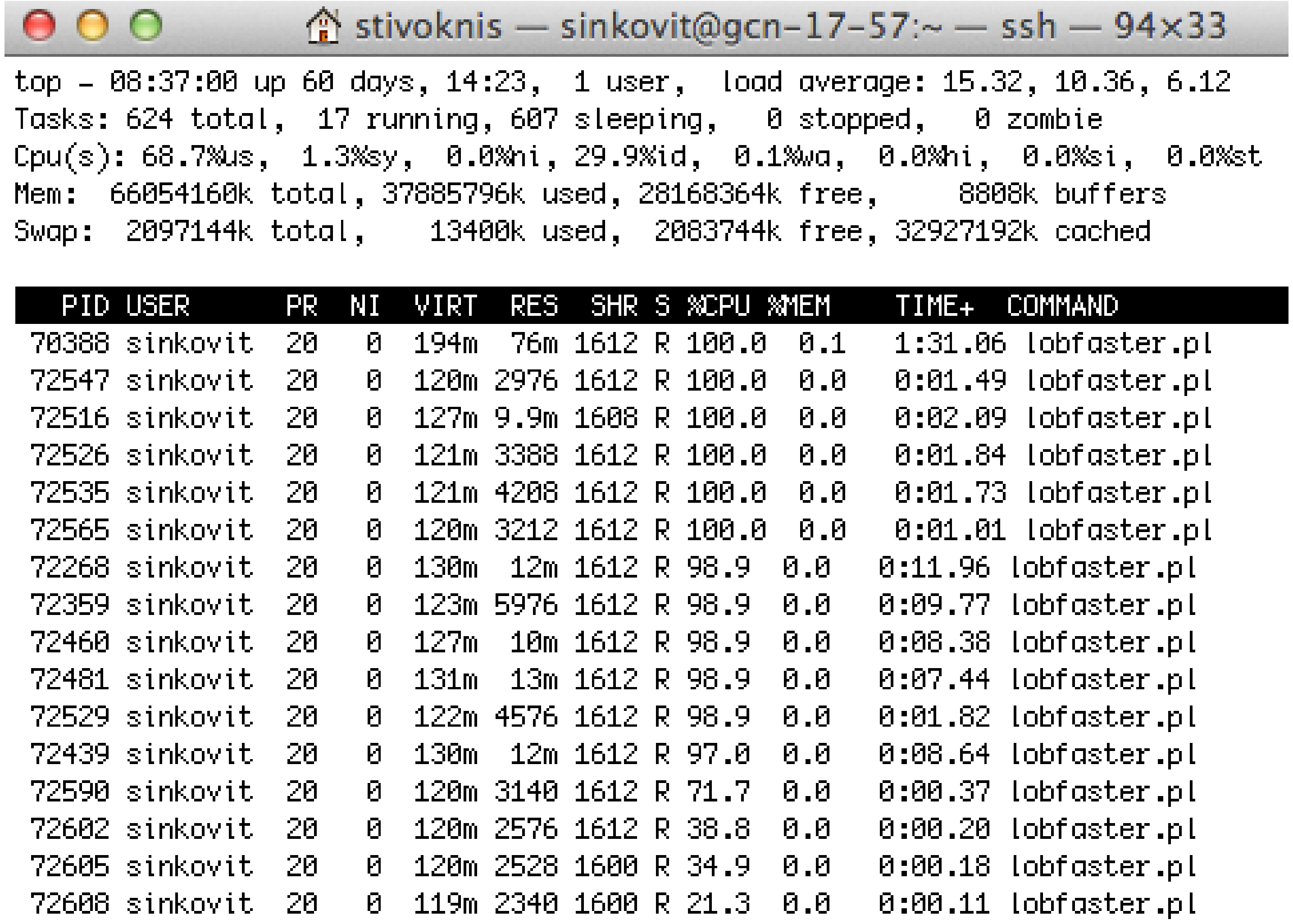
- How many of my processes are running?
- What are the states of the processes (running, sleeping, etc.)?
- Which cores are being utilized?
- Are there any competing processes that may be affecting my performance?
- What fraction of the CPU is each process using?
- How much memory does each process use?
- Is the memory usage growing over time? (Useful for identifying memory leaks)
- How many threads are my processes using?

top utility control

By Default:

- Reports on Processes only (no threads)
  - “H” - To toggle threads display, type “H” while top is running
- Displays information for all users
  - Can restrict to a single user by launching with “top -u username”
  - “u” – sort by username
  - “n” – limit number of process
- Updates information every 3 seconds
  - Change refresh rate by launching with “top -d n”
- Ordered by CPU usage
  - “M” - order by memory usage
- Process ID, priority, ‘nice’ level, virtual memory, physical memory, shared memory, state, %CPU, %memory, CPU time, command
  - “f” - to manage fields and toggle fields
  - “c” – display full path of process in COMMAND column

