

实验报告

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1 Perf List

Perf List查看当前软硬件平台支持的性能事件列表，性能事件的属性。

```
a@ubuntu:~$ perf list
List of pre-defined events (to be used in -e):

    duration_time                                [Tool event]

    msr/tsc/                                      [Kernel PMU event]
    ref-cycles OR cpu/ref-cycles/                [Kernel PMU event]

    rNNN                                          [Raw hardware event descri
    cpu/t1=v1[,t2=v2,t3 ...]/modifier          [Raw hardware event descri
    (see 'man perf-list' on how to encode it)

    mem:<addr>[/len][:access]                   [Hardware breakpoint]

(END)
```

2 Perf Stat

Perf Stat分析性能,perf stat -a -d sleep 5会检测5秒钟内系统的性能事件。

```
root@ubuntu:/home/a#
root@ubuntu:/home/a# perf stat -a -d sleep 5

Performance counter stats for 'system wide':

      10,003.53 msec  cpu-clock                #    2.000 CPUs utilized
         1,181      context-switches          #    0.118 K/sec
           4         cpu-migrations           #    0.000 K/sec
          111       page-faults               #    0.011 K/sec
<not supported>    cycles
<not supported>    instructions
<not supported>    branches
<not supported>    branch-misses
<not supported>    L1-dcache-loads
<not supported>    L1-dcache-load-misses
<not supported>    LLC-loads
<not supported>    LLC-load-misses

      5.001897621 seconds time elapsed

root@ubuntu:/home/a#
```

3 Perf Top

实时显示系统进程的性能统计信息。

Samples: 4K of event 'cpu-clock:pppH', 4000 Hz, Event count (approx.): 910912951 lost: 0/0 drop: 0/0

Overhead	Shared Object	Symbol
23.12%	[kernel]	[k] __lock_text_start
15.03%	[kernel]	[k] vmw_cmdbuf_header_submit
8.37%	[kernel]	[k] clear_page_erms
3.59%	[kernel]	[k] exit_to_usermode_loop
2.91%	libjpeg.so.8.1.2	[.] jinit_merged_upsampler
1.95%	libjpeg.so.8.1.2	[.] jinit_arith_decoder
1.75%	libgdk_pixbuf-2.0.so.0.3611.0	[.] gdk_pixbuf_rotation_get_type
1.52%	[kernel]	[k] __softirqentry_text_start
1.24%	vmwgfx_dri.so	[.] nouveau_drm_screen_create
0.90%	Xorg	[.] ResourceClientBits
0.87%	libpixman-1.so.0.34.0	[.] _pixman_internal_only_get_implementation
0.87%	[kernel]	[k] finish_task_switch
0.83%	[kernel]	[k] mpt_put_msg_frame
0.71%	libglib-2.0.so.0.5600.4	[.] g_hash_table_lookup
0.68%	libgirepository-1.0.so.1.0.0	[.] g_type_info_get_array_type
0.65%	libc-2.27.so	[.] __strncpy_sse2_unaligned
0.65%	Xorg	[.] DeletePassiveGrabFromList
0.54%	[kernel]	[k] __do_page_fault
0.50%	[kernel]	[k] eventfd_write
0.49%	libgtk-3.so.0.2200.30	[.] gtk_css_section_get_end_position
0.46%	[kernel]	[k] kallsyms_expand_symbol.constprop.1
0.44%	[kernel]	[k] _raw_spin_lock

4 Python调试器pdb

在Python代码中，可以插入pdb.set_trace()来启动调试器。

```
j = i-1
v = array[i]
while j >= 0 and v < array[j]:
    array[j+1] = array[j]
    j -= 1
array[j+1] = v
return array

def quicksort(array):
    pdb.set_trace()
    if len(array) <= 1:
        return array
    pivot = array[0]
    left = [i for i in array[1:] if i < pivot]
    right = [i for i in array[1:] if i >= pivot]
    return quicksort(left) + [pivot] + quicksort(right)

def quicksort_inplace(array, low=0, high=None):
    if len(array) <= 1:
        return array
    if high is None:
        high = len(array)-1
    if low >= high:
        return array

    pivot = array[high]
```

```
a@ubuntu:~$ python sorts.py
> /home/a/sorts.py(26)quicksort()
-> if len(array) <= 1:
(Pdb) l
21         return array
22
23
24     def quicksort(array):
25         pdb.set_trace()
26 ->     if len(array) <= 1:
27         return array
28         pivot = array[0]
29         left = [i for i in array[1:] if i < pivot]
30         right = [i for i in array[1:] if i >= pivot]
31         return quicksort(left) + [pivot] + quicksort(right)
(Pdb)
```

在命令行中使用-m pdb 来启动调试器。

```

a@ubuntu:~$ python -m pdb sorts.py
> /home/a/sorts.py(1)<module>()
-> import random
(Pdb) l
1  -> import random
2
3
4      def test_sorted(fn, iters=1000):
5          for i in range(iters):
6              l = [random.randint(0, 100) for i in range(0, random.randint(0,
50))]
7              assert fn(l) == sorted(l)
8              # print(fn.__name__, fn(l))
9
10
11     def insertionsort(array):
(Pdb) n
> /home/a/sorts.py(4)<module>()
-> def test_sorted(fn, iters=1000):
(Pdb) l
1      import random
2
3
4  -> def test_sorted(fn, iters=1000):
5      for i in range(iters):
6          l = [random.randint(0, 100) for i in range(0, random.randint(0,
50))]
7          assert fn(l) == sorted(l)
8          # print(fn.__name__, fn(l))
9

