Chapter 14 I/O Monitoring and Tuning - Notes

14.3 Learning Objectives:

- Understand the importance of monitoring I/O activity and when it constitutes system performance bottlenecks.
- Use **iostat** to monitor system I/O device activity.
- Use **iotop** to display a constantly updated table of current I/O usage.
- Use **ionice** to set both the **I/O scheduling class** and the **priority** for a given process.

14.4 I/O Monitoring and Disk Bottlenecks

Disk performance problems -> strongly coupled to other factors, eg. insufficient memory, inadequate network hardware/tuning. Disentanglement difficult.

Rule: system considered as **I/O-bound** when CPU found sitting idle waiting for I/O to complete, or network waiting to clear buffers.

However, can be misled. What appears to be insufficient memory can result from too slow I/O. If memory buffers being used for reading/writing fill up, may appear that memory is problem, when real problem is that buffers are not filling up or emptying out fast enough. Similarly, network transfers may be waiting for I/O to complete, causing network throughput to suffer.

Real-time monitoring + tracing -> both necessary tools for locating/mitigating disk bottlenecks. However, rare/non-repeating problems can make this difficult to accomplish.

Many relevant variables, I/O tuning complex. Will also consider **I/O scheduling** later.

14.5 iostat

iostat: basic workhorse utility for monitoring I/O device activity on system. Can generate reports with lot of information, with precise content controlled by options.

Can see below what simply typing **iostat** shows:

```
File  Edit  View  Search  Terminal  Help
c7:/tmp>iostat
Linux 4.11.3 (c7)       06/02/2017      _x86_64_        (8 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
          1.27    0.00    0.94    0.25    0.00   97.53

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
sda               0.60        32.32         0.25     509530       3908
sdb              11.76       283.35       176.27    4467320    2779108
dm-0              0.19        30.42         0.24     479617       3812
dm-1              0.07         0.33         0.00       5196         12
dm-2              0.02         0.12         0.00       1921         12
dm-3              0.03         0.15         0.00       2417         12
dm-4              0.02         0.12         0.00       1892         48
....
dm-12             1.59       118.88        74.54    1874200    1175172
loop0             0.99         1.01         0.00      16002          0

coop@c7:/tmp
c7:/tmp>
```

After brief summary of CPU utilization, I/O statistics given: **tps** (I/O transactions per second; logical requests can be **merged** into one actual request), clocks read/written per unit time, where blocks are generally sectors of 512 bytes; total blocks read/written.

Information broken out by disk partition (and if LVM is being used also by **dm**, or device mapper, logical partitions).

14.6 iostat Options

Somewhat different display generated by giving `-k` option, results in showing KB instead of blocks. Can also use `-m` to get results in MB.

```
$ iostat -k
```

```
File  Edit  View  Search  Terminal  Help
c7:/tmp>iostat -k
Linux 4.11.3 (c7)       06/02/2017      _x86_64_        (8 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
          1.30    0.00    0.94    0.27    0.00   97.48

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
sda               0.82       258.31         0.25    4211894       4064
sdb              11.96       274.27       174.60    4472104    2846868
dm-0              0.19        30.67         0.24     500021       3944
dm-1              0.07         0.32         0.00       5196         12
dm-2              0.02         0.12         0.00       1921         12
dm-3              0.03         0.15         0.00       2417         12
dm-4              0.24       225.93         0.00    3683852         72
....
dm-12             1.55       114.94        72.17    1874200    1176720
loop0             0.96         0.98         0.00      16002          0
c7:/tmp>
c7:/tmp>
```

Another useful option: `-N`, to show device name (or `-d` for somewhat different format), as shown below:

```
$ iostat -N
```

```
File  Edit  View  Search  Terminal  Help
c7:/tmp>iostat -N
Linux 4.11.3 (c7)       06/02/2017      _x86_64_        (8 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           1.29    0.00    0.94    0.27    0.00   97.49

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
sda               0.81       256.52         0.25    4219286       4108
sdb              12.05       272.67       174.42    4484900    2868920
VG2-pictures      0.19        30.85         0.24     507413       3988
VG2-dead          0.07         0.32         0.00       5196         12
VG2-iso_images    0.02         0.12         0.00       1921         12
VG2-audio         0.03         0.15         0.00       2417         12
VG2-virtual       0.24       223.97         0.00    3683852         72
VG2-w7back        0.00         0.03         0.00        456          0
VG2-P             0.00         0.00         0.00         76          0
VG2-isabelle      0.00         0.03         0.00        456          0
VG2-dead2         0.21         0.88         0.00      14489         12
VG2-PLAY          0.00         0.03         0.00        456          0
VG-local          7.02        35.91        65.06     590629    1070180
VG-src            1.27         5.85         0.44      96264       7224
VG-vms            1.54       113.95        71.56    1874200    1177052
loop0             0.95         0.97         0.00      16002          0
c7:/tmp>
c7:/tmp>
```

