

Лабораторная работа №5. Управление памятью в ОС Linux

Начальная конфигурация системы:

- PageSize: 4096 B

```
[user@localhost ~]$ getconf PAGE_SIZE
4096
[user@localhost ~]$ _
```

- MemTotal: 1870900 kB

```
[user@localhost ~]$ grep MemTotal /proc/meminfo
MemTotal:          1870900 kB
```

- SwapTotal: 839676 kB

```
[user@localhost ~]$ grep SwapTotal /proc/meminfo
SwapTotal:           839676 kB
```

- MemFree: 1234708 kB

```
[user@localhost ~]$ grep MemFree /proc/meminfo
MemFree:             1234708 kB
```

- SwapFree: 839676 kB

```
[user@localhost ~]$ grep SwapFree /proc/meminfo
SwapFree:             839676 kB
```

Эксперимент №1

Первый этап

-Скрипт : mem.bash

```
GNU nano 2.9.8 mem.bash

#!/bin/bash
echo "" > report.log
arr=()
iter=0
while true; do
    arr+=( 1 2 3 4 5 6 7 8 9 10 )
    let iter=iter+1
    if [[ $((iter % 100000)) -eq 0 ]]
    then
        echo "${#arr[@]}" >> report.log
    fi
done
```

-Скрипт слежения: watch1.bash

```
#!/bin/bash
echo "" > first_five_proces1.txt
echo "" > proc_membash1.txt
echo "Time" > mem1.txt
echo "Time" > swap1.txt

while true; do
    proc_exist=$(top -b -n 1 | grep "mem.bash")
    st=$(echo "$proc_exist" | awk '{print $8}')
    if [[ -z proc_exist || "$st" != "R" ]]; then
        exit 0
    fi
    mem_and_swap=$(top -b -n 1 | head -n5 | tail -n2)
    mem=$(echo "mem_and_swap" | head -n1)
    swap=$(echo "mem_and_swap" | tail -n1)
    first_five=$(top -b -n 1 | head -n12 | tail -n5)
    echo -e "\n" >> first_five_proces1.txt
    proc_exist=$(top -b -n 1 | grep "mem.bash")
    cur_time=$(echo "proc_exist" | awk '{print $11}')
    echo "$cur_time $proc_exist" >> proc_membash1.txt
    echo "$cur_time $mem" >> mem1.txt
    echo "$cur_time $swap" >> swap1.txt
    sleep 1
done
```

-Скрипт запуска: run1.bash

-Журнал при втором запуске mem.bash:

```
[111776.634943] [ 868] 0 868 124680 0 475136 5502 0 firewallld
[111776.635320] [ 869] 0 869 24456 234 212992 432 0 systemd-logind
[111776.635713] [ 885] 0 885 188627 240 409600 435 0 NetworkManager
[111776.636142] [ 896] 0 896 23242 21 196608 205 -1000 sshd
[111776.636537] [ 897] 0 897 158766 104 454656 4112 0 tuned
[111776.636868] [ 1118] 0 1118 10656 16 106496 39 0 atd
[111776.637184] [ 1120] 0 1120 61472 173 106496 57 0 crond
[111776.637524] [26371] 1000 26371 23439 38 217088 326 0 systemd
[111776.637822] [26376] 1000 26376 61685 115 311296 1208 0 (sd-pam)
[111776.638113] [33925] 1000 33925 55622 30 65536 30 0 task4_prog.sh
[111776.638436] [33927] 1000 33927 55622 29 73728 31 0 task4_prog.sh
[111776.638726] [33948] 1000 33948 55622 30 81920 30 0 task4_prog.sh
[111776.639006] [33950] 1000 33950 55622 29 77824 31 0 task4_prog.sh
[111776.639311] [33963] 1000 33963 55622 30 73728 30 0 task4_prog.sh
[111776.639593] [33965] 1000 33965 55622 29 77824 31 0 task4_prog.sh
[111776.639869] [33989] 1000 33989 55622 30 73728 30 0 task4_prog.sh
[111776.640166] [33991] 1000 33991 55622 28 81920 33 0 task4_prog.sh
[111776.640443] [34021] 1000 34021 55622 42 69632 25 0 task6_handler.
s
[111776.640955] [34880] 1000 34880 55622 52 73728 15 0 task6_handler.
s
[111776.641510] [40830] 1000 40830 55622 60 77824 8 0 task6_handler.
s
[111776.642031] [145735] 0 145735 33689 22 270336 221 0 login
[111776.642334] [145811] 1000 145811 58621 124 81920 392 0 bash
[111776.642610] [147816] 1000 147816 580850 335794 4296704 189453 0 mem.bash
[111776.642888] [148792] 1000 148792 138122 82526 733184 0 0 mem.bash
[111776.643192] [148996] 1000 148996 54261 16 69632 0 0 sleep
[111776.643472] [148997] 1000 148997 55622 42 61440 25 0 task6_handle
r.s
[111776.644027] [148998] 1000 148998 55622 53 65536 15 0 task6_handle
r.s
[111776.644613] Out of memory: Killed process 147816 (mem.bash) total-vm:2323400kB, anon-rss:1343176
kB, file-rss:0kB, shmem-rss:0kB, UID:1000
[111777.353107] oom_reaper: reaped process 147816 (mem.bash), now anon-rss:0kB, file-rss:0kB, shmem-
rss:0kB
-
```

