Performance Analysis

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? (1996-2016)

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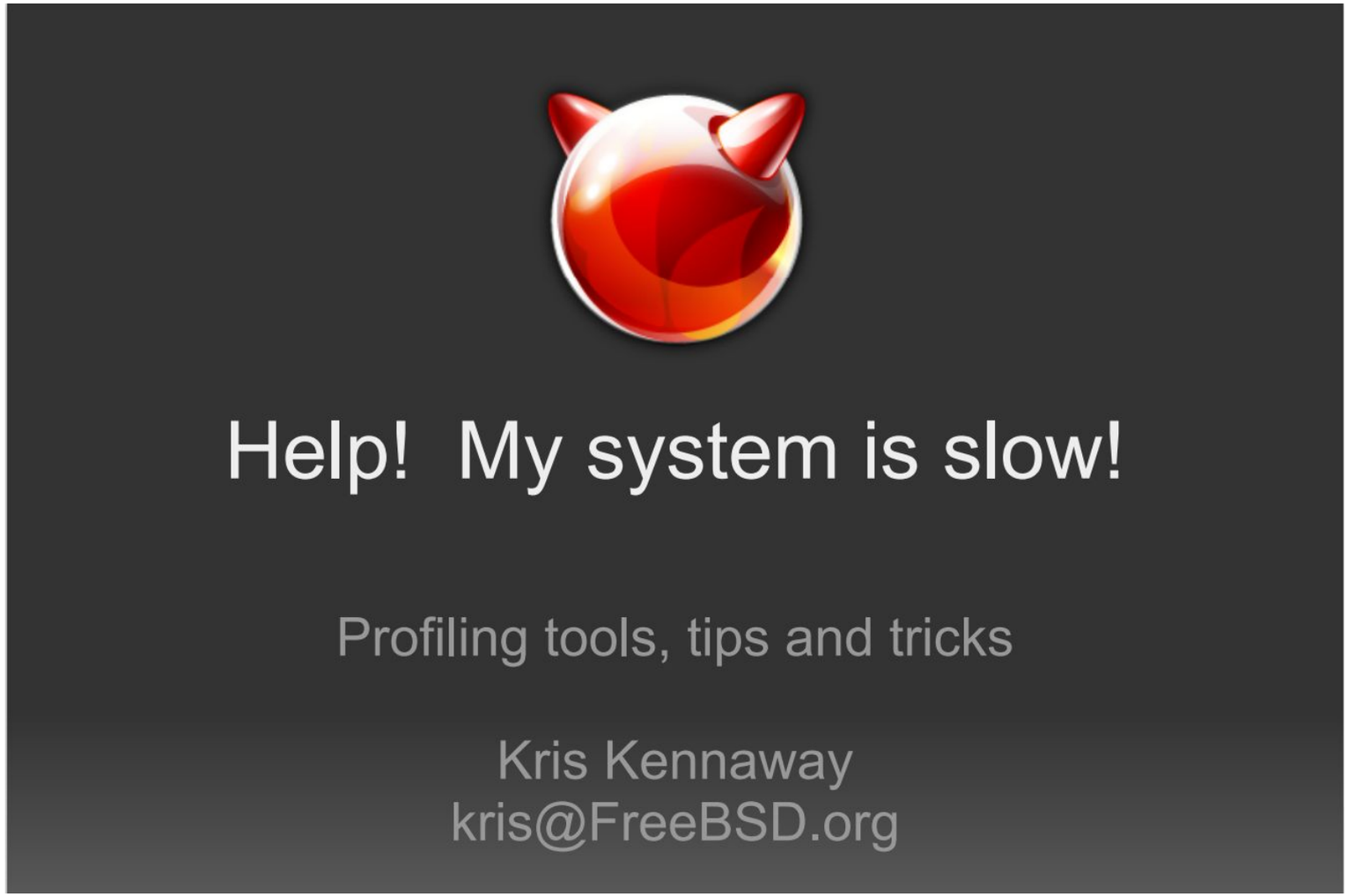
Help! My system is slow!

