

HPC & Parallel Programming

Overview

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<https://kevinsuo.github.io/>

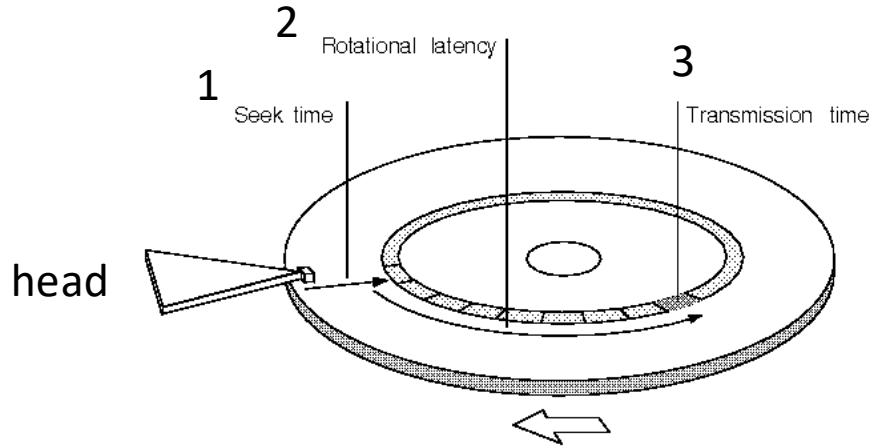
Disk



- A stack of platters, a surface with a magnetic coating
- Typical numbers (depending on the disk size):
 - 500 to 2,000 tracks per surface
 - 32 to 128 sectors per track
 - ▶ A sector is the smallest unit that can be read or written
- Originally, all tracks have the same number of sectors