[111776.644613] Out of memory: Killed process 147816 (mem.bash) total-vm:2323400 kB, anon-rss: 1343176 kB, file-rss: 0 kB, shmem-rss:0kb, UID: 1000

[111777.353107] oom_reaper: reaped process 147816 (mem.bash), now anon-rss: 0 kB, file-rss 0 kB, shmem-rss: 0 kB

-Файл отслеживания памяти: mem1.txt

```
GNU nano 2.9.8      mem1.txt

Time
0:00.86 MiB Mem : 1826.8 total, 1414.5 free, 184.6 used, 227.7 buff/cache
0:02.70 MiB Mem : 1826.8 total, 1374.4 free, 224.6 used, 227.8 buff/cache
0:04.48 MiB Mem : 1826.8 total, 1334.3 free, 264.7 used, 227.8 buff/cache
0:06.28 MiB Mem : 1826.8 total, 1295.4 free, 303.6 used, 227.8 buff/cache
0:08.09 MiB Mem : 1826.8 total, 1255.9 free, 343.1 used, 227.8 buff/cache
0:09.88 MiB Mem : 1826.8 total, 1217.2 free, 381.8 used, 227.8 buff/cache
0:11.68 MiB Mem : 1826.8 total, 1179.4 free, 419.6 used, 227.8 buff/cache
0:13.50 MiB Mem : 1826.8 total, 1144.0 free, 455.0 used, 227.8 buff/cache
0:15.32 MiB Mem : 1826.8 total, 1109.6 free, 489.4 used, 227.8 buff/cache
0:17.10 MiB Mem : 1826.8 total, 1077.0 free, 522.0 used, 227.8 buff/cache
0:18.91 MiB Mem : 1826.8 total, 1040.7 free, 558.3 used, 227.8 buff/cache
0:20.70 MiB Mem : 1826.8 total, 1003.0 free, 596.0 used, 227.8 buff/cache
0:22.50 MiB Mem : 1826.8 total, 966.1 free, 632.9 used, 227.8 buff/cache
0:24.29 MiB Mem : 1826.8 total, 928.7 free, 670.3 used, 227.8 buff/cache
0:26.10 MiB Mem : 1826.8 total, 899.3 free, 699.7 used, 227.8 buff/cache
0:27.90 MiB Mem : 1826.8 total, 869.4 free, 729.5 used, 227.9 buff/cache
0:29.69 MiB Mem : 1826.8 total, 836.8 free, 762.2 used, 227.9 buff/cache
0:31.49 MiB Mem : 1826.8 total, 803.8 free, 795.1 used, 227.9 buff/cache
0:33.29 MiB Mem : 1826.8 total, 770.8 free, 828.1 used, 227.9 buff/cache
0:35.13 MiB Mem : 1826.8 total, 738.1 free, 860.8 used, 227.9 buff/cache
0:36.90 MiB Mem : 1826.8 total, 708.8 free, 890.1 used, 227.9 buff/cache
0:38.75 MiB Mem : 1826.8 total, 672.0 free, 926.9 used, 227.9 buff/cache
0:40.54 MiB Mem : 1826.8 total, 630.7 free, 960.2 used, 227.9 buff/cache
0:42.36 MiB Mem : 1826.8 total, 591.3 free, 1007.6 used, 227.9 buff/cache
0:44.17 MiB Mem : 1826.8 total, 553.4 free, 1045.5 used, 227.9 buff/cache
0:45.97 MiB Mem : 1826.8 total, 512.3 free, 1086.7 used, 227.9 buff/cache
0:47.78 MiB Mem : 1826.8 total, 471.1 free, 1127.9 used, 227.9 buff/cache
0:49.60 MiB Mem : 1826.8 total, 429.3 free, 1169.6 used, 227.9 buff/cache
0:51.42 MiB Mem : 1826.8 total, 387.8 free, 1211.1 used, 227.9 buff/cache
0:53.22 MiB Mem : 1826.8 total, 347.0 free, 1252.0 used, 227.9 buff/cache
0:55.00 MiB Mem : 1826.8 total, 306.4 free, 1292.6 used, 227.9 buff/cache

[ Read 54 lines ]
G Get Help  O Write Out  W Where Is  K Cut Text  J Justify  C Cur Pos  T-U Undo
X Exit      R Read File  N Replace  U Uncut Text  I To Spell  G Go To Line  T-E Redo
```