Top utility: default output



```
top - 08:37:00 up 60 days, 14:23,  1 user,  load average: 15.32, 10.36, 6.12
Tasks: 624 total,  17 running, 607 sleeping,   0 stopped,   0 zombie
Cpu(s): 68.7%us,  1.3%sy,  0.0%ni, 29.9%id,  0.1%wa,  0.0%hi,  0.0%si,  0.0%st
Mem:  66054160k total, 37885796k used, 28168364k free,     8808k buffers
Swap:  2097144k total,    13400k used,  2083744k free, 32927192k cached

  PID USER      PR  NI  VIRT  RES  SHR S %CPU %MEM    TIME+  COMMAND
70388 sinkovit  20   0  194m  76m 1612 R 100.0  0.1   1:31.06 lobfaster.pl
72547 sinkovit  20   0  120m 2976 1612 R 100.0  0.0   0:01.49 lobfaster.pl
72516 sinkovit  20   0  127m 9.9m 1608 R 100.0  0.0   0:02.09 lobfaster.pl
72526 sinkovit  20   0  121m 3388 1612 R 100.0  0.0   0:01.84 lobfaster.pl
72535 sinkovit  20   0  121m 4208 1612 R 100.0  0.0   0:01.73 lobfaster.pl
72565 sinkovit  20   0  120m 3212 1612 R 100.0  0.0   0:01.01 lobfaster.pl
72268 sinkovit  20   0  130m  12m 1612 R 98.9  0.0   0:11.96 lobfaster.pl
72359 sinkovit  20   0  123m 5976 1612 R 98.9  0.0   0:09.77 lobfaster.pl
72460 sinkovit  20   0  127m  10m 1612 R 98.9  0.0   0:08.38 lobfaster.pl
72481 sinkovit  20   0  131m  13m 1612 R 98.9  0.0   0:07.44 lobfaster.pl
72529 sinkovit  20   0  122m 4576 1612 R 98.9  0.0   0:01.82 lobfaster.pl
72439 sinkovit  20   0  130m  12m 1612 R 97.0  0.0   0:08.64 lobfaster.pl
72590 sinkovit  20   0  120m 3140 1612 R 71.7  0.0   0:00.37 lobfaster.pl
72602 sinkovit  20   0  120m 2576 1612 R 38.8  0.0   0:00.20 lobfaster.pl
72605 sinkovit  20   0  120m 2528 1600 R 34.9  0.0   0:00.18 lobfaster.pl
72608 sinkovit  20   0  119m 2340 1600 R 21.3  0.0   0:00.11 lobfaster.pl
```

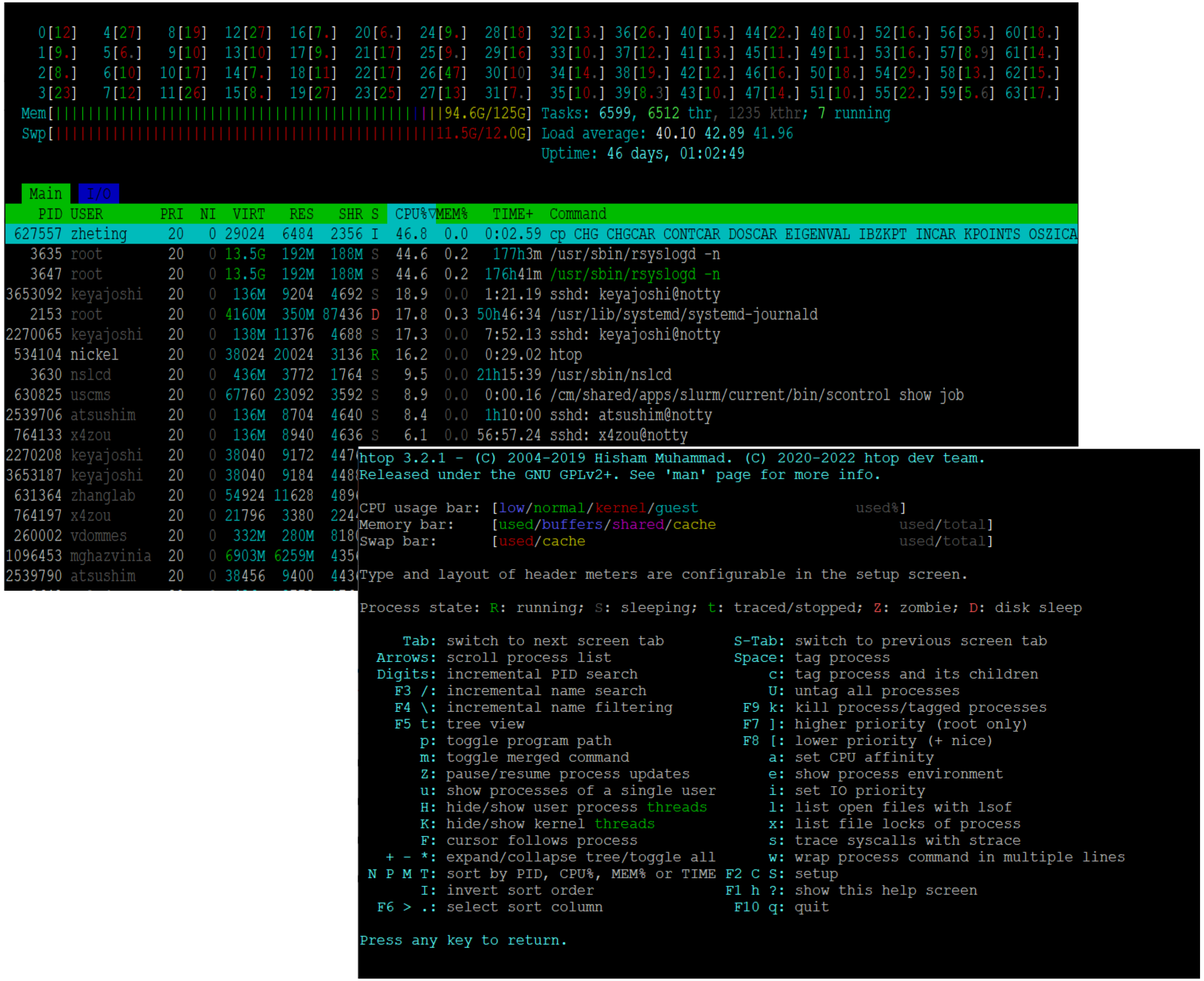
Shown are 16 processes, each using anywhere from 21.3% to 100% of a compute core.