14.7 iostat Extended Options

Much more detailed report obtained by using `-x` option (for extended).

```
$ iostat -xk
```

```
File  Edit  View  Search  Terminal  Help
c7:/tmp>iostat -xk
Linux 4.11.3 (c7)       06/02/2017      _x86_64_        (8 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           1.30    0.00    0.94    0.27    0.00   97.49

Device:         rrqm/s   wrqm/s     r/s     w/s    rkB/s    wkB/s avgrq-sz avgqu-sz   await r_await w_await  svctm  %util
sda               0.00     0.02    0.72    0.08   251.52     0.25   630.23     0.05   63.63   58.61  109.68  25.59   2.04
sdb               0.09     4.66    5.79    6.41   267.04   174.83    72.47     0.03    2.41    0.49    4.14   0.43   0.52
dm-0              0.00     0.00    0.13    0.06    30.87     0.24   330.18     0.02  128.02  126.65  130.89  97.60   1.84
dm-1              0.00     0.00    0.07    0.00     0.31     0.00     9.36     0.00    7.93    7.64   73.20   4.19   0.03
dm-2              0.00     0.00    0.02    0.00     0.11     0.00    14.01     0.00   15.46   14.99   41.40  14.12   0.02
dm-3              0.00     0.00    0.03    0.00     0.14     0.00    11.09     0.00   36.09   36.28   19.80  12.95   0.03
dm-4              0.00     0.00    0.23    0.00   218.98     0.00  1897.46     0.02   95.29   94.75  199.20   8.82   0.20
dm-12             0.00     0.00    1.12    0.38   111.41    70.02   240.59     0.02   11.01    0.86   40.76   0.44   0.07
loop0             0.00     0.00    0.93    0.00     0.95     0.00     2.05     0.00    0.01    0.01    0.00   0.01   0.00
c7:/tmp>
c7:/tmp>
```

Fields seen above have following meanings:

Extended iostat Fields

Field	Meaning
Device	Device or partition name

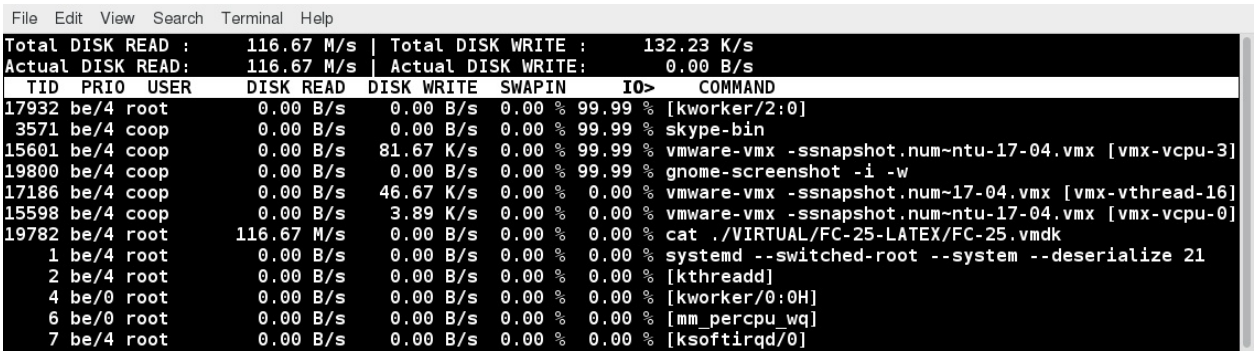
rrqm/s	Number of read requests merged per second, queued to device
w rqm/s	Number of w rite requests merged per second, queued to device
r/s	number of read requests per second, issued to device
w /s	number of w rite requests per second, issued to device
rkB/s	KB read from the device per second
w kB/s	KB w ritten to the device per second
avgrq-sz	Average request size in 512 byte sectors per second
avgqu-sz	Average queue length of requests issued to the device
aw ait	Average time (in msecs) I/O requests betw een w hen a request is issued and w hen it is completed: queue time plus service time
svctm	Average service time (in msecs) for I/O requests
%util	Percentage of CPU time during the device serviced requests

Note: if utilization percentages approaches 100, system saturated, or I/O bound.

14.8 iotop

iotop -> another very useful utility, must be run as root. Displays table of current I/O usage, updated periodically, like **top**. Can see below w hat typing `sudo iotop` w ith no options show s.