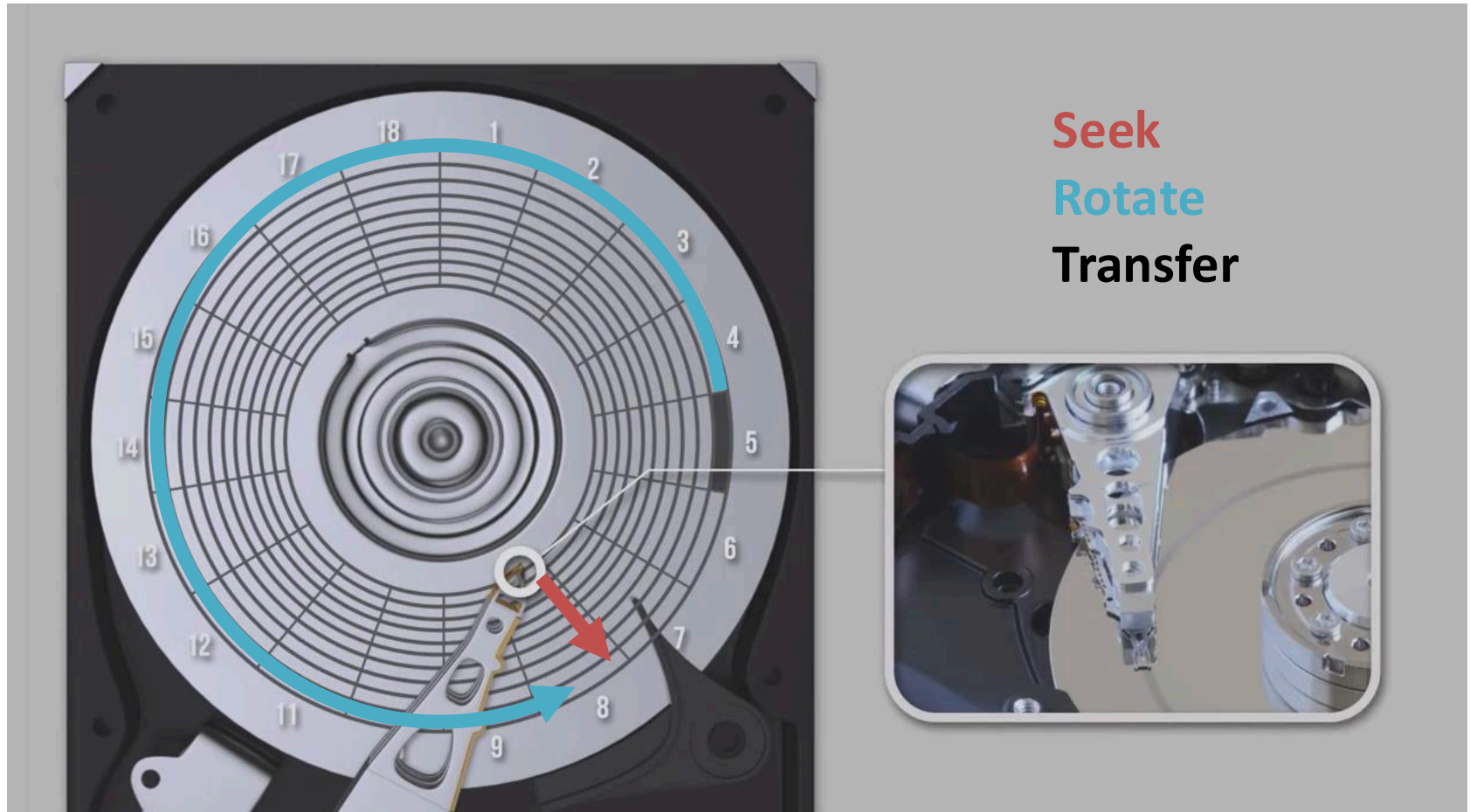
Disk



- Disk head: each side of a platter has separate disk head
- Read/write data is a three-stage process:
 - Seek time: position the arm over the proper track
 - Rotational latency: wait for the desired sector to rotate under the read/write head
 - Transfer time: transfer a block of bits (sector) under the read-write head
- Average seek time as reported by the industry:
 - Typically in the range of 8 ms to 15 ms



Disk



Disk information

- lsblk
 - Lists out all the storage blocks, which includes disk partitions and optical drives. Details include the total size of the partition/block and the mount point if any.

```
administrator@ubuntuvm-1604 ~> lsblk
NAME        MAJ:MIN RM  SIZE RO TYPE MOUNTPOINT
sr0          11:0    1   1.5G  0  rom  /media/administrator/Ubuntu 16.04.5 LTS amd64
sda           8:0     0   40G   0  disk
├─sda2        8:2     0    1K   0  part
├─sda5        8:5     0   975M   0  part [SWAP]
└─sda1        8:1     0   39G   0  part /
```



Disk information

- df
 - prints out details about only mounted file systems. The list generated by df even includes file systems that are not real disk partitions.

```
administrator@ubuntuvm-1604 ~> df
Filesystem      1K-blocks    Used Available Use% Mounted on
udev            4054632         0   4054632  0% /dev
tmpfs           816876    42148    774728  6% /run
/dev/sda1       40168028 7350596  30753972 20% /
tmpfs           4084376     1044    4083332  1% /dev/shm
tmpfs           5120         0        5120  0% /run/lock
tmpfs           4084376         0    4084376  0% /sys/fs/cgroup
/dev/sr0        1610928 1610928         0 100% /media/administrator/Ubuntu 16.04.5 LTS amd64
tmpfs           816876         56    816820  1% /run/user/1000
```



Disk information

- fdisk
 - display the partitions and details like file system type

```
administrator@ubuntuvm-1604 ~> sudo fdisk -l
[sudo] password for administrator:
Disk /dev/sda: 40 GiB, 42949672960 bytes, 83886080 sectors
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disklabel type: dos
Disk identifier: 0x6e6dc012

Device      Boot      Start          End      Sectors  Size Id Type
/dev/sda1   *           2048 81885183 81883136   39G 83 Linux
/dev/sda2             81887230 83884031  1996802   975M  5 Extended
/dev/sda5             81887232 83884031  1996800   975M 82 Linux swap / Solaris
```



Disk R/W Process



Disk R/W Speed

- \$ sudo hdparm -Tt /dev/sda

The image shows a terminal window with the command `sudo hdparm -Tt /dev/sda` and its output. Four callout boxes highlight specific parts of the output:

- Read cache data size:** Points to the value `17132 MB` in the first line of the output.
- Read cache speed:** Points to the value `8599.49 MB/sec` in the first line of the output.
- Read disk data size:** Points to the value `592 MB` in the second line of the output.
- Read disk speed:** Points to the value `194.58 MB/sec` in the second line of the output.

```
administrator@ubuntuvm-14 ~> sudo hdparm -Tt /dev/sda
/dev/sda:
Timing cached reads:   17132 MB in  1.99 seconds = 8599.49 MB/sec
Timing buffered disk reads: 592 MB in  3.04 seconds = 194.58 MB/sec
```



dd: Disk Write Speed

- `$ dd if=/dev/zero of=/testw.dbf bs=4k count=100000 oflag=direct`

/dev/zero: generate
null string stream

Write into
this file

```
sudo dd if=/dev/zero of=/testw.dbf bs=4k count=100000 oflag=direct
100000+0 records in
100000+0 records out
409600000 bytes (410 MB, 391 MiB) copied, 25.1254 s, 16.3 MB/s
```

Block size 4k

Block number
100000



dd: Disk Read Speed

- \$ dd if=/dev/sdb of=/dev/null bs=4k count=100000

/dev/zero: the
source file

Write into this file (it is
an empty file)

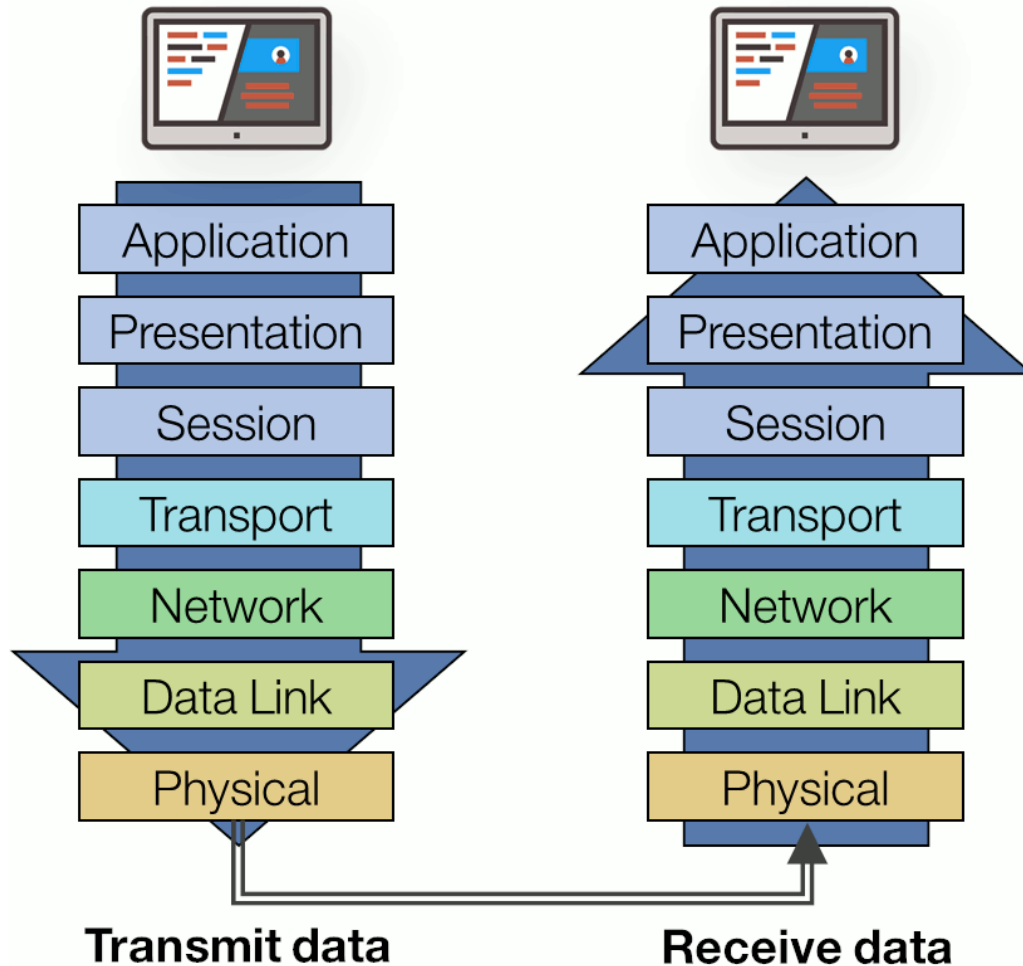
```
administrator@ubuntuvm-1604 ~>  
sudo dd if=/dev/sda of=/dev/null bs=4k count=100000  
100000+0 records in  
100000+0 records out  
409600000 bytes (410 MB, 391 MiB) copied, 2.08187 s, 197 MB/s
```