Memory footprint (RES) is minimal, with each process only using up to 76 MB.

CPU times ranging from 0.11s (just started) to 1:31

htop utility

- System monitoring
- Process Viewing
- Process Management
- Interactive commands
  - F1: help
  - M: sort by memory
  - P: sort by processor
  - T: sort by time
  - U: display for specific user

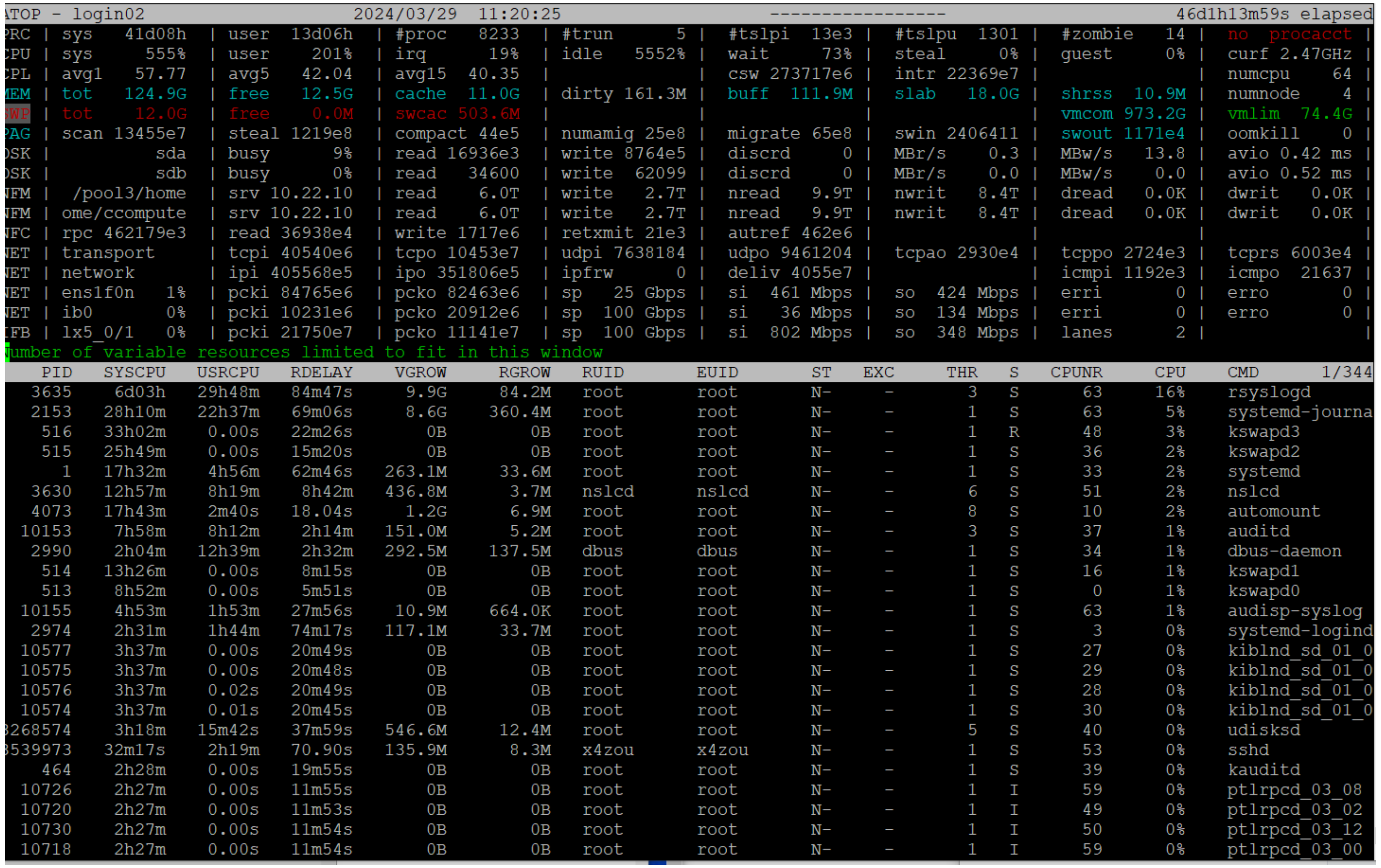


```
    0[12]   4[27]   8[19]  12[27]  16[7.]  20[6.]  24[9.]  28[18]  32[13.] 36[26.] 40[15.] 44[22.] 48[10.] 52[16.] 56[35.] 60[18.]
    1[9.]   5[6.]   9[10]  13[10]  17[9.]  21[17]  25[9.]  29[16]  33[10.] 37[12.] 41[13.] 45[11.] 49[11.] 53[16.] 57[8.9] 61[14.]
    2[8.]   6[10]  10[17]  14[7.]  18[11]  22[17]  26[47]  30[10]  34[14.] 38[19.] 42[12.] 46[16.] 50[18.] 54[29.] 58[13.] 62[15.]
    3[23]   7[12]  11[26]  15[8.]  19[27]  23[25]  27[13]  31[7.]  35[10.] 39[8.3] 43[10.] 47[14.] 51[10.] 55[22.] 59[5.6] 63[17.]
  Mem[||||||||||||||||||||||||||||||||||||||||||||||94.6G/125G] Tasks: 6599, 6512 thr, 1235 kthr; 7 running
  Swp[|||||||||||||||||||||||||||||||||||||||||||||||11.5G/12.0G] Load average: 40.10 42.89 41.96
                                                                  Uptime: 46 days, 01:02:49

  Main  I/O
    PID USER       PRI  NI  VIRT   RES   SHR S  CPU%▽MEM%   TIME+  Command
 627557 zheting     20   0 29024  6484  2356 I  46.8  0.0  0:02.59 cp CHG CHGCAR CONTCAR DOSCAR EIGENVAL IBZKPT INCAR KPOINTS OSZICA
   3635 root        20   0 13.5G  192M  188M S  44.6  0.2   177h3m /usr/sbin/rsyslogd -n
   3647 root        20   0 13.5G  192M  188M S  44.6  0.2 176h41m /usr/sbin/rsyslogd -n
3653092 keyajoshi   20   0  136M  9204  4692 S  18.9  0.0  1:21.19 sshd: keyajoshi@notty
   2153 root        20   0 4160M  350M 87436 D  17.8  0.3 50h46:34 /usr/lib/systemd/systemd-journald
2270065 keyajoshi   20   0  138M 11376  4688 S  17.3  0.0  7:52.13 sshd: keyajoshi@notty
 534104 nickel      20   0 38024 20024  3136 R  16.2  0.0  0:29.02 htop
   3630 nslcd       20   0  436M  3772  1764 S   9.5  0.0 21h15:39 /usr/sbin/nslcd
 630825 uscms       20   0 67760 23092  3592 S   8.9  0.0  0:00.16 /cm/shared/apps/slurm/current/bin/scontrol show job
2539706 atsushim    20   0  136M  8704  4640 S   8.4  0.0  1h10:00 sshd: atsushim@notty