-Файл отслеживания памяти раздела подкачки (Swap): swap1.txt

```
GNU nano 2.9.8      swap1.txt

Time
0:00.86 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 1490.7 avail Mem
0:02.70 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 1450.0 avail Mem
0:04.48 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 1410.7 avail Mem
0:06.28 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 1371.7 avail Mem
0:08.09 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 1332.2 avail Mem
0:09.88 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 1293.5 avail Mem
0:11.68 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 1255.7 avail Mem
0:13.50 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 1220.3 avail Mem
0:15.32 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 1185.9 avail Mem
0:17.10 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 1153.3 avail Mem
0:18.91 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 1117.0 avail Mem
0:20.70 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 1079.3 avail Mem
0:22.50 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 1042.4 avail Mem
0:24.29 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 1005.0 avail Mem
0:26.10 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 975.6 avail Mem
0:27.90 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 945.8 avail Mem
0:29.69 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 913.2 avail Mem
0:31.49 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 880.2 avail Mem
0:33.29 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 847.2 avail Mem
0:35.13 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 814.5 avail Mem
0:36.90 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 785.3 avail Mem
0:38.75 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 748.4 avail Mem
0:40.54 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 707.1 avail Mem
0:42.36 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 667.7 avail Mem
0:44.17 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 629.8 avail Mem
0:45.97 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 588.7 avail Mem
0:47.78 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 547.5 avail Mem
0:49.60 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 505.8 avail Mem
0:51.42 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 464.2 avail Mem
0:53.22 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 423.4 avail Mem
0:55.00 MiB Swap: 820.0 total, 820.0 free, 0.0 used, 382.8 avail Mem

[ Read 54 lines ]
G Get Help  O Write Out  W Where Is  K Cut Text  J Justify  C Cur Pos  T-U Undo
X Exit      R Read File  N Replace  U Uncut Text  I To Spell  G Go To Line  T-E Redo
```