Block size 4k

Block number
100000



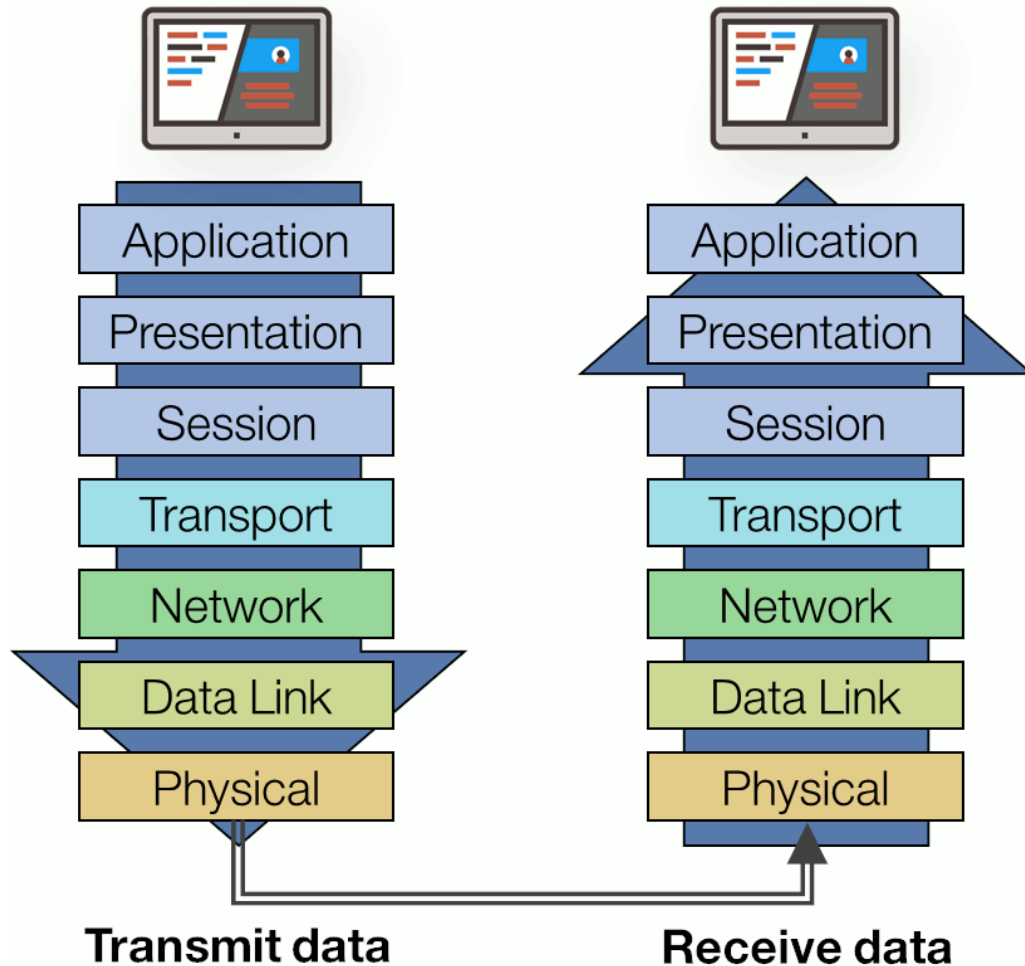
Networking



- Physical: represents the electrical and physical representation of the system
- Data link: provides node-to-node data transfer and handles error correction
- Network: router function, packet forwarding, etc.