- https://people.freebsd.org/~kris/scaling/Help_my_system_is_slow.pdf



What you can do to improve performance

- Memory size has a major influence on performance
- Correct the problems of usage
- Load balance appliance
- Organize the system's hard disks and filesystems
- Monitoring your networks
- …

Factors that affect Performance

- Four major resources
  - CPU Time
  - Memory
  - Hard disk I/O bandwidth
  - Network I/O bandwidth
- Where is the real bottleneck
  - Not CPU, hard disk bandwidth it is !!
  - When memory is not enough, system will do swap, so memory and disk bandwidth are the major suspects

System Performance Checkup – Analyzing CPU usage (1)

- Three information of CPU
  - Overall utilization
    - Help to identify whether the CPU resource is the system bottleneck
  - Load average
  - Per-process consumption
    - Identify specific process's CPU utilization

System Performance Checkup – Analyzing CPU usage (2)

- vmstat command
  - Report kernel statistics about process, memory, cpu, ..
  - Usage: % vmstat -c 2 -w 1
    - us: user time
      - High us means high computation
    - sy: system time
      - High sy means process are making lots of system call or performing I/O
    - id: cpu idle
  - us and sy time should half-half
  - Monitoring interval should not be too small

```
$ vmstat -c 2 -w 5
procs  memory       page                    disks     faults         cpu
r b w  avm    fre   flt  re  pi  po    fr  sr da0 cd0   in    sy    cs us sy id
0 0 0 2.0T  5.7G    97   0   0   0   106   9   0   0   39   398   457  0  0 100
0 0 0 2.0T  5.7G     0   0   0   0     0  20  21   0   40   156   458  0  0 100
```

System Performance Checkup – Analyzing CPU usage (3)

- faults (average per second over last 5 seconds)
  - in: device interrupt per interval
  - sy: system calls per interval
  - cs: cpu context switch rate

- Nothing to do Server

```
$ vmstat -c 2 -w 5
procs memory         page                    disks     faults           cpu
r b w avm   fre      flt  re  pi  po  fr  sr  da0 da1   in    sy   cs   us sy id
3 2 0 50364 1587316  3    0   0   0   3   0   0   0    931   786 181   0  0  100
0 2 0 50368 1587312  5    0   0   0   0   0   0   0    250   91  23    0  0  99
```

- High load, busy http server

```
$ vmstat -c 5 -w 5
procs memory         page                    disks     faults         cpu
r b w avm    fre     flt  re  pi  po  fr  sr  da0   in    sy    cs   us sy id
0 0 0 231320 68792   320  4   0   0   264 7   0    2273 3381 952  16  4 80
0 0 0 232984 67100   558  0   0   0   386 0   1    1958 3285 551  11  5 84
1 0 0 228252 69272   192  2   0   0   292 0   5    2787 2626 681  23  4 73
1 0 0 221564 72048   102  0   0   0   229 0   0    1395 556  184   1  2 97
0 0 0 209624 76684    96  0   0   0   306 0   0    1350 935  279   0  2 97
```

System Performance Checkup – Analyzing CPU usage (4)

- Load average
  - The average number of runnable processes
    - Including processes waiting for disk or network I/O
- uptime command
  - Show how long system has been running and the load average of the system over the last 1, 5, and 15 minutes
  - Usage: % uptime

```
$ uptime
2:52AM  up 31 days,  6:48, 1 user, load averages: 0.42, 0.28, 0.22
```

System Performance Checkup – Analyzing CPU usage (5)

- top command
  - Display and update information about the top cpu processes
- ps command
  - Show process status
- renice command
  - renice -n increment -p pid
  - renice +1 987 -u daemon root -p 32

System Performance Checkup – Analyzing memory usage (1)

- When memory is not enough …
  - Memory page has to be "swapped out" to the disk block
  - LRU (Least Recently Used) algorithm
  - Bad situation – "desperation swapping"
    - Kernel forcibly swaps out runnable process
    - Extreme memory shortage

- Two numbers that quantify memory activity
  - Total amount of active virtual memory
    - Tell you the total demand for memory
  - Page rate
    - suggest the proportion of actively used memory

System Performance Checkup – Analyzing memory usage (2)

- To see amount of swap space in use
  - pstat -s or swapinfo -k (FreeBSD)
  - swapon -s (Linux)
  - swap -l (Solaris)
- pstat command
  - pstat -s

```
$ pstat -s
Device                  1K-blocks     Used  Avail       Capacity
/dev/label/swap-0         1048572        0  1048572     0%
/dev/label/swap-1         1048572        0  1048572     0%
Total                     2097144        0  2097144     0%
```

System Performance Checkup – Analyzing memory usage (3)

- vmstat command
  - procs
    - r: in run queue
    - b: blocked for resource
    - w: runnable or short sleeper but swapped
  - memory
    - avm: active virtual pages
    - fre: size of the free list
  - page (averaged each five seconds, given in units per second)
    - flt: total number of page faults
    - pi: pages paged in
    - po: pages paged out
      - 50 page-out cause about 1 seconds latency
    - fr: pages freed per second

```
$ vmstat -c 3 -w 5
procs     memory                 page                    disks
r b w     avm    fre     flt   re pi po     fr   sr da0 da1
0 3 0     1427M 1196M  224    0  0  0    312    0   0   0
0 3 0     1427M 1196M    3    0  0  0    169    0  12  12
0 3 0     1427M 1196M    3    0  0  0    110    0  15  15
```