```

5 追踪程序执行时系统调用

`sudo strace -e lstat ls -l ; /dev/null`

当这个命令执行时，`strace` 会跟踪 `ls -l` 命令执行过程中所有的 `lstat` 系统调用，并将跟踪的详细信息输出到终端。

```

a@ubuntu:~$ sudo strace -e lstat ls -l > /dev/null
lstat("Templates", {st_mode=S_IFDIR|0775, st_size=4096, ...}) = 0
lstat("compare.sh", {st_mode=S_IFREG|0664, st_size=189, ...}) = 0
lstat("gcd.sh", {st_mode=S_IFREG|0664, st_size=186, ...}) = 0
lstat("perf.data", {st_mode=S_IFREG|0600, st_size=2105924, ...}) = 0
lstat("rho.sh", {st_mode=S_IFREG|0664, st_size=329, ...}) = 0
lstat("FlameGraph-master", {st_mode=S_IFDIR|0775, st_size=4096, ...}) = 0
lstat("test.py", {st_mode=S_IFREG|0664, st_size=298, ...}) = 0
lstat("sorts.py.lprof", {st_mode=S_IFREG|0664, st_size=147, ...}) = 0
lstat("test.sh", {st_mode=S_IFREG|0775, st_size=195, ...}) = 0
lstat("2.sh", {st_mode=S_IFREG|0664, st_size=40, ...}) = 0
lstat("Desktop", {st_mode=S_IFDIR|0775, st_size=4096, ...}) = 0
lstat("Videos", {st_mode=S_IFDIR|0775, st_size=4096, ...}) = 0
lstat("sorts.py", {st_mode=S_IFREG|0600, st_size=1314, ...}) = 0
lstat("Music", {st_mode=S_IFDIR|0775, st_size=4096, ...}) = 0
lstat("Public", {st_mode=S_IFDIR|0775, st_size=4096, ...}) = 0
lstat("1.sh", {st_mode=S_IFREG|0664, st_size=52, ...}) = 0
lstat("Documents", {st_mode=S_IFDIR|0775, st_size=4096, ...}) = 0
lstat("Downloads", {st_mode=S_IFDIR|0775, st_size=4096, ...}) = 0
lstat("prime.sh", {st_mode=S_IFREG|0664, st_size=400, ...}) = 0
lstat("Pictures", {st_mode=S_IFDIR|0775, st_size=4096, ...}) = 0
lstat("nar.sh", {st_mode=S_IFREG|0664, st_size=191, ...}) = 0
+++ exited with 0 +++

```

6 cProfile

cProfile列出了每个函数的调用次数、总时间、累计时间等统计信息。

```

a@ubuntu:~$ python -m cProfile sorts.py
395968 function calls (330188 primitive calls) in 0.157 seconds

Ordered by: standard name

ncalls  tottime  percall  cumtime  percall filename:lineno(function)
      1     0.000      0.000      0.000      0.000 __future__.py:48(<module>)
      1     0.000      0.000      0.000      0.000 __future__.py:74(_Feature)
       7     0.000      0.000      0.000      0.000 __future__.py:75(__init__)
       6     0.000      0.000      0.000      0.000 hashlib.py:100(__get_openssl_con
structor)
       1     0.001      0.001      0.001      0.001 hashlib.py:56(<module>)
       1     0.000      0.000      0.000      0.000 random.py:100(seed)
    77817     0.045      0.000      0.049      0.000 random.py:177(randrange)
    77817     0.017      0.000      0.066      0.000 random.py:240(randint)
       1     0.000      0.000      0.002      0.002 random.py:40(<module>)
       1     0.000      0.000      0.000      0.000 random.py:657(WichmannHill)
       1     0.000      0.000      0.000      0.000 random.py:72(Random)
       1     0.000      0.000      0.000      0.000 random.py:807(SystemRandom)
       1     0.000      0.000      0.000      0.000 random.py:91(__init__)
       1     0.000      0.000      0.157      0.157 sorts.py:1(<module>)
    1000     0.014      0.000      0.014      0.000 sorts.py:11(insertionsort)
32916/1000     0.025      0.000      0.027      0.000 sorts.py:23(quick sort)
34864/1000     0.023      0.000      0.026      0.000 sorts.py:32(quick sort_inplace)
       3     0.017      0.006      0.155      0.052 sorts.py:4(test_sorted)
       1     0.000      0.000      0.000      0.000 {_hashlib.openssl_md5}

```

7 memory_profiler

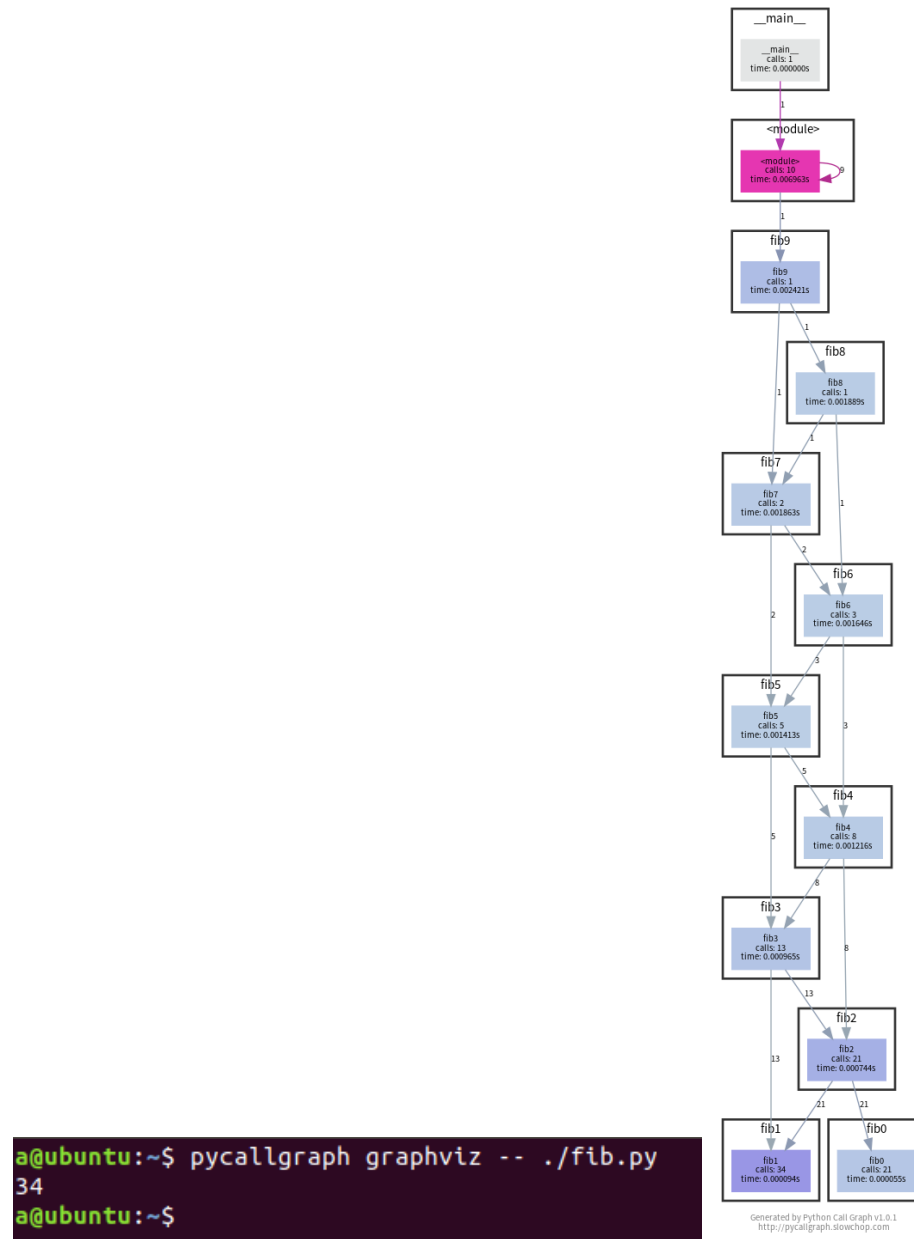
memory_profiler检查内存消耗

```
a@ubuntu:~$ python -m memory_profiler sorts.py

Filename: sorts.py

Line #    Mem usage    Increment    Line Contents
=====
     9    13.867 MiB    13.867 MiB    @profile
    10                def insertionsort(array):
    11
    12    13.867 MiB    0.000 MiB        for i in range(len(array)):
    13    13.867 MiB    0.000 MiB            j = i-1
    14    13.867 MiB    0.000 MiB            v = array[i]
    15    13.867 MiB    0.000 MiB            while j >= 0 and v < array[j]:
    16    13.867 MiB    0.000 MiB                array[j+1] = array[j]
    17    13.867 MiB    0.000 MiB                j -= 1
    18    13.867 MiB    0.000 MiB            array[j+1] = v
    19    13.867 MiB    0.000 MiB        return array
```