 764133 x4zou       20   0  136M  8940  4636 S   6.1  0.0 56:57.24 sshd: x4zou@notty
2270208 keyajoshi   20   0 38040  9172  447
3653187 keyajoshi   20   0 38040  9184  448
 631364 zhanglab    20   0 54924 11628  489
 764197 x4zou       20   0 21796  3380  224
 260002 vdommes     20   0  332M  280M  818
1096453 mghazvinia  20   0 6903M 6259M  435
2539790 atsushim    20   0 38456  9400  443
```

```
htop 3.2.1 - (C) 2004-2019 Hisham Muhammad. (C) 2020-2022 htop dev team.
Released under the GNU GPLv2+. See 'man' page for more info.

CPU usage bar:  [low/normal/kernel/guest                     used%]
Memory bar:     [used/buffers/shared/cache                     used/total]
Swap bar:       [used/cache                                    used/total]

Type and layout of header meters are configurable in the setup screen.

Process state: R: running; S: sleeping; t: traced/stopped; Z: zombie; D: disk sleep

     Tab: switch to next screen tab        S-Tab: switch to previous screen tab
  Arrows: scroll process list              Space: tag process
  Digits: incremental PID search               c: tag process and its children
    F3 /: incremental name search              U: untag all processes
    F4 \: incremental name filtering        F9 k: kill process/tagged processes
    F5 t: tree view                         F7 ]: higher priority (root only)
       p: toggle program path               F8 [: lower priority (+ nice)
       m: toggle merged command                a: set CPU affinity
       Z: pause/resume process updates         e: show process environment
       u: show processes of a single user      i: set IO priority
       H: hide/show user process threads       l: list open files with lsof
       K: hide/show kernel threads             x: list file locks of process
       F: cursor follows process               s: trace syscalls with strace
   + - *: expand/collapse tree/toggle all      w: wrap process command in multiple lines
 N P M T: sort by PID, CPU%, MEM% or TIME F2 C S: setup
       I: invert sort order               F1 h ?: show this help screen
  F6 > .: select sort column                F10 q: quit

Press any key to return.
```