System Performance Checkup – Analyzing disk I/O

- iostat command
  - Report I/O statistics
  - Usage: iostat -w 1 -c 5
    - tin/tout: characters read from /write to terminal
    - KB/t: kilobytes per transfer
    - tps: transfers per second
    - MB/s: megabytes per second

```
$ iostat da0 -w 1
      tty                 da0                 cpu
tin   tout     KB/t     tps      MB/s      us  ni  sy  in  id
  0   258   59.78     253     14.77       3   0   4   0   94
  0   127   63.13     501     30.89       3   0   4   0   93
  0    43   62.58     346     21.14       5   0   5   0   90
  0    42   62.40     289     17.63       3   0   5   0   92
  0    43   61.19     720     43.02       1   0   2   0   97
```

System Performance Checkup – Analyzing network

- The four most common uses of netstat
  - Monitoring the status of network connections
  - netstat -a
  - Inspecting interface configuration information
  - netstat -i

```
$ netstat -i
Name    Mtu Network       Address         Ipkts       Ierrs    Opkts     Oerrs  Coll
bge0   1500 140.113.240.0 derek        2256736153    -     3709378394   -      -
bge0   1500 192.168.7.0   192.168.7.1    1744582     -     49144622     -      -
lo0   16384 your-net      localhost       433424     -       433424     -      -
```

- Examining the routing table
  - netstat -r -n
- Viewing operational statistics for network protocols

systat

- Display system statistics
  - systat -ifstat

```
                /0   /1   /2   /3   /4   /5   /6   /7   /8   /9   /10
  Load Average   ||

   Interface           Traffic               Peak                Total
         lo0  in      0.000 KB/s          0.000 KB/s            97.325 KB
              out     0.000 KB/s          0.000 KB/s            97.325 KB

        vmx1  in      0.000 KB/s          0.000 KB/s             6.335 GB
              out     0.000 KB/s          0.000 KB/s             2.263 GB

        vmx0  in      0.000 KB/s          0.000 KB/s             2.169 GB
              out     0.000 KB/s          0.000 KB/s           289.635 MB
```

systat

- systat -vmstat

```
   1 users    Load  0.20  0.29  0.28                  Dec 20 03:13
   Mem usage:  63%Phy 60%Kmem                       VN PAGER   SWAP PAGER
Mem:        REAL               VIRTUAL                in   out     in   out
        Tot   Share      Tot    Share    Free  count
Act 209516K  16036K 2097752M   22356K   5821M  pages
All 221072K  27492K 2097781M   52088K                     ioflt  Interrupts
Proc:                                                     cow     255 total
  r   p   d   s   w   Csw  Trp  Sys  Int  Sof  Flt   6033 zfod         atkbd0 1
             41       445   5K   4K              6K       ozfod         ata0 14
                                                        %ozfod     64 cpu0:timer
25.0%Sys   0.0%Intr  0.0%User  0.0%Nice 75.0%Idle         daefr         cpu1:timer
|    |    |    |    |    |    |    |    |    |         prcfr    191 cpu2:timer
=============                                           totfr         cpu3:timer
                                        dtbuf           react         mpt0 257
Namei     Name-cache   Dir-cache    349995 desvn        pdwak         vmx0:irq0
   Calls     hits   %    hits   %    349982 numvn        pdpgs         vmx1:irq0
      18       18 100               323816 frevn        intrn
                                                    9644M wire
Disks   da0   cd0 pass0 pass1                      52764K act
KB/t   0.00  0.00  0.00  0.00                       383M inact
tps       0     0     0     0                          0 laund
MB/s   0.00  0.00  0.00  0.00                      5821M free
%busy     0     0     0     0                      55808 buf
```