8 绘制python调用关系图



9 htop进程查看器

1 [] 2.40s Tasks: 139, 302 thr; 1 running											
Mem [] 4.73% Load average: 0.16 0.08 0.09											
Swap [] 1.39G/7.81G Uptime: 00:17:18											
0K/472K											
PID	USER	PRI	NI	U162	RES	SHR	S	CRUS	MEMS	TIME	Command
4698	a	20	0	37484	6704	3704	B	0-7	0-3	0:00.45	htop
1	root	20	0	1568	112	644	S	0-0	0-2	0:02.49	/sbin/init auto noprompt
358	root	19	0	1888	3816	3812	S	0-0	0-8	0:00.32	/lib/systemd/systemd-journald
384	root	20	0	47880	0004	204	S	0-0	0-2	0:00.24	/lib/systemd/systemd-udev
433	root	20	0	1558	252	0	S	0-0	0-0	0:00.00	vmware-vmblock-fuse /run/vmblock-fuse -o rw,subtype=vmware-vmblock,default_permissions,allow_other,dev,suid
434	root	20	0	1558	252	0	S	0-0	0-0	0:00.00	vmware-vmblock-fuse /run/vmblock-fuse -o rw,subtype=vmware-vmblock,default_permissions,allow_other,dev,suid
432	root	20	0	1558	252	0	S	0-0	0-0	0:00.00	vmware-vmblock-fuse /run/vmblock-fuse -o rw,subtype=vmware-vmblock,default_permissions,allow_other,dev,suid
551	systemd-r	20	0	7492	104	640	S	0-0	0-1	0:00.03	/lib/systemd/systemd-resolved
577	systemd-t	20	0	1428	060	592	S	0-0	0-1	0:00.00	/lib/systemd/systemd-timesyncd
552	systemd-t	20	0	1428	060	592	S	0-0	0-1	0:00.02	/lib/systemd/systemd-timesyncd
644	root	20	0	8292	1040	976	S	0-3	0:00.04	/usr/bin/VGAuthService	
701	root	0	20	2248	496	464	S	0-0	0-2	0:00.05	/usr/bin/vmtouch
894	root	0	20	2248	496	464	S	0-0	0-2	0:00.00	/usr/bin/vmtouch
651	root	0	20	2248	496	464	S	0-0	0-2	0:01.28	/usr/bin/vmtouch
764	root	20	0	1078	516	188	S	0-0	0-1	0:00.00	/usr/bin/lrqlbalance --foreground
761	root	20	0	1078	516	188	S	0-0	0-1	0:00.04	/usr/bin/lrqlbalance --foreground
762	messagebu	20	0	1692	268	088	S	0-0	0-2	0:00.42	/usr/bin/dbus-daemon --system --address=systemd: --nofork --nopidfile --systemd-activation --syslog-only
766	root	20	0	1576	892	152	S	0-0	0-1	0:00.07	/lib/systemd/systemd-logind
767	avahi	20	0	4268	292	956	S	0-0	0-1	0:00.07	avahi-daemon: running [ubuntu.local]
768	root	20	0	1692	628	832	S	0-0	0-2	0:00.03	/usr/sbin/cupsd -l
769	avahi	20	0	1084	336	0	S	0-0	0-0	0:00.00	avahi-daemon: chroot helper
774	root	20	0	2828	200	240	S	0-0	0-2	0:00.03	/usr/lib/accounts-service/accounts-daemon
780	root	20	0	2828	200	240	S	0-0	0-2	0:00.01	/usr/lib/accounts-service/accounts-daemon
770	root	20	0	832	280	240	S	0-0	0-2	0:00.00	/usr/lib/accounts-service/accounts-daemon
782	root	20	0	4560	804	740	S	0-0	0-0	0:00.03	/usr/sbin/acpid
773	root	20	0	1688	120	840	S	0-0	0-1	0:00.00	/usr/sbin/cron -f
785	root	20	0	4240	796	752	S	0-0	0-1	0:00.01	/sbin/wpa_supplicant -u -s -O /run/wpa_supplicant
1131	root	20	0	13788	3944	2308	S	0-0	0-8	0:00.04	/usr/lib/snmpd/snmpd
1137	root	20	0	13788	3944	2308	S	0-0	0-8	0:00.13	/usr/lib/snmpd/snmpd
1138	root	20	0	13788	3944	2308	S	0-0	0-8	0:00.07	/usr/lib/snmpd/snmpd
1139	root	20	0	13788	3944	2308	S	0-0	0-8	0:00.00	/usr/lib/snmpd/snmpd
1140	root	20	0	13788	3944	2308	S	0-0	0-8	0:00.00	/usr/lib/snmpd/snmpd
1180	root	20	0	13788	3944	2308	S	0-0	0-8	0:00.01	/usr/lib/snmpd/snmpd
1206	root	20	0	13788	3944	2308	S	0-0	0-8	0:00.29	/usr/lib/snmpd/snmpd
1275	root	20	0	13788	3944	2308	S	0-0	0-8	0:00.31	/usr/lib/snmpd/snmpd
1278	root	20	0	13788	3944	2308	S	0-0	0-8	0:00.12	/usr/lib/snmpd/snmpd
788	root	20	0	13788	3944	2308	S	0-0	0-8	0:01.07	/usr/lib/snmpd/snmpd
861	root	20	0	5478	1948	1084	S	0-0	0-4	0:00.01	/usr/sbin/NetworkManager --no-daemon
865	root	20	0	5478	1948	1084	S	0-0	0-4	0:00.03	/usr/sbin/NetworkManager --no-daemon
789	root	20	0	5478	1948	1084	S	0-0	0-4	0:00.19	/usr/sbin/NetworkManager --no-daemon
883	systemd	20	0	2568	516	440	S	0-0	0-1	0:00.02	/usr/sbin/syslogd -n
884	syslog	20	0	2568	516	440	S	0-0	0-1	0:00.00	/usr/sbin/syslogd -n
885	syslog	20	0	2568	516	440	S	0-0	0-1	0:00.02	/usr/sbin/syslogd -n
790	syslog	20	0	2568	516	440	S	0-0	0-1	0:00.00	/usr/sbin/syslogd -n