atop utility

- Tool for monitoring system resources in Linux.
  - System load information at the process level.
  - Default shows cpu usage
  - -m shows memory usage
  - -d shows disc usage
  - -au processes per user



```
ATOP - login02                  2024/03/29  11:20:25                  -----------------                  46d1h13m59s elapsed
PRC | sys    41d08h  | user   13d06h | #proc    8233 | #trun       5 | #tslpi   13e3 | #tslpu   1301 | #zombie    14 | no  procacct |
CPU | sys      555%  | user     201% | irq       19% | idle    5552% | wait      73% | steal      0% | guest      0% | curf 2.47GHz |
CPL | avg1    57.77  | avg5    42.04 | avg15   40.35 |               | csw 273717e6  | intr 22369e7  |               | numcpu    64 |
MEM | tot    124.9G  | free    12.5G | cache   11.0G | dirty 161.3M  | buff  111.9M  | slab    18.0G | shrss  10.9M  | numnode    4 |
SWP | tot     12.0G  | free     0.0M | swcac 503.6M  |               |               |               | vmcom 973.2G  | vmlim  74.4G |
PAG | scan 13455e7   | steal 1219e8  | compact 44e5  | numamig 25e8  | migrate 65e8  | swin 2406411  | swout 1171e4  | oomkill    0 |
DSK |           sda  | busy      9%  | read 16936e3  | write 8764e5  | discrd      0 | MBr/s     0.3 | MBw/s   13.8  | avio 0.42 ms |
DSK |           sdb  | busy      0%  | read   34600  | write  62099  | discrd      0 | MBr/s     0.0 | MBw/s    0.0  | avio 0.52 ms |
NFM |  /pool3/home   | srv 10.22.10  | read    6.0T  | write   2.7T  | nread    9.9T | nwrit    8.4T | dread   0.0K  | dwrit   0.0K |
NFM | ome/ccompute   | srv 10.22.10  | read    6.0T  | write   2.7T  | nread    9.9T | nwrit    8.4T | dread   0.0K  | dwrit   0.0K |
NFC | rpc 462179e3   | read 36938e4  | write 1717e6  | retxmit 21e3  | autref 462e6  |               |               |              |
NET | transport      | tcpi 40540e6  | tcpo 10453e7  | udpi 7638184  | udpo 9461204  | tcpao 2930e4  | tcppo 2724e3  | tcprs 6003e4 |
NET | network        | ipi 405568e5  | ipo 351806e5  | ipfrw       0 | deliv 4055e7  |               | icmpi 1192e3  | icmpo  21637 |
NET | ens1f0n     1% | pcki 84765e6  | pcko 82463e6  | sp   25 Gbps  | si  461 Mbps  | so  424 Mbps  | erri       0  | erro       0 |
NET | ib0         0% | pcki 10231e6  | pcko 20912e6  | sp  100 Gbps  | si   36 Mbps  | so  134 Mbps  | erri       0  | erro       0 |
IFB | lx5_0/1     0% | pcki 21750e7  | pcko 11141e7  | sp  100 Gbps  | si  802 Mbps  | so  348 Mbps  | lanes      2  |              |
Number of variable resources limited to fit in this window
    PID   SYSCPU   USRCPU   RDELAY    VGROW    RGROW  RUID      EUID      ST  EXC    THR  S  CPUNR   CPU  CMD        1/344
   3635   6d03h   29h48m   84m47s     9.9G    84.2M  root      root      N-   -       3  S     63   16%  rsyslogd
   2153  28h10m   22h37m   69m06s     8.6G   360.4M  root      root      N-   -       1  S     63    5%  systemd-journa
    516  33h02m    0.00s   22m26s       0B       0B  root      root      N-   -       1  R     48    3%  kswapd3
    515  25h49m    0.00s   15m20s       0B       0B  root      root      N-   -       1  S     36    2%  kswapd2
      1  17h32m    4h56m   62m46s   263.1M    33.6M  root      root      N-   -       1  S     33    2%  systemd
   3630  12h57m    8h19m    8h42m   436.8M     3.7M  nslcd     nslcd     N-   -       6  S     51    2%  nslcd
   4073  17h43m    2m40s   18.04s     1.2G     6.9M  root      root      N-   -       8  S     10    2%  automount
  10153   7h58m    8h12m    2h14m   151.0M     5.2M  root      root      N-   -       3  S     37    1%  auditd
   2990   2h04m   12h39m    2h32m   292.5M   137.5M  dbus      dbus      N-   -       1  S     34    1%  dbus-daemon
    514  13h26m    0.00s    8m15s       0B       0B  root      root      N-   -       1  S     16    1%  kswapd1
    513   8h52m    0.00s    5m51s       0B       0B  root      root      N-   -       1  S      0    1%  kswapd0
  10155   4h53m    1h53m   27m56s    10.9M   664.0K  root      root      N-   -       1  S     63    1%  audisp-syslog
   2974   2h31m    1h44m   74m17s   117.1M    33.7M  root      root      N-   -       1  S      3    0%  systemd-logind
  10577   3h37m    0.00s   20m49s       0B       0B  root      root      N-   -       1  S     27    0%  kiblnd_sd_01_0
  10575   3h37m    0.00s   20m48s       0B       0B  root      root      N-   -       1  S     29    0%  kiblnd_sd_01_0
  10576   3h37m    0.02s   20m49s       0B       0B  root      root      N-   -       1  S     28    0%  kiblnd_sd_01_0
  10574   3h37m    0.01s   20m45s       0B       0B  root      root      N-   -       1  S     30    0%  kiblnd_sd_01_0
3268574   3h18m   15m42s   37m59s   546.6M    12.4M  root      root      N-   -       5  S     40    0%  udisksd
3539973  32m17s    2h19m   70.90s   135.9M     8.3M  x4zou     x4zou     N-   -       1  S     53    0%  sshd
    464   2h28m    0.00s   19m55s       0B       0B  root      root      N-   -       1  S     39    0%  kauditd
  10726   2h27m    0.00s   11m55s       0B       0B  root      root      N-   -       1  I     59    0%  ptlrpcd_03_08
  10720   2h27m    0.00s   11m53s       0B       0B  root      root      N-   -       1  I     49    0%  ptlrpcd_03_02
  10730   2h27m    0.00s   11m54s       0B       0B  root      root      N-   -       1  I     50    0%  ptlrpcd_03_12
  10718   2h27m    0.00s   11m54s       0B       0B  root      root      N-   -       1  I     59    0%  ptlrpcd_03_00
```