*stat commands

```
$ ls -al {,/usr}{/bin,/sbin}/*stat
-r-xr-xr-x  1 root  wheel  -  49976 Jan  2 18:52 /sbin/ipfstat*
-r-xr-xr-x  1 root  wheel  -   7264 Jan  2 18:52 /sbin/kldstat*
-r-xr-sr-x  1 root  kmem   -  11872 Jan  2 18:53 /usr/bin/btsockstat*
-r-xr-sr-x  1 root  kmem   -  20432 Jan  2 18:53 /usr/bin/fstat*
-r-xr-sr-x  1 root  kmem   - 144208 Jan  2 18:53 /usr/bin/netstat*
-r-xr-xr-x  1 root  wheel  -  12352 Jan  2 18:53 /usr/bin/nfsstat*
-r-xr-xr-x  1 root  wheel  -  16912 Jan  2 18:53 /usr/bin/procstat*
-r-xr-xr-x  1 root  wheel  -  15696 Jan  2 18:53 /usr/bin/sockstat*
-r-xr-xr-x  2 root  wheel  -  15560 Jan  2 18:53 /usr/bin/stat*
-r-xr-xr-x  1 root  wheel  -  82424 Jan  2 18:53 /usr/bin/systat*
-r-xr-xr-x  1 root  wheel  -  25552 Jan  2 18:53 /usr/bin/vmstat*
-r-xr-xr-x  1 root  wheel  -  15760 Jan  2 18:53 /usr/sbin/gstat*
lrwxr-xr-x  1 root  wheel  -     21 Jan  2 18:53 /usr/sbin/hoststat@ ->
                          /usr/sbin/mailwrapper
-r-xr-x---  1 root  wheel  -  11504 Jan  2 18:53 /usr/sbin/ifmcstat*
-r-xr-xr-x  1 root  wheel  -  19808 Jan  2 18:53 /usr/sbin/iostat*
-r-xr-xr-x  1 root  wheel  -  39376 Jan  2 18:53 /usr/sbin/pmcstat*
-r-xr-xr-x  2 root  wheel  -  13040 Jan  2 18:53 /usr/sbin/pstat*
lrwxr-xr-x  1 root  wheel  -     21 Jan  2 18:53 /usr/sbin/purgestat@ ->
                          /usr/sbin/mailwrapper
-r-xr-xr-x  1 root  wheel  -  10048 Jan  2 18:53 /usr/sbin/slstat*
```

top

- top -m cpu (default)

```
last pid: 61540;  load averages:  0.30,  0.31,  0.32   up 17+09:57:18  13:57:14
242 processes: 1 running, 241 sleeping
CPU states:     % user,     % nice,     % system,     % interrupt,     % idle
Mem: 2195M Active, 7466M Inact, 1574M Wired, 21M Cache, 214M Buf, 619M Free
Swap: 2048M Total, 140K Used, 2048M Free

  PID USERNAME      THR PRI NICE   SIZE    RES STATE  C   TIME   WCPU COMMAND
26091 squid          17  44    0   414M   384M ucond  1  35:51  0.00% squid
11945 bind           11  44    0 71696K 59544K select 1  32:06  0.00% named
11375 root            1  58    0 20960K  3144K select 1   9:35  0.00% sshd
68517 nobody          1  44    0 24472K 14716K select 3   8:00  0.00% rsync
```

- top -m io

```
last pid:  9347;  load averages:  0.21,  0.29,  0.32    up 17+09:58:20  13:58:16
243 processes: 1 running, 242 sleeping
CPU states:  0.5% user,  0.0% nice,  1.2% system,  0.0% interrupt, 98.3% idle
Mem: 2200M Active, 7484M Inact, 1604M Wired, 25M Cache, 214M Buf, 562M Free
Swap: 2048M Total, 140K Used, 2048M Free

  PID USERNAME      VCSW  IVCSW   READ  WRITE  FAULT  TOTAL PERCENT COMMAND
18107 cvsup            0      0      0      0      0      0   0.00% cvsupd
26091 squid           34      0      0      0      0      0   0.00% squid
11945 bind             9      3      0      0      0      0   0.00% named
11375 root             4      0      0      0      0      0   0.00% sshd
```

Wait Channels: https://wiki.freebsd.org/WaitChannels

gstat

```
L(q)  ops/s    r/s   kBps   ms/r    w/s   kBps   ms/w   %busy Name
    0      0      0      0    0.0      0      0    0.0    0.0| acd0
    5    218    218  15756    9.3      0      0    0.0   94.0| da0
    0    111      2    214    5.0    107    933    4.3   23.4| ad4
    0    113      0      0    0.0    111    933    4.3   24.1| ad5
    0    111      2    214    5.0    107    933    4.3   23.5| ad4s1
    0    113      0      0    0.0    111    933    4.3   24.1| ad5s1
    0      0      0      0    0.0      0      0    0.0    0.0| ad6
    0      5      0      0    0.0      5     40    0.6    0.3| ad4s1a
    0      0      0      0    0.0      0      0    0.0    0.0| ad4s1b
    0      0      0      0    0.0      0      0    0.0    0.0| ad4s1c
    0    106      2    214    5.0    102    893    4.7   23.4| ad4s1d
    0      0      0      0    0.0      0      0    0.0    0.0| ad7
    0      5      0      0    0.0      5     40    0.3    0.1| ad5s1a
    0      0      0      0    0.0      0      0    0.0    0.0| ad5s1b
    0      0      0      0    0.0      0      0    0.0    0.0| ad5s1c
    0    108      0      0    0.0    106    893    4.7   24.1| ad5s1d
    0      4      0      0    0.0      4     40    0.8    0.3| mirror/gm0s1a
```