10 journalctl

journalctl命令来获取最近一天中超级用户的登录信息及其所执行的指令

```
ubuntu:~$ journalctl
-- Logs begin at Thu 2024-09-05 20:01:46 PDT, end at Fri 2024-09-13 23:06:53 PDT.
9月 05 20:01:46 ubuntu kernel: Linux version 5.4.0-150-generic (buildd@bos03-and
9月 05 20:01:46 ubuntu kernel: Command line: BOOT_IMAGE=/boot/vmlinuz-5.4.0-150-
9月 05 20:01:46 ubuntu kernel: KERNEL supported cpus:
9月 05 20:01:46 ubuntu kernel: Intel GenuineIntel
9月 05 20:01:46 ubuntu kernel: AMD AuthenticAMD
9月 05 20:01:46 ubuntu kernel: Hygon HygonGenuine
9月 05 20:01:46 ubuntu kernel: Centaur CentaurHauls
9月 05 20:01:46 ubuntu kernel: zhaoxin Shanghai
9月 05 20:01:46 ubuntu kernel: x86/fpu: Supporting XSAVE feature 0x001: 'x87 flo
9月 05 20:01:46 ubuntu kernel: x86/fpu: Supporting XSAVE feature 0x002: 'SSE reg
9月 05 20:01:46 ubuntu kernel: x86/fpu: Supporting XSAVE feature 0x004: 'AVX reg
9月 05 20:01:46 ubuntu kernel: x86/fpu: Supporting XSAVE feature 0x200: 'Protect
9月 05 20:01:46 ubuntu kernel: x86/fpu: xstate offset[2]: 576, xstate sizes[2]:
9月 05 20:01:46 ubuntu kernel: x86/fpu: xstate_offset[9]: 832, xstate_sizes[9]:
9月 05 20:01:46 ubuntu kernel: x86/fpu: Enabled xstate features 0x207, context s
9月 05 20:01:46 ubuntu kernel: BIOS-provided physical RAM map:
9月 05 20:01:46 ubuntu kernel: BIOS-e820: [mem 0x0000000000000000-0x000000000000
9月 05 20:01:46 ubuntu kernel: BIOS-e820: [mem 0x00000000000009e800-0x000000000000
9月 05 20:01:46 ubuntu kernel: BIOS-e820: [mem 0x000000000000dc000-0x000000000000
9月 05 20:01:46 ubuntu kernel: BIOS-e820: [mem 0x00000000000100000-0x000000000bfc
9月 05 20:01:46 ubuntu kernel: BIOS-e820: [mem 0x000000000bfed0000-0x000000000bfef
9月 05 20:01:46 ubuntu kernel: BIOS-e820: [mem 0x000000000bfeff000-0x000000000bfef
lines 1-23... skipping...
-- Logs begin at Thu 2024-09-05 20:01:46 PDT, end at Fri 2024-09-13 23:06:53 PDT. --
9月 05 20:01:46 ubuntu kernel: Linux version 5.4.0-150-generic (buildd@bos03-and64-012) (gcc version 7.5.0 (Ubuntu 7.5.0-3ubuntu1))
9月 05 20:01:46 ubuntu kernel: Command line: BOOT_IMAGE=/boot/vmlinuz-5.4.0-150-generic root=UUID=c2155a75-5d05-43c4-8296-2ed
9月 05 20:01:46 ubuntu kernel: KERNEL supported cpus:
9月 05 20:01:46 ubuntu kernel: Intel GenuineIntel
9月 05 20:01:46 ubuntu kernel: AMD AuthenticAMD
9月 05 20:01:46 ubuntu kernel: Hygon HygonGenuine
9月 05 20:01:46 ubuntu kernel: Centaur CentaurHauls
9月 05 20:01:46 ubuntu kernel: zhaoxin Shanghai
9月 05 20:01:46 ubuntu kernel: x86/fpu: Supporting XSAVE feature 0x001: 'x87 floating point registers'
9月 05 20:01:46 ubuntu kernel: x86/fpu: Supporting XSAVE feature 0x002: 'SSE registers'
9月 05 20:01:46 ubuntu kernel: x86/fpu: Supporting XSAVE feature 0x004: 'AVX registers'
```