mpstat

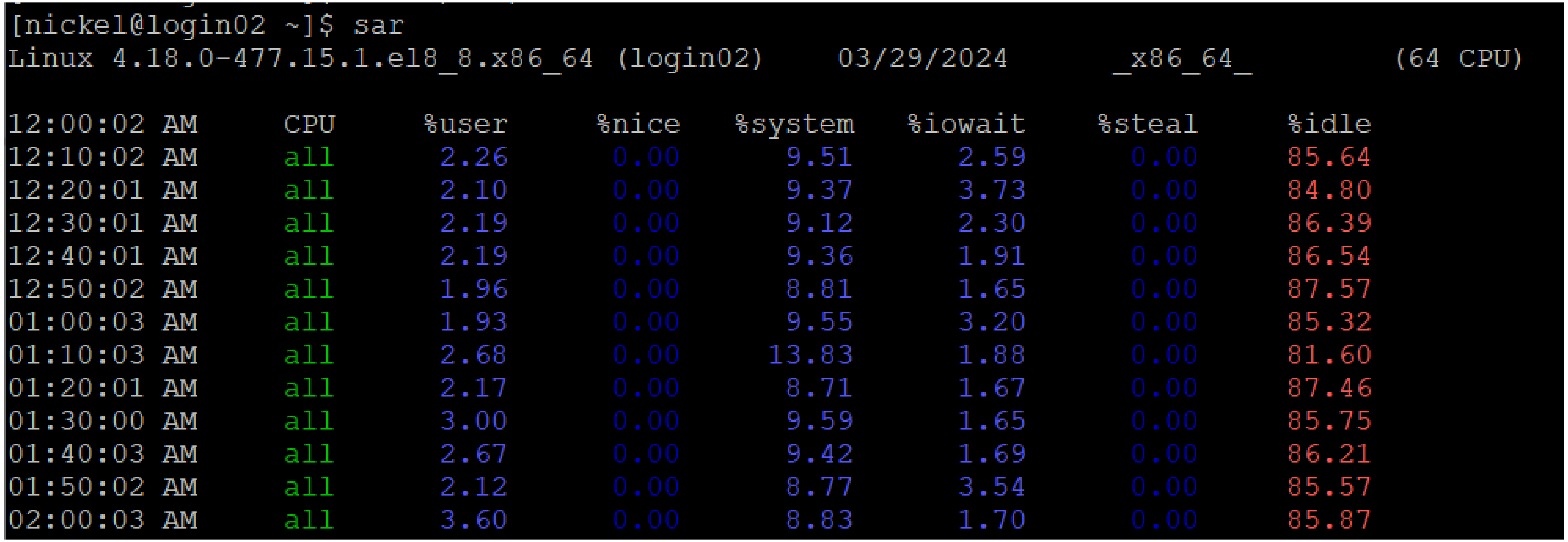
- Report processors related statistics
- Uasge: mpstat [options] [<interval> [<count>]]

```
login02 ~]$ mpstat -A
Linux 4.18.0-477.15.1.el8_8.x86_64 (login02)    03/29/2024      _x86_64_        (64 CPU)

08:19:33 AM  CPU    %usr   %nice    %sys %iowait    %irq   %soft  %steal  %guest  %gnice   %idle
08:19:33 AM  all    3.07    0.06    8.66    1.14    0.16    0.13    0.00    0.00    0.00   86.77
08:19:33 AM    0    3.97    0.14   10.38    0.90    0.19    0.08    0.00    0.00    0.00   84.34
08:19:33 AM    1    2.78    0.13    9.61    1.00    0.16    0.07    0.00    0.00    0.00   86.25
08:19:33 AM    2    2.36    0.02    8.81    0.95    0.15    0.06    0.00    0.00    0.00   87.65
08:19:33 AM    3    2.39    0.02    8.20    0.87    0.14    0.05    0.00    0.00    0.00   88.33
08:19:33 AM    4    2.96    0.14    9.57    0.64    0.15    0.05    0.00    0.00    0.00   86.48
.
.
.
```

sar

sar – (system activity report)