-Файл отслеживания параметров процесса mem.bash: proc_membash1.txt

```
GNU nano 2.9.8 proc_membash1.txt
0:00.86 1454 user 20 0 242420 22992 2920 R 93.8 1.2 0:00.86 nen.bash
0:02.70 1454 user 20 0 283208 63912 2920 R 94.4 3.4 0:02.70 nen.bash
0:04.48 1454 user 20 0 323864 104304 2920 R 93.3 5.6 0:04.48 nen.bash
0:06.28 1454 user 20 0 363332 143904 2920 R 88.2 7.7 0:06.28 nen.bash
0:08.09 1454 user 20 0 404120 184560 2920 R 93.8 9.9 0:08.09 nen.bash
0:09.88 1454 user 20 0 443588 224160 2920 R 88.2 12.0 0:09.88 nen.bash
0:11.68 1454 user 20 0 482132 262704 2920 R 82.4 14.0 0:11.68 nen.bash
0:13.50 1454 user 20 0 517508 298080 2920 R 99.9 15.9 0:13.50 nen.bash
0:15.32 1454 user 20 0 551960 332400 2920 R 87.5 17.8 0:15.32 nen.bash
0:17.10 1454 user 20 0 585224 365920 2920 R 82.4 19.6 0:17.10 nen.bash
0:18.91 1454 user 20 0 623768 404208 2920 R 83.3 21.6 0:18.91 nen.bash
0:20.70 1454 user 20 0 662180 442752 2920 R 88.2 23.7 0:20.70 nen.bash
0:22.50 1454 user 20 0 699404 479976 2920 R 88.2 25.7 0:22.50 nen.bash
0:24.29 1454 user 20 0 735836 516408 2920 R 82.4 27.6 0:24.29 nen.bash
0:26.10 1454 user 20 0 766320 546768 2920 R 93.8 29.2 0:26.10 nen.bash
0:27.90 1454 user 20 0 797216 577920 2920 R 82.4 30.9 0:27.90 nen.bash
0:29.69 1454 user 20 0 831140 611712 2920 R 88.2 32.7 0:29.69 nen.bash
0:31.49 1454 user 20 0 864404 644976 2920 R 94.1 34.5 0:31.49 nen.bash
0:33.29 1454 user 20 0 898592 679296 2920 R 88.9 36.3 0:33.29 nen.bash
0:35.13 1454 user 20 0 931592 712832 2920 R 94.1 38.1 0:35.13 nen.bash
0:36.90 1454 user 20 0 962348 742920 2920 R 88.2 39.7 0:36.90 nen.bash
0:38.75 1454 user 20 0 1001816 782256 2920 R 88.2 41.8 0:38.75 nen.bash
0:40.54 1454 user 20 0 1043000 823440 2920 R 87.5 44.0 0:40.54 nen.bash
0:42.36 1454 user 20 0 1083788 864360 2920 R 88.2 46.2 0:42.36 nen.bash
0:44.17 1454 user 20 0 1122728 903168 2920 R 82.4 48.3 0:44.17 nen.bash
0:45.97 1454 user 20 0 1164176 944616 2920 R 99.9 50.5 0:45.97 nen.bash
0:47.78 1454 user 20 0 1206416 986856 2920 R 99.9 52.8 0:47.78 nen.bash
0:49.60 1454 user 20 0 1249316 1.0g 2920 R 81.2 55.1 0:49.60 nen.bash
0:51.42 1454 user 20 0 1291556 1.0g 2920 R 93.8 57.3 0:51.42 nen.bash
0:53.22 1454 user 20 0 1333268 1.1g 2920 R 88.9 59.5 0:53.22 nen.bash
0:55.00 1454 user 20 0 1374452 1.1g 2920 R 83.3 61.7 0:55.00 nen.bash
[ Read 32 lines ]
G Get Help  O Write Out  W Where Is  K Cut Text  J Justify  C Cur Pos  T-U Undo
X Exit      R Read File  N Replace  U Uncut Text  T To Spell  G Go To Line  E Redo
```