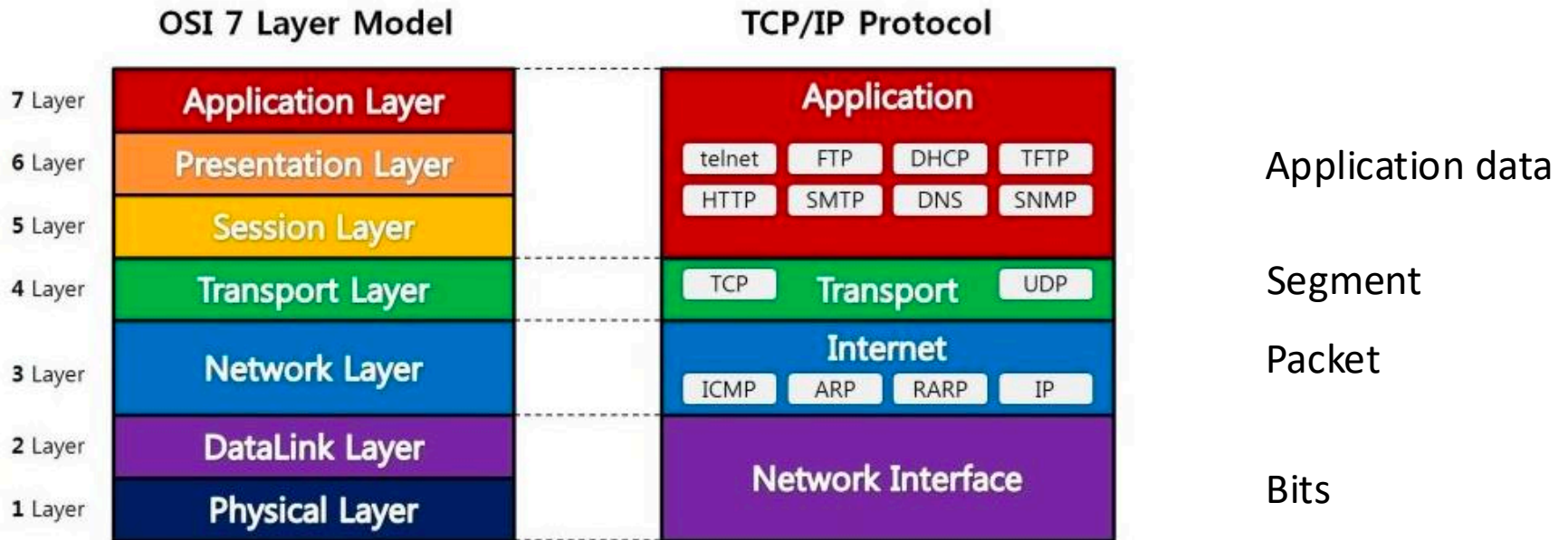
Networking



- Transport: coordination of the data transfer between end systems and hosts. How much data to send, at what rate, where it goes, etc.
- Session/Presentation/Application: interaction with the user level application



Networking



Networking connection: ping

- Ping is a computer network administration software utility used to test the reachability of a host on an Internet Protocol network.

```
administrator@ubuntuvm-1604 ~-> ping www.google.com X
PING www.google.com (216.58.194.228) 56(84) bytes of data.
64 bytes from atl14s63-in-f4.1e100.net (216.58.194.228): icmp_seq=1 ttl=116 time=2.70 ms
64 bytes from atl14s63-in-f4.1e100.net (216.58.194.228): icmp_seq=2 ttl=116 time=3.11 ms
64 bytes from atl14s63-in-f4.1e100.net (216.58.194.228): icmp_seq=3 ttl=116 time=2.81 ms
64 bytes from atl14s63-in-f4.1e100.net (216.58.194.228): icmp_seq=4 ttl=116 time=3.14 ms
64 bytes from atl14s63-in-f4.1e100.net (216.58.194.228): icmp_seq=5 ttl=116 time=3.01 ms
64 bytes from atl14s63-in-f4.1e100.net (216.58.194.228): icmp_seq=6 ttl=116 time=3.07 ms
64 bytes from atl14s63-in-f4.1e100.net (216.58.194.228): icmp_seq=7 ttl=116 time=3.03 ms
^C
```



Networking throughput: speedtest-cli

- \$ `wget https://github.com/sivel/speedtest-cli/archive/master.zip`
- \$ `unzip master.zip`
- \$ `cd speedtest-cli-master/`
- `./speedtest.py`

```
administrator@ubuntu1804vm ~/speedtest-cli-master> ./speedtest.py
Retrieving speedtest.net configuration...
Testing from PeachNet (168.28.186.189)...
Retrieving speedtest.net server list...
Selecting best server based on ping...
Hosted by Nitel (Atlanta, GA) [27.97 km]: 5.091 ms
Testing download speed.....
.....
Download: 1596.49 Mbit/s
Testing upload speed.....
.....
Upload: 1035.54 Mbit/s
```



An interesting video introducing hardware

Computer Parts!