11 valgrind内存泄漏检查

-leak-check=full 执行全面的内存泄漏检查

-show-leak-kinds=all 显示所有类型的内存泄漏。

-track-origins=yes 跟踪未初始化值的来源。

```
a@ubuntu:~$ valgrind --leak-check=full --show-leak-kinds=all --track-origins=yes ./t
==3708== Memcheck, a memory error detector
==3708== Copyright (C) 2002-2017, and GNU GPL'd, by Julian Seward et al.
==3708== Using Valgrind-3.13.0 and LibVEX; rerun with -h for copyright info
==3708== Command: ./test
==3708==
ptr [0x(nil)]
==3708== Invalid write of size 4
==3708==    at 0x10867D: main (in /home/a/test)
==3708== Address 0x0 is not stack'd, malloc'd or (recently) free'd
==3708==
==3708== Process terminating with default action of signal 11 (SIGSEGV)
==3708== Access not within mapped region at address 0x0
==3708==    at 0x10867D: main (in /home/a/test)
==3708== If you believe this happened as a result of a stack
==3708== overflow in your program's main thread (unlikely but
==3708== possible), you can try to increase the size of the
==3708== main thread stack using the --main-stacksize= flag.
==3708== The main thread stack size used in this run was 8388608.
==3708==
==3708== HEAP SUMMARY:
==3708==    in use at exit: 0 bytes in 0 blocks
==3708==   total heap usage: 1 allocs, 1 frees, 1,024 bytes allocated
==3708==
==3708== All heap blocks were freed -- no leaks are possible
==3708==
==3708== For counts of detected and suppressed errors, rerun with: -v
==3708== ERROR SUMMARY: 1 errors from 1 contexts (suppressed: 0 from 0)
段错误 (核心已转储)
```

12 iostat

显示自系统启动以来的CPU 和磁盘统计报告

```
a@ubuntu:~$ iostat
Linux 5.4.0-150-generic (ubuntu)      2024年09月13日  _x86_64_      (2 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
            1.01    0.14   1.66    0.08    0.00   97.11

Device            tps    kB_read/s    kB_wrtn/s    kB_read  kB_wrtn
loop0              0.01         0.02         0.00         47         0
loop1              0.02         0.16         0.00        334         0
loop2              0.02         0.50         0.00       1064         0
loop3              0.02         0.05         0.00        115         0
loop4              0.01         0.02         0.00         44         0
loop5              0.01         0.02         0.00         45         0
loop6              0.00         0.00         0.00          4         0
loop7              0.02         0.05         0.00        109         0
sda                12.89       439.12       282.41     926225    595684
loop8              0.02         0.05         0.00        110         0
loop9              0.03         0.50         0.00       1058         0
loop10             0.03         0.50         0.00       1048         0
loop11             0.03         0.50         0.00       1054         0
loop12             0.02         0.16         0.00        340         0
loop13             0.03         0.51         0.00       1070         0
loop14             0.02         0.05         0.00        110         0
loop15             0.02         0.16         0.00        328         0
loop16             0.02         0.16         0.00        332         0
loop17             6.90         7.38         0.00     15569         0
loop18             0.00         0.00         0.00          8         0

a@ubuntu:~$
```

显示CPU 使用情况和磁盘I/O 统计信息

```
a@ubuntu:~$ iostat -c
Linux 5.4.0-150-generic (ubuntu)      2024年09月13日  _x86_64_      (2 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
            0.95    0.13   1.57    0.08    0.00   97.27
```

显示自系统启动以来的统计信息

```

a@ubuntu:~$ iostat -d -t
Linux 5.4.0-150-generic (ubuntu)      2024年09月13日  _x86_64_      (2 CPU)

2024年09月13日 23时43分17秒
Device            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
loop0              0.01      0.02         0.00         47         0
loop1              0.02      0.15         0.00        334         0
loop2              0.02      0.46         0.00       1064         0
loop3              0.02      0.05         0.00        115         0
loop4              0.01      0.02         0.00         44         0
loop5              0.01      0.02         0.00         45         0
loop6              0.00      0.00         0.00          4         0
loop7              0.01      0.05         0.00        109         0
sda                11.97     403.92      260.44    926225    597200
loop8              0.02      0.05         0.00        110         0
loop9              0.03      0.46         0.00       1058         0
loop10             0.02      0.46         0.00       1048         0
loop11             0.02      0.46         0.00       1054         0
loop12             0.02      0.15         0.00        340         0
loop13             0.02      0.47         0.00       1070         0
loop14             0.02      0.05         0.00        110         0
loop15             0.02      0.14         0.00        328         0
loop16             0.02      0.14         0.00        332         0
loop17             6.35      6.79         0.00     15569         0
loop18             0.00      0.00         0.00          8         0

```

13 dstat

dstat显示了cpu使用情况，磁盘io情况，网络发包情况和换页情况，输出是彩色的，可读性较强，相对于vmstat和iostat的输入更加详细且较为直观。

```
a@ubuntu:~$ dstat
You did not select any stats, using -cdngy by default.
--total-cpu-usage-- -dsk/total- -net/total- ---paging-- ---system--
usr sys idl wai stl | read | writ | recv | send | in | out | int | csw
3 21 75 1 0 | 9131k | 284k | 0 | 0 | 0 | 0 | 1230 | 3125
1 4 95 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 792 | 1589
0 0 100 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 204 | 338
0 1 99 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 132 | 228
2 0 98 1 0 | 0 | 60k | 0 | 0 | 0 | 0 | 134 | 234
3 1 97 0 0 | 156k | 0 | 0 | 0 | 0 | 0 | 181 | 295
7 1 92 0 0 | 2280k | 0 | 0 | 0 | 0 | 0 | 193 | 377
0 1 100 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 117 | 196
0 2 99 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 143 | 227
0 1 99 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 139 | 217
1 0 99 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 113 | 179
1 2 98 0 0 | 0 | 4112k | 0 | 0 | 0 | 0 | 160 | 232
1 0 99 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 107 | 184
1 1 99 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 85 | 195
2 1 98 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 87 | 206
0 1 99 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 180
1 1 98 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 221 | 363
0 1 99 0 0 | 0 | 328k | 0 | 0 | 0 | 0 | 273 | 451
0 1 99 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 112 | 188
0 1 99 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 141 | 238
1 0 99 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 93 | 194
1 1 99 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 106 | 229
0 1 99 0 0 | 28k | 456k | 0 | 0 | 0 | 0 | 141 | 238
0 1 99 0 0 | 0 | 84k | 0 | 0 | 0 | 0 | 84 | 177
1 0 99 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 132 | 229
1 1 99 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 80 | 163
0 0 100 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 80 | 176
--total-cpu-usage-- -dsk/total- -net/total- ---paging-- ---system--
```