- Collect, report, or save system activity information
- CPU usage(default) –u (similar to iosatt)
- Memory usage -r
- File system usage -F



```
[nickel@login02 ~]$ sar
Linux 4.18.0-477.15.1.el8_8.x86_64 (login02)    03/29/2024     _x86_64_        (64 CPU)

12:00:02 AM     CPU     %user     %nice   %system   %iowait    %steal     %idle
12:10:02 AM     all      2.26      0.00      9.51      2.59      0.00     85.64
12:20:01 AM     all      2.10      0.00      9.37      3.73      0.00     84.80
12:30:01 AM     all      2.19      0.00      9.12      2.30      0.00     86.39
12:40:01 AM     all      2.19      0.00      9.36      1.91      0.00     86.54
12:50:02 AM     all      1.96      0.00      8.81      1.65      0.00     87.57
01:00:03 AM     all      1.93      0.00      9.55      3.20      0.00     85.32
01:10:03 AM     all      2.68      0.00     13.83      1.88      0.00     81.60
01:20:01 AM     all      2.17      0.00      8.71      1.67      0.00     87.46
01:30:00 AM     all      3.00      0.00      9.59      1.65      0.00     85.75
01:40:03 AM     all      2.67      0.00      9.42      1.69      0.00     86.21
01:50:02 AM     all      2.12      0.00      8.77      3.54      0.00     85.57
02:00:03 AM     all      3.60      0.00      8.83      1.70      0.00     85.87
```

free

- Evaluate memory Usage statics of the Linux operating system
- Usage: free [options]

```
@login02 ~]$ free -h
          total        used        free      shared    buff/cache   available
Mem:      124Gi        89Gi        10Gi      72Mi        25Gi            34Gi
Swap:      11Gi        11Gi          0B
```

ps

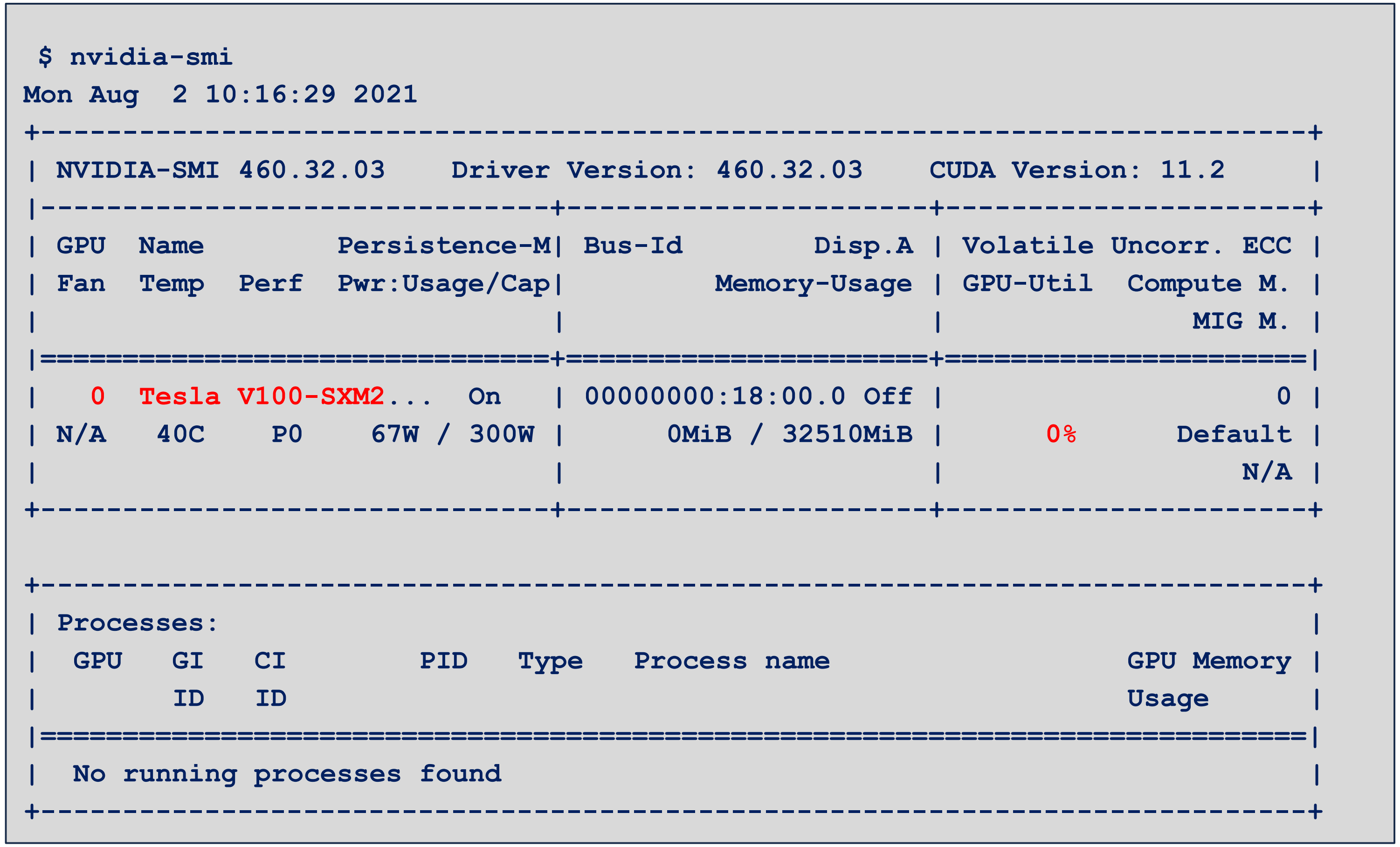
- Returns the users current processes
- M an ps - will provide all the options
- -e: returns every process on system

```
login01 gpu]$ ps -aux | head -10
USER         PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root           1  1.1  0.0 253436 22956 ?        Ss   Mar21 225:43 /usr/lib/systemd/systemd
root           2  0.0  0.0      0     0 ?        S    Mar21   3:44 [kthreadd]
user1   1790480  0.0  0.0  12736  3156 ?        Ss   Mar29   0:00 /bin/bash /usr/libexec/dbus-1/dbus-kill-process-with-session
1790477
user1   1790487  0.0  0.0 149644  9224 ?        Sl   Mar29   0:29 gio monitor -f /run/systemd/sessions/76616 /tmp/dbus-
session-monitor.NGdpD
user2   1794352  0.0  0.0  12884  2944 pts/1    T    Mar26   0:00 /bin/bash /home/jitsuk/gene-dev/tools/runassign 01
user3     1797357  0.0  0.0 136692 10396 ?        Ss   Apr02   0:00 sshd: cyang2 [priv]
user4    1797526  0.2  0.0  98640 16760 ?        Ss   Mar25  28:10 /usr/lib/systemd/systemd --user
user5     1797539  0.0  0.0 307424  1648 ?        S    Mar25   0:00 (sd-
```