<https://www.youtube.com/watch?v=ExxFxD4OSZ0>



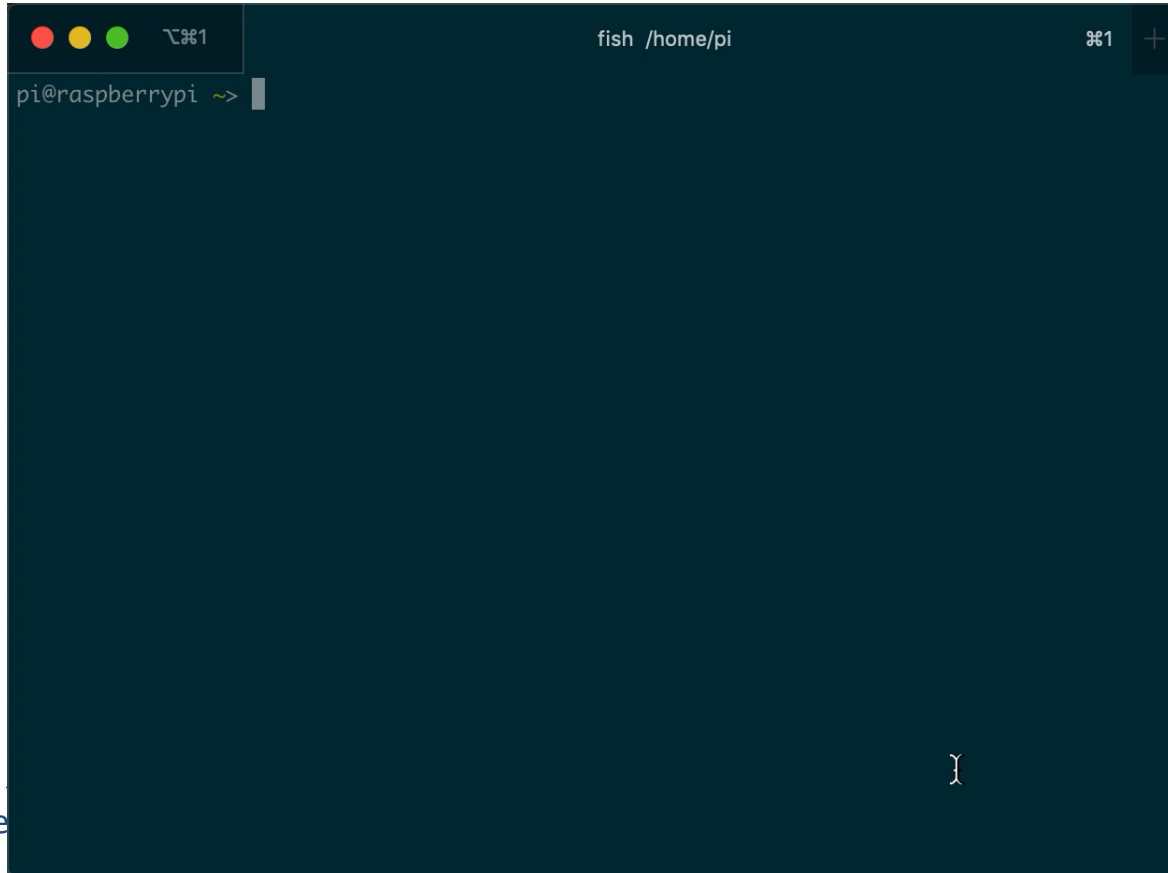
Test: Your VM hardware specs?

- CPU? → How many cores? Frequency? Topology?
- Cache? → Size?
- Memory? → Size? Speed?
- Disk? → Size?
- Network? → Latency? Bandwidth?