Файл отслеживания первых пяти процессов top: first_five_process1.txt

```
1454 user 20 0 230460 19032 2920 R 82.4 1.0 0:00.60 nen.bash
1473 user 20 0 274140 4464 3892 R 5.9 0.2 0:00.01 top
1 root 20 0 179200 13608 8644 S 0.0 0.7 0:02.58 systemd
2 root 20 0 0 0 0 S 0.0 0.0 0:00.00 kthreadd
3 root 0 -20 0 0 0 I 0.0 0.0 0:00.00 rcu_gp

1454 user 20 0 278984 59688 2920 R 77.8 3.2 0:02.50 nen.bash
1 root 20 0 179200 13608 8644 S 0.0 0.7 0:02.58 systemd
2 root 20 0 0 0 0 S 0.0 0.0 0:00.00 kthreadd
3 root 0 -20 0 0 0 I 0.0 0.0 0:00.00 rcu_gp
4 root 0 -20 0 0 0 I 0.0 0.0 0:00.00 rcu_par_gp

1454 user 20 0 320168 100608 2920 R 99.9 5.4 0:04.32 nen.bash
1 root 20 0 179200 13608 8644 S 0.0 0.7 0:02.58 systemd
2 root 20 0 0 0 0 S 0.0 0.0 0:00.00 kthreadd
3 root 0 -20 0 0 0 I 0.0 0.0 0:00.00 rcu_gp
4 root 0 -20 0 0 0 I 0.0 0.0 0:00.00 rcu_par_gp

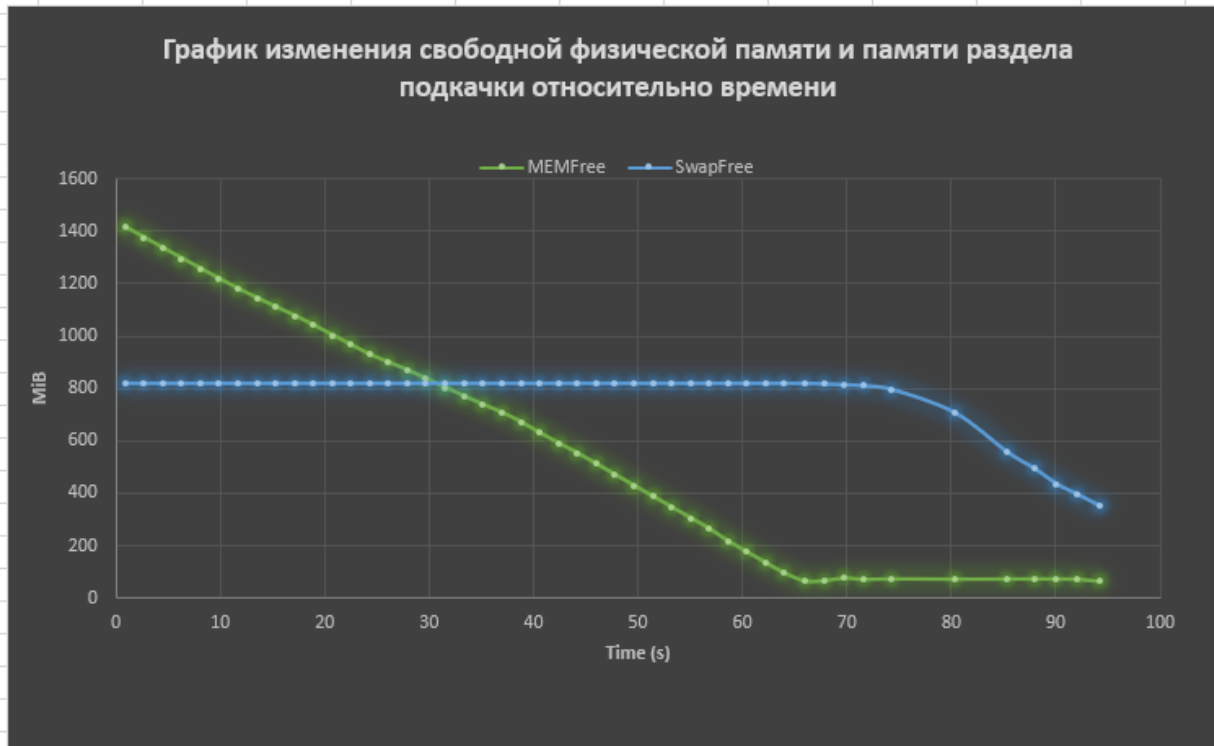
1454 user 20 0 359908 140472 2920 R 82.4 7.5 0:06.10 nen.bash
1 root 20 0 179200 13608 8644 S 0.0 0.7 0:02.58 systemd
2 root 20 0 0 0 0 S 0.0 0.0 0:00.00 kthreadd
3 root 0 -20 0 0 0 I 0.0 0.0 0:00.00 rcu_gp
4 root 0 -20 0 0 0 I 0.0 0.0 0:00.00 rcu_par_gp

1454 user 20 0 400028 180600 2920 R 93.8 9.7 0:07.91 nen.bash
[ Read 372 lines ]
G Get Help  O Write Out  W Where Is  K Cut Text  J Justify  C Cur Pos  T-U Undo
X Exit      R Read File  N Replace  U Uncut Text  T To Spell  G Go To Line  E Redo
```

Последняя строка report.log: 30000000

```
GNU nano 2.9.8 report.log
12000000
13000000
14000000
15000000
16000000
17000000
18000000
19000000
20000000
21000000
22000000
23000000
24000000
25000000
26000000
27000000
28000000
29000000
30000000
```

График изменения свободной физической памяти и памяти раздела подкачки относительно времени (Построение из значений файлов mem1.txt и swap1.txt)