Getting GPU information

If you're using GPU nodes, you can use nvidia-smi (NVIDIA System Management Interface program) to get GPU information (type, count, etc.)

When running in gpu-shared partition, will only see the GPUs you had requested (typically one)



```
 $ nvidia-smi
Mon Aug  2 10:16:29 2021
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 460.32.03    Driver Version: 460.32.03    CUDA Version: 11.2     |
|-------------------------------+----------------------+----------------------+
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|                               |                      |               MIG M. |
|===============================+======================+======================|
|   0  Tesla V100-SXM2...  On   | 00000000:18:00.0 Off |                    0 |
| N/A   40C    P0    67W / 300W |      0MiB / 32510MiB |      0%      Default |
|                               |                      |                  N/A |
+-------------------------------+----------------------+----------------------+

+-----------------------------------------------------------------------------+
| Processes:                                                                  |
|  GPU   GI   CI        PID   Type   Process name                  GPU Memory |
|        ID   ID                                                   Usage      |
|=============================================================================|
|  No running processes found                                                 |
+-----------------------------------------------------------------------------+
```

Obtaining job hardware usage info (seff and sacct)

- seff
  - Slurm Job Efficiency Report
  - seff <<completed_jobid>>

- sacct:
  - Usage: sacct [options]
  - Slurm command to evaluate pending, running, and finished jobs

- Unfortunately, no details on GPU usage, just cpu and memory

In Conclusion

- Machine Information overkill?
- Use the correct tools
  - System tools
  - Scheduler tools
- Avoid wasting resources and money

Machine info – cheat sheet

File or command	Information provided
less /proc/cpuinfo or lscpu	CPU specs
less /proc/meminfo	Memory specs and usage
nvidia-smi	GPU specs and usage
cd /sys/devices/system/cpu/cpu0/cache … then look at directory contents	Cache configuration
less /proc/scsi/scsi or lsscsi	Peripherals (e.g. SSDs)
less /etc/mtab	Mounted file systems
df -h	File system usage (readable format)
du -sh	Disk usage (human readable)
/sbin/ip link	Networking information
uname -a	OS information
less /etc/centos-release	Centos version

Machine and job monitoring – cheat sheet

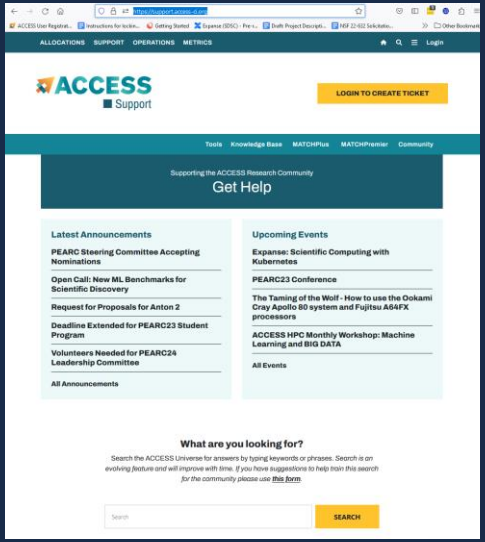
File or command	Information provided
top	Monitor process activity
atop	Monitor process activity
htop	Monitor process activity
sar	System utilization
free	Memory utilization
ps	Process
mpstat	Processors
seff	Slurm Job efficiency data
sacct	https://slurm.schedmd.com/sacct.html

Review and helpful links

- Slurm
  - https://slurm.schedmd.com/sacct.html
- seff and sacct:
  - *https://csc-training.github.io/csc-env-eff/handson/batch_resources/tutorial_sacct_and_seff.html*
- Training Catalog
  - *https://www.sdsc.edu/education_and_training/training_hpc.html#catalog*

Questions

- consult@sdsc.edu
- https://support.access-ci.org/



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- Request for Proposals for Anton 2
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- Volunteers Needed for PEARC24 Leadership Committee

All Announcements

Upcoming Events

- Expanse: Scientific Computing with Kubernetes
- PEARC23 Conference
- The Taming of the Wolf - How to use the Ookami Cray Apollo 80 system and Fujitsu A64FX processors
- ACCESS HPC Monthly Workshop: Machine Learning and BIG DATA

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