14 mpstat

mpstat用于监控CPU 利用率和性能统计的命令行工具。

```
a@ubuntu:~$ mpstat
Linux 5.4.0-150-generic (ubuntu)      2024年09月14日  _x86_64_      (2 CPU)

04时35分03秒  CPU    %usr   %nice    %sys %iowait    %irq   %soft  %steal  %guest  %gnice
%idle
04时35分03秒  all     1.15    0.08    3.38    0.21    0.00    0.20    0.00    0.00    0.00
94.98
a@ubuntu:~$
```

15 ps

ps 是Linux 系统中用于监控活动进程的命令行工具。它显示系统中正在运行的进程及其相关信息

```
a@ubuntu:~$ ps
```

PID	TTY	TIME	CMD
1810	pts/0	00:00:00	bash
3450	pts/0	00:00:00	ps

ps后可以跟不同参数。
列出所有系统上的进程

```
a@ubuntu:~$ ps -A
```

PID	TTY	TIME	CMD
1	?	00:00:02	systemd
2	?	00:00:00	kthreadd
3	?	00:00:00	rcu_gp
4	?	00:00:00	rcu_par_gp
6	?	00:00:00	kworker/0:0H-kb
8	?	00:00:00	mm_percpu_wq
9	?	00:00:00	ksoftirqd/0
10	?	00:00:00	rcu_sched
11	?	00:00:00	migration/0
12	?	00:00:00	idle_inject/0
14	?	00:00:00	cpuhp/0
15	?	00:00:00	cpuhp/1
16	?	00:00:00	idle_inject/1
17	?	00:00:00	migration/1
18	?	00:00:00	ksoftirqd/1
20	?	00:00:00	kworker/1:0H-kb
21	?	00:00:00	kdevtmpfs
22	?	00:00:00	netns
23	?	00:00:00	rcu_tasks_kthre
24	?	00:00:00	kauditd
26	?	00:00:00	khungtaskd
27	?	00:00:00	oom_reaper
28	?	00:00:00	writeback

列出当前用户的进程

```

a@ubuntu:~$ ps -x
  PID TTY          STAT       TIME COMMAND
 1366 ?            Ss          0:00 /lib/systemd/systemd --user
 1367 ?            S            0:00 (sd-pam)
 1380 ?            Sl           0:00 /usr/bin/gnome-keyring-daemon --daemonize --login
 1384 tty2         Ssl+        0:00 /usr/lib/gdm3/gdm-x-session --run-script env GNOME_S
 1386 tty2         Rl+         0:06 /usr/lib/xorg/Xorg vt2 -displayfd 3 -auth /run/user/
 1390 ?            Ss          0:00 /usr/bin/dbus-daemon --session --address=systemd: --
 1393 tty2         Sl+         0:00 /usr/lib/gnome-session/gnome-session-binary --sessio
 1470 ?            Ss          0:00 /usr/bin/ssh-agent /usr/bin/im-launch env GNOME_SHEL
 1472 ?            Ssl         0:00 /usr/lib/at-spi2-core/at-spi-bus-launcher
 1477 ?            S            0:00 /usr/bin/dbus-daemon --config-file=/usr/share/default
 1479 ?            Sl           0:00 /usr/lib/at-spi2-core/at-spi2-registryd --use-gnome-
 1496 tty2         Rl+         0:14 /usr/bin/gnome-shell
 1502 ?            Ssl         0:00 /usr/lib/gvfs/gvfsd
 1507 ?            Sl           0:00 /usr/lib/gvfs/gvfsd-fuse /run/user/1000/gvfs -f -o b
 1518 ?            S<l         0:00 /usr/bin/pulseaudio --start --log-target=syslog
 1530 tty2         Sl           0:00 ibus-daemon --xim --panel disable
 1534 tty2         Sl           0:00 /usr/lib/ibus/ibus-dconf
 1535 ?            Ssl         0:00 /usr/libexec/xdg-permission-store
 1540 tty2         Sl           0:00 /usr/lib/ibus/ibus-x11 --kill-daemon

```

以用户为中心的格式显示进程信息

```

a@ubuntu:~$ ps -u
USER          PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
a             1384  0.0  0.1 206912  6080 tty2    Ssl+  04:31   0:00 /usr/lib/gdm3/gdm-x-sess
a             1386  0.4  1.5 403364  63796 tty2    Sl+   04:31   0:06 /usr/lib/xorg/Xorg vt2 -
a             1393  0.0  0.3 701968 14892 tty2    Sl+   04:31   0:00 /usr/lib/gnome-session/g
a             1496  1.0  5.1 3458104 205960 tty2    Rl+   04:31   0:15 /usr/bin/gnome-shell
a             1530  0.0  0.2 356396  8128 tty2    Sl    04:31   0:00 ibus-daemon --xim --pane
a             1534  0.0  0.1 275652  6888 tty2    Sl    04:31   0:00 /usr/lib/ibus/ibus-dconf
a             1540  0.0  0.5 340064  22168 tty2    Sl    04:31   0:00 /usr/lib/ibus/ibus-x11 -
a             1586  0.0  0.5 513076  23512 tty2    Sl+   04:31   0:00 /usr/lib/gnome-settings-
a             1588  0.0  0.2 344276  10172 tty2    Sl+   04:31   0:00 /usr/lib/gnome-settings-
a             1590  0.0  0.1 418156  6024 tty2    Sl+   04:31   0:00 /usr/lib/gnome-settings-
a             1599  0.0  0.1 270544  5860 tty2    Sl+   04:31   0:00 /usr/lib/gnome-settings-
a             1600  0.0  0.2 447640  9336 tty2    Sl+   04:31   0:00 /usr/lib/gnome-settings-
a             1604  0.0  0.2 373000  8320 tty2    Sl+   04:31   0:00 /usr/lib/gnome-settings-
a             1605  0.0  0.2 329896  8296 tty2    Sl+   04:31   0:00 /usr/lib/gnome-settings-
a             1613  0.0  0.5 489900  23284 tty2    Sl+   04:31   0:00 /usr/lib/gnome-settings-
a             1618  0.0  0.5 498160  22340 tty2    Sl+   04:31   0:00 /usr/lib/gnome-settings-
a             1624  0.0  0.1 273084  5884 tty2    Sl+   04:31   0:00 /usr/lib/gnome-settings-
a             1625  0.0  0.5 339596  21480 tty2    Sl+   04:31   0:00 /usr/lib/gnome-settings-
a             1628  0.0  0.6 654720  24108 tty2    Sl+   04:31   0:00 /usr/lib/gnome-settings-
a             1632  0.0  0.3 464660  13744 tty2    Sl+   04:31   0:00 /usr/lib/gnome-settings-
a             1633  0.0  0.1 359376  7336 tty2    Sl+   04:31   0:00 /usr/lib/gnome-settings-
a             1634  0.0  0.5 502620  23116 tty2    Sl+   04:31   0:00 /usr/lib/gnome-settings-
a             1640  0.0  0.6 1077812 24884 tty2    Sl+   04:31   0:00 /usr/lib/gnome-settings-
a             1642  0.0  0.1 273088  5844 tty2    Sl+   04:31   0:00 /usr/lib/gnome-settings-
a             1662  0.0  0.3 503584  12860 tty2    Sl+   04:31   0:00 /usr/lib/gnome-settings-