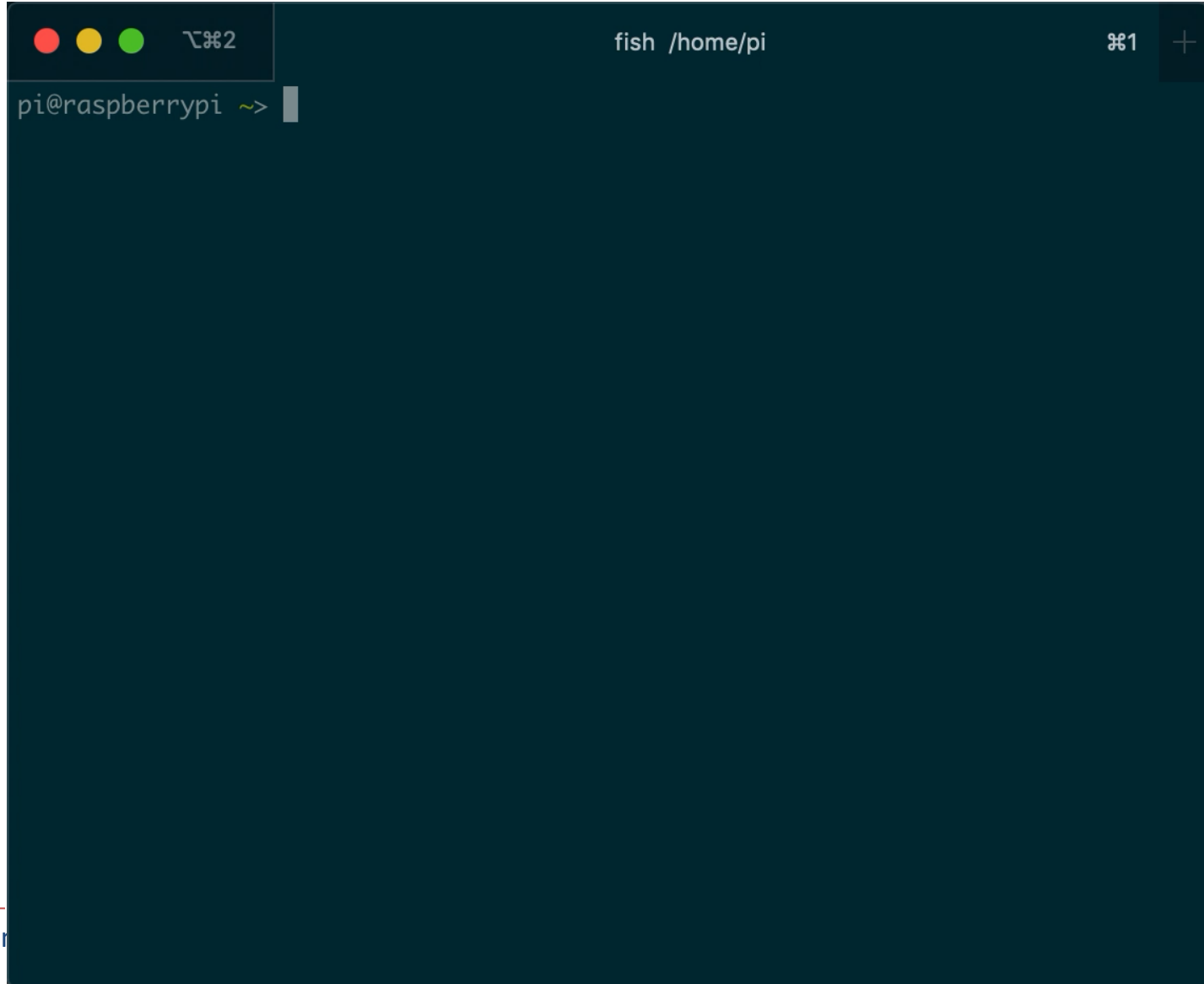


How to get my machine spec?