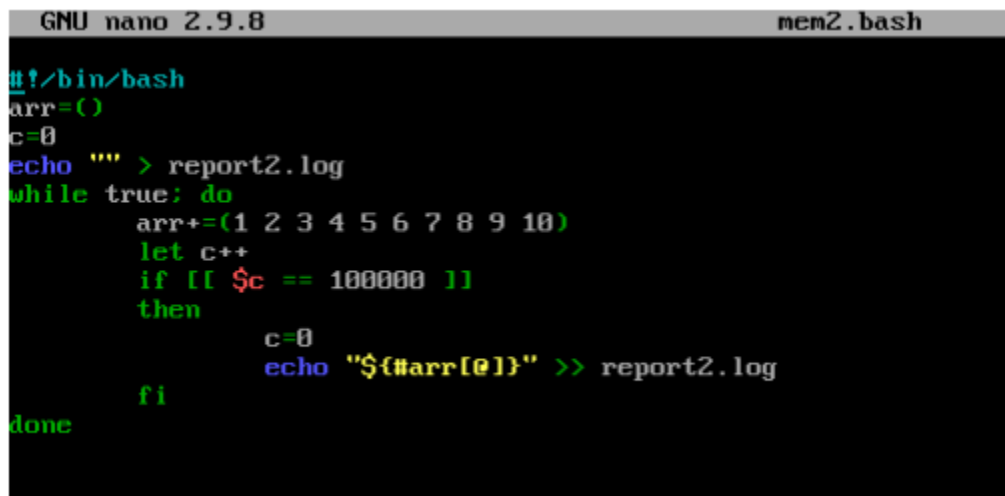
Выводы

В начале программа занимает только физическую память. Как можно увидеть по графику, свободная физическая память линейно убывает, а размер свободной памяти раздела подкачки остается постоянным. Однако в определенный момент времени (42-43с) свободная физическая память заканчивается, и начинается использование раздела подкачки. Когда же заканчивается и он, программа аварийно завершается.

Размер массива в момент аварийного завершения программы: 30 000 000

Второй этап:

Второй скрипт: mem2.bash



```
GNU nano 2.9.8 mem2.bash
#!/bin/bash
arr=()
c=0
echo "" > report2.log
while true; do
    arr+=(1 2 3 4 5 6 7 8 9 10)
    let c++
    if [[ $c == 1000000 ]]
    then
        c=0
        echo "${#arr[@]}" >> report2.log
    fi
done
```

Скрипт слежения: w2.bash


```

#!/bin/bash
echo "" > five_process2.txt
echo "" > proc_membash2.txt
echo "Time" > mem2.txt
echo "Time" > swap2.txt

while true; do
    procExist=$(top -b -n 1 | grep "mem2.bash")
    st=$(echo "$procExist" | awk '{print $8}')
    if [[ -z procExist || "$st" != "R" ]]; then
        exit 0
    fi
    mem_and_swap=$(top -b -n 1 | head -n 5 | tail -n 2)
    mem=$(echo "$mem_and_swap" | head -n 1)
    swap=$(echo "$mem_and_swap" | tail -n 1)
    five_process=$(top -b -n 1 | head -n 12 | tail -n 5)
    echo -e "\n" >> five_process2.txt
    procExist=$(top -b -n 1 | grep "mem2.bash")
    cur_time=$(echo "$procExist" | awk '{print $11}')
    echo "$cur_time $procExist" >> proc_membash2.txt
    echo "$cur_time $mem" >> mem2.txt
    echo "$cur_time $swap" >> swap2.txt
    sleep 1
done

```

Скрипт запуска: run2.bash

-Журнал при втором запуске

```

[ 537.569066] Out of memory: Killed process 1463 (mem.bash) total-vm:2662904kB, anon-rss:1679568kB,
file-rss:0kB, shmem-rss:0kB, UID:1000
[ 537.728607] oom_reaper: reaped process 1463 (mem.bash), now anon-rss:0kB, file-rss:0kB, shmem-rss:
0kB
Killed

```

Последняя строка report.log: 15000000

```
10000000
20000000
30000000
40000000
50000000
60000000
70000000
80000000
90000000
100000000
110000000
120000000
130000000
140000000
150000000
```

Последняя строка report2.log: 30000000

```
170000000
180000000
190000000
200000000
210000000
220000000
230000000
240000000
250000000
260000000
270000000
280000000
290000000
300000000
```