```

16 strace

strace 是一个在Linux 中用于追踪系统调用、信号和其他相关信息的强大工具。

```

a@ubuntu:~$ strace ls
execve("/bin/ls", ["ls"], 0x7ffc7788ff80 /* 62 vars */) = 0
brk(NULL) = 0x55b238b4c000
access("/etc/ld.so.nohwcap", F_OK) = -1 ENOENT (No such file or directory)
access("/etc/ld.so.preload", R_OK) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3
fstat(3, {st_mode=S_IFREG|0644, st_size=66999, ...}) = 0
mmap(NULL, 66999, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7f9352adc000
close(3) = 0
access("/etc/ld.so.nohwcap", F_OK) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libselinux.so.1", O_RDONLY|O_CLOEXEC) = 3
read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\0\3\0-\0\1\0\0\0\20b\0\0\0\0\0"... , 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=154832, ...}) = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f9352ada000
mmap(NULL, 2259152, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f935269c000
mprotect(0x7f93526c1000, 2093056, PROT_NONE) = 0
mmap(0x7f93528c0000, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x24000) = 0x7f93528c0000
mmap(0x7f93528c2000, 6352, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7f93528c2000
close(3) = 0
access("/etc/ld.so.nohwcap", F_OK) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC) = 3
read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\0\3\0-\0\1\0\0\0\240\35\2\0\0\0\0"... , 832) = 832
fstat(3, {st_mode=S_IFREG|0755, st_size=2030928, ...}) = 0
mmap(NULL, 4131552, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f93522ab000
mprotect(0x7f9352492000, 2097152, PROT_NONE) = 0
mmap(0x7f9352692000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1e7000) = 0x7f9352692000
mmap(0x7f9352698000, 15072, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7f9352698000
close(3) = 0
access("/etc/ld.so.nohwcap", F_OK) = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libpcr.so.3", O_RDONLY|O_CLOEXEC) = 3
read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\0\3\0-\0\1\0\0\0\25\0\0\0\0\0"... , 832) = 832
fstat(3, {st_mode=S_IFREG|0644, st_size=460728, ...}) = 0

```

17 uptime

uptime 是Linux 系统中一个简单的命令，用于显示系统运行了多长时间，包括系统上一次启动以来的时间、当前时间、登录的用户数量以及过去1、5 和15 分钟的系统负载平均值。

```

a@ubuntu:~$ uptime
 05:12:19 up 44 min,  1 user,  load average: 0.07, 0.03, 0.01
a@ubuntu:~$

```

显示系统启动以来的日期和时间

```

a@ubuntu:~$ uptime -s
2024-09-14 04:28:09
a@ubuntu:~$

```

18 lsof

lsof用于列出由进程、用户或特定文件系统打开的文件。
lsof 显示系统中所有进程打开的文件列表


```
138365 /lib/x86_64-linux-gnu/libkeyutils.so.1.5
pool 1746 1762 a mem REG 8,1 1237640 1029 /usr/lib/x86_64-linux-gnu/lib
p11-kit.so.0.3.0
pool 1746 1762 a mem REG 8,1 206904 4809 /usr/lib/x86_64-linux-gnu/lib
gck-1.so.0.0.0
pool 1746 1762 a mem REG 8,1 526792 7432 /usr/lib/x86_64-linux-gnu/lib
curl-gnutls.so.4.5.0
pool 1746 1762 a mem REG 8,1 84032 138352 /lib/x86_64-linux-gnu/libgpg-
error.so.0.22.0
pool 1746 1762 a mem REG 8,1 14488 5321 /usr/lib/x86_64-linux-gnu/lib
plds4.so
pool 1746 1762 a mem REG 8,1 18680 5320 /usr/lib/x86_64-linux-gnu/lib
plc4.so
pool 1746 1762 a mem REG 8,1 191360 7676 /usr/lib/x86_64-linux-gnu/lib
nssutil3.so
pool 1746 1762 a mem REG 8,1 27112 138454 /lib/x86_64-linux-gnu/libuuid
.so.1.3.0
pool 1746 1762 a mem REG 8,1 43616 2720 /usr/lib/x86_64-linux-gnu/lib
krb5support.so.0.1
pool 1746 1762 a mem REG 8,1 14248 134953 /lib/x86_64-linux-gnu/libcom_
err.so.2.1
pool 1746 1762 a mem REG 8,1 199104 7618 /usr/lib/x86_64-linux-gnu/lib
k5crypto.so.3.1
pool 1746 1762 a mem REG 8,1 877056 4539 /usr/lib/x86_64-linux-gnu/lib
krb5.so.3.3
pool 1746 1762 a mem REG 8,1 300968 4933 /usr/lib/x86_64-linux-gnu/lib
gss-1.0.so.0.0.0
pool 1746 1762 a mem REG 8,1 610824 4871 /usr/lib/x86_64-linux-gnu/lib
gcr-base-3.so.1.0.0
pool 1746 1762 a mem REG 8,1 34656 5260 /usr/lib/x86_64-linux-gnu/lib
oauth.so.0.8.7
pool 1746 1762 a mem REG 8,1 26904112 7593 /usr/lib/x86_64-linux-gnu/lib
```