- Inxi: <https://www.tecmint.com/inxi-command-to-find-linux-system-information/>



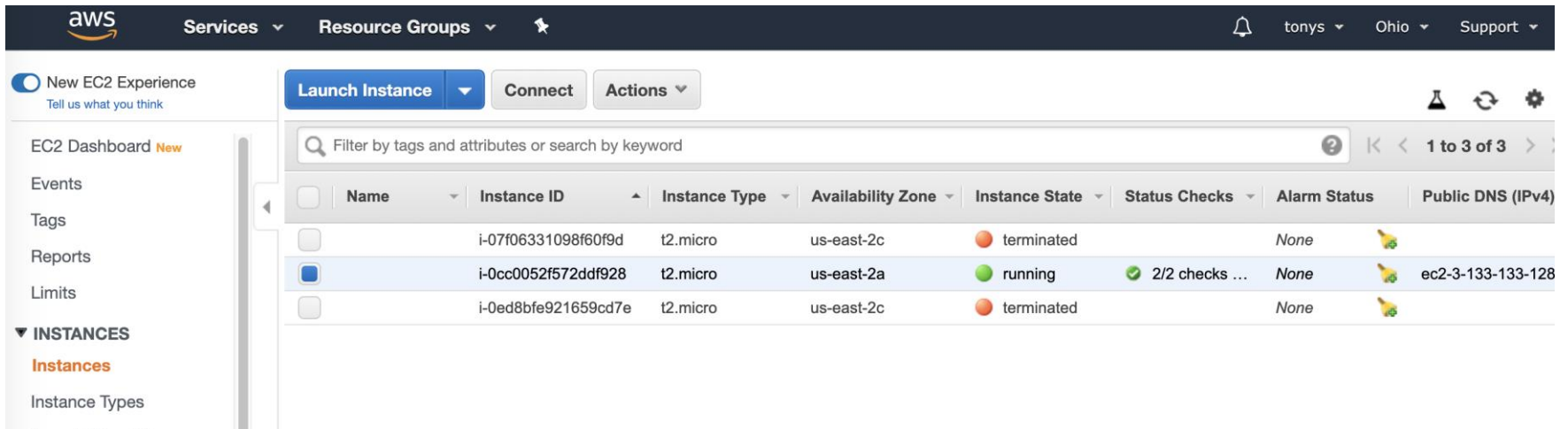
How to get my machine spec? One command for All!



Con

Test 1: Try to create Amazon Web Service VM and test its hardware

- AWS Free Tier: <https://aws.amazon.com/free/>
- <https://aws.amazon.com/education/awseducate/>
- `ssh -i "osclass.pem" ubuntu@ec2-3-133-133-128.us-east-2.compute.amazonaws.com`



The screenshot shows the AWS Management Console interface. The top navigation bar includes the AWS logo, 'Services', 'Resource Groups', and user information. The left sidebar shows the 'EC2 Dashboard' and 'INSTANCES' section. The main content area displays a table of EC2 instances. The table has columns for Name, Instance ID, Instance Type, Availability Zone, Instance State, Status Checks, Alarm Status, and Public DNS (IPv4). One instance is in the 'running' state with the public DNS address 'ec2-3-133-133-128'.

| Name | Instance ID | Instance Type | Availability Zone | Instance State | Status Checks | Alarm Status | Public DNS (IPv4) |
|------|---------------------|---------------|-------------------|----------------|----------------|--------------|-------------------|
| | i-07f06331098f60f9d | t2.micro | us-east-2c | terminated | | None | |
| | i-0cc0052f572ddf928 | t2.micro | us-east-2a | running | 2/2 checks ... | None | ec2-3-133-133-128 |
| | i-0ed8bfe921659cd7e | t2.micro | us-east-2c | terminated | | None | |



Test 2: Try to create Microsoft Azure VM and test its hardware

- Azure for Students for free:
<https://azure.microsoft.com/en-us/free/students>
- `ssh ksu@13.90.101.24`

The screenshot displays the Microsoft Azure portal interface. The top navigation bar includes the 'Microsoft Azure' logo, a search bar, and user information for 'ksuo@kennesaw.edu'. The main content area shows the details of a virtual machine named 'test'. The left sidebar contains navigation links for Overview, Activity log, Access control (IAM), Tags, Diagnose and solve problems, Settings, Networking, Disks, Size, Security, Extensions, Continuous delivery (Preview), Availability + scaling, Configuration, Identity, and Properties.

The virtual machine details page shows the following information:

- Resource group (change): test
- Status: Running
- Location: East US
- Subscription (change): Azure subscription 1
- Subscription ID: dd8ac868-cf63-4b5d-9abf-edcb82209bb5
- Computer name: test
- Operating system: Linux (ubuntu 16.04)
- Size: Standard B1s (1 vcpus, 1 GiB memory)
- Tags (change): Click here to add tags

Below the details, there are two charts: 'CPU (average)' and 'Network (total)'. The CPU chart shows a line graph with a peak around 6% usage. The Network chart shows a line graph with a peak around 4MB usage.

On the right side, a 'Connect to virtual machine' dialog box is open. It has tabs for RDP, SSH, and BASTION. The SSH tab is selected. The dialog box contains the following information:

- To improve security, enable just-in-time access on this VM. →
- IP address *: Public IP address (13.90.101.24)
- Port number *: 22
- Login using VM local account ⓘ: ssh ksu@13.90.101.24
- Having trouble connecting to this VM?
 - Diagnose and solve problems
 - Troubleshoot connection
 - Serial console
 - Reset password