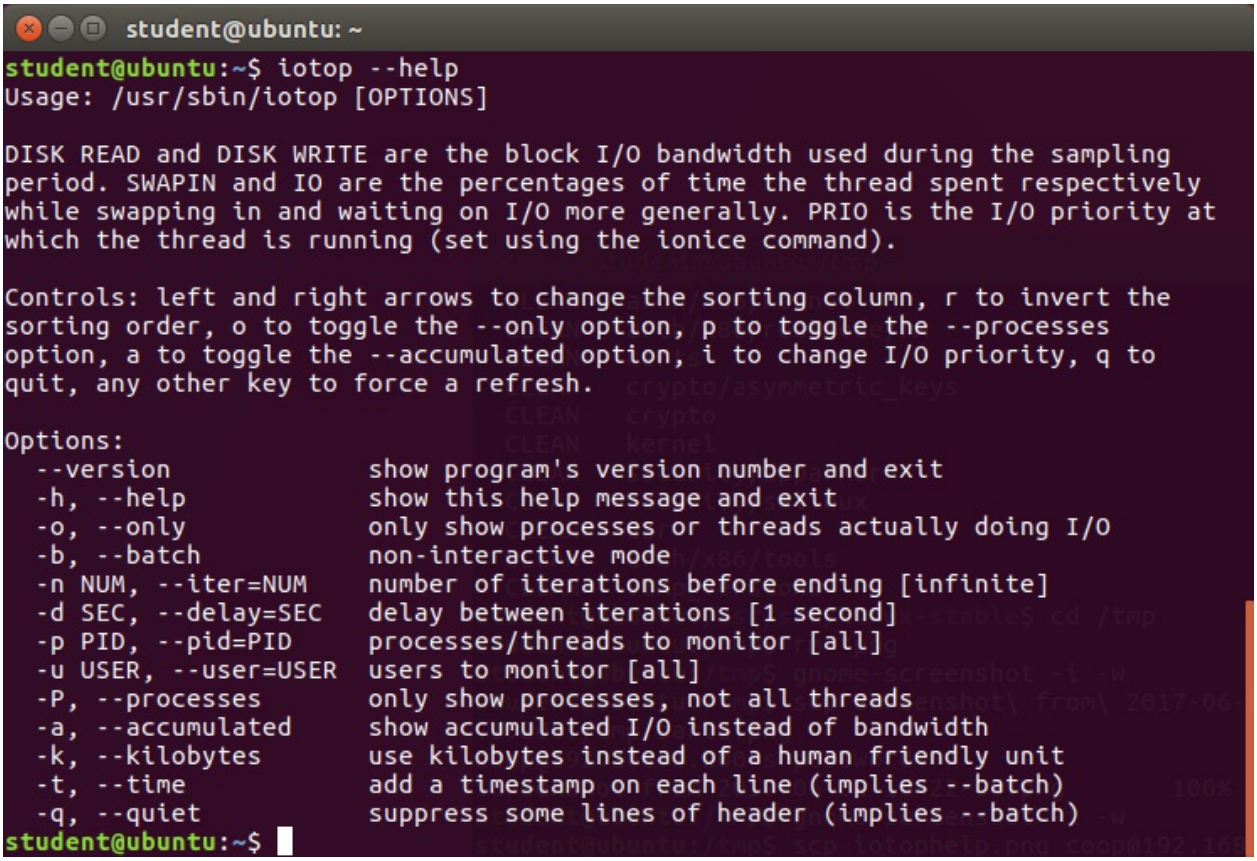
Note: `be` and `rt` entries in `PRIO` field explained in **ionice** section, stand for **best effort** and **real time**.



Available options show n by using `--help` option.

```
$ iotop --help
```

Using `-o` option can be useful to avoid clutter.



14.9 Using ionice to Set I/O Priorities

ionice utility sets both I/O **scheduling class** and **priority** for given process. Takes the form:

```
$ ionice [-c class] [-n priority] [-p pid] [COMMAND [ARGS] ]
```

If **pid** given with `-p` argument results apply to requested process, otherwise it is process that will be started by `COMMAND` with possible arguments. If no arguments given, **ionice** returns scheduling class and priority of current shell process:

```
$ ionice
idle: prio 7
```

`-c` parameter specifies I/O scheduling class, which can have following 3 values:

I/O Scheduling Class

I/O Scheduling Class	`-c` value	Meaning
None or Unknown	0	Default value
Real Time	1	Get first access to disk, can starve other processes. Priority defines how big a time slice each process gets
Best Effort	2	All programs serviced in round-robin fashion, according to priority settings. The Default

Idle	3	No access to disk I/O unless no other program has asked for it for a defined period

Best Effort and **Real Time** classes take `-n` argument which gives **priority**, which can range from 0 to 7, with 0 being highest priority:

```
$ ionice -c 2 -n 3 -p 30078
```

Note: **ionice** works only when using **CFQ** I/O Scheduler (will talk about in next chapter).

##

Back to top

Previous Chapter - Table of Contents - Next Chapter