lsuf -u username 列出特定用户打开的文件

```
rmislon denied)
kworker/0 3483 root txt unknown /proc/3483/exe (readlink: Per
mission denied)
kworker/0 3483 root NOFD /proc/3483/fd (opendir: Permi
ssion denied)
kworker/0 3503 root cwd unknown /proc/3503/cwd (readlink: Per
mission denied)
kworker/0 3503 root rtd unknown /proc/3503/root (readlink: Pe
rmislon denied)
kworker/0 3503 root txt unknown /proc/3503/exe (readlink: Per
mission denied)
kworker/0 3503 root NOFD /proc/3503/fd (opendir: Permi
ssion denied)
kworker/u 3549 root cwd unknown /proc/3549/cwd (readlink: Per
mission denied)
kworker/u 3549 root rtd unknown /proc/3549/root (readlink: Pe
rmislon denied)
kworker/u 3549 root txt unknown /proc/3549/exe (readlink: Per
mission denied)
kworker/u 3549 root NOFD /proc/3549/fd (opendir: Permi
ssion denied)
kworker/u 3592 root cwd unknown /proc/3592/cwd (readlink: Per
mission denied)
kworker/u 3592 root rtd unknown /proc/3592/root (readlink: Pe
rmislon denied)
kworker/u 3592 root txt unknown /proc/3592/exe (readlink: Per
mission denied)
```

19 vmstat显示虚拟内存统计信息

vmstat用于报告各种系统资源信息的命令行工具

```
a@ubuntu:~$ vmstat
procs -----memory----- --swap-- -----io---- -system-- -----cpu-----
r b 交换 空闲 缓冲 缓存 si so bi bo in cs us sy id wa st
1 0 0 1547400 119284 1136524 0 0 137 51 72 161 0 1 99 0
0
a@ubuntu:~$
```

显示自系统启动以来的平均值

```

a@ubuntu:~$ vmstat -s
3994720 K total memory
1190984 K used memory
1198016 K active memory
679344 K inactive memory
1547912 K free memory
119300 K buffer memory
1136524 K swap cache
483800 K total swap
0 K used swap
483800 K free swap
3173 non-nice user cpu ticks
260 nice user cpu ticks
5995 system cpu ticks
711029 idle cpu ticks
244 IO-wait cpu ticks
0 IRQ cpu ticks
261 softirq cpu ticks
0 stolen cpu ticks
971083 pages paged in
360980 pages paged out
0 pages swapped in

```

20 tcpdump

tcpdump允许用户捕获和交互式或记录下来通过网络接口的数据包。

```

a@ubuntu:~$ sudo tcpdump
[sudo] a 的密码:
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on any, link-type LINUX_SLL (Linux cooked), capture size 262144 bytes
05:44:51.397443 IP localhost.60682 > localhost.domain: 53531+ [1au] A? ntp.ubuntu.com. (43)
05:44:51.397468 IP localhost.60682 > localhost.domain: 34604+ [1au] AAAA? ntp.ubuntu.com. (43)
05:44:51.397605 IP localhost.domain > localhost.60682: 53531 ServFail 0/0/1 (43)
05:44:51.397651 IP localhost.domain > localhost.60682: 34604 ServFail 0/0/1 (43)
05:44:51.399419 IP localhost.51362 > localhost.domain: 6769+ [1au] A? ntp.ubuntu.com. (43)
05:44:51.399451 IP localhost.51362 > localhost.domain: 33917+ [1au] AAAA? ntp.ubuntu.com. (43)
05:44:51.399678 IP localhost.domain > localhost.51362: 6769 ServFail 0/0/1 (43)
05:44:51.399723 IP localhost.domain > localhost.51362: 33917 ServFail 0/0/1 (43)
05:44:51.400142 IP localhost.51026 > localhost.domain: 33260+ [1au] A? ntp.ubuntu.com. (43)
05:44:51.400498 IP localhost.domain > localhost.51026: 33260 ServFail 0/0/1 (43)
05:44:51.400548 IP localhost.domain > localhost.51026: 56313 ServFail 0/0/1 (43)
05:44:51.400660 IP localhost.51026 > localhost.domain: 33260+ [1au] A? ntp.ubuntu.com. (43)
05:44:51.400694 IP localhost.51026 > localhost.domain: 56313+ [1au] AAAA? ntp.ubuntu.com. (43)
05:44:51.400969 IP localhost.domain > localhost.51026: 33260 ServFail 0/0/1 (43)
05:44:51.401028 IP localhost.domain > localhost.51026: 56313 ServFail 0/0/1 (43)
05:44:51.401306 IP localhost.33249 > localhost.domain: 18869+ [1au] A? ntp.ubuntu.com. (43)
05:44:51.401722 IP localhost.domain > localhost.33249: 18869 ServFail 0/0/1 (43)
05:44:51.401813 IP localhost.domain > localhost.33249: 18370 ServFail 0/0/1 (43)
05:44:51.402241 IP localhost.domain > localhost.38697: 32083 ServFail 0/0/1 (43)
05:44:51.402330 IP localhost.domain > localhost.38697: 37208 ServFail 0/0/1 (43)
05:44:51.402403 IP localhost.38697 > localhost.domain: 32083+ [1au] A? ntp.ubuntu.com. (43)
05:44:51.402433 IP localhost.38697 > localhost.domain: 37208+ [1au] AAAA? ntp.ubuntu.com. (43)
05:44:51.402487 IP localhost.domain > localhost.38697: 32083 ServFail 0/0/1 (43)

```

感悟

学习Linux调试及性能分析的过程让我深刻感悟到理论与实践相结合的重要性，工具的熟练运用是关键，日志和动态追踪的价值，性能监控与分析的必要性，持续学习的态度，实践案例的宝贵经验以及资源的重要性。只有掌握了操作系统原理等基础知识，才能在实际的调试和分析中游刃有余，而这些理论知识又需要通过不断的实践来巩固。

<https://github.com/asd279/myrepo>