Файл отслеживания памяти: mem2.txt

```
GNU nano 2.9.8 mem2.txt
Time
0:00.00 MiB Mem : 1827.1 total, 1594.8 free, 124.4 used, 107.8 buff/cache
0:01.00 MiB Mem : 1827.1 total, 1547.4 free, 171.8 used, 107.9 buff/cache
0:02.77 MiB Mem : 1827.1 total, 1505.3 free, 213.8 used, 107.9 buff/cache
0:03.76 MiB Mem : 1827.1 total, 1461.8 free, 257.3 used, 107.9 buff/cache
0:04.72 MiB Mem : 1827.1 total, 1411.7 free, 302.4 used, 112.9 buff/cache
0:05.70 MiB Mem : 1827.1 total, 1365.4 free, 347.6 used, 114.0 buff/cache
0:06.68 MiB Mem : 1827.1 total, 1322.5 free, 390.5 used, 114.0 buff/cache
0:07.67 MiB Mem : 1827.1 total, 1277.3 free, 435.8 used, 114.0 buff/cache
0:08.65 MiB Mem : 1827.1 total, 1233.3 free, 479.7 used, 114.0 buff/cache
0:09.61 MiB Mem : 1827.1 total, 1176.8 free, 520.1 used, 122.2 buff/cache
0:10.60 MiB Mem : 1827.1 total, 1133.6 free, 571.0 used, 122.5 buff/cache
0:11.57 MiB Mem : 1827.1 total, 1087.8 free, 616.8 used, 122.5 buff/cache
0:12.55 MiB Mem : 1827.1 total, 1042.7 free, 661.9 used, 122.5 buff/cache
0:13.52 MiB Mem : 1827.1 total, 997.6 free, 707.0 used, 122.5 buff/cache
0:14.50 MiB Mem : 1827.1 total, 952.4 free, 752.1 used, 122.5 buff/cache
0:15.47 MiB Mem : 1827.1 total, 907.3 free, 797.3 used, 122.5 buff/cache
0:16.47 MiB Mem : 1827.1 total, 863.5 free, 841.1 used, 122.5 buff/cache
0:17.43 MiB Mem : 1827.1 total, 817.9 free, 886.6 used, 122.5 buff/cache
0:18.42 MiB Mem : 1827.1 total, 772.7 free, 931.9 used, 122.5 buff/cache
0:19.41 MiB Mem : 1827.1 total, 728.8 free, 975.8 used, 122.5 buff/cache
0:20.39 MiB Mem : 1827.1 total, 689.3 free, 1015.2 used, 122.5 buff/cache
0:21.39 MiB Mem : 1827.1 total, 644.4 free, 1060.1 used, 122.5 buff/cache
0:22.37 MiB Mem : 1827.1 total, 599.9 free, 1104.6 used, 122.5 buff/cache
0:23.37 MiB Mem : 1827.1 total, 555.1 free, 1149.4 used, 122.5 buff/cache
0:24.36 MiB Mem : 1827.1 total, 508.1 free, 1196.4 used, 122.5 buff/cache
0:25.35 MiB Mem : 1827.1 total, 463.1 free, 1241.5 used, 122.5 buff/cache
0:26.33 MiB Mem : 1827.1 total, 417.4 free, 1287.2 used, 122.5 buff/cache
0:27.33 MiB Mem : 1827.1 total, 371.0 free, 1332.0 used, 122.5 buff/cache
0:28.31 MiB Mem : 1827.1 total, 326.1 free, 1378.4 used, 122.5 buff/cache
0:29.31 MiB Mem : 1827.1 total, 279.1 free, 1425.4 used, 122.5 buff/cache
0:30.30 MiB Mem : 1827.1 total, 233.3 free, 1471.2 used, 122.5 buff/cache
Read 73 lines
Get Help Write Out Where Is Cut Text Justify Cur Pos Undo
Exit Read File Replace Uncut Text To Spell Go To Line Redo
```

Файл отслеживания памяти раздела подкачки (Swap): swap2.txt

```

GNU nano 2.9.8 swap2.txt

Time
0:00.80 MiB Swap: 820.0 total, 731.1 free, 88.9 used. 1575.4 avail Mem
0:01.80 MiB Swap: 820.0 total, 731.1 free, 88.9 used. 1528.0 avail Mem
0:02.77 MiB Swap: 820.0 total, 731.1 free, 88.9 used. 1486.0 avail Mem
0:03.76 MiB Swap: 820.0 total, 731.1 free, 88.9 used. 1442.5 avail Mem
0:04.72 MiB Swap: 820.0 total, 731.1 free, 88.9 used. 1394.9 avail Mem
0:05.70 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 1349.1 avail Mem
0:06.68 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 1306.2 avail Mem
0:07.67 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 1260.9 avail Mem
0:08.65 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 1217.0 avail Mem
0:09.61 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 1164.5 avail Mem
0:10.60 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 1121.5 avail Mem
0:11.57 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 1075.7 avail Mem
0:12.55 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 1030.6 avail Mem
0:13.52 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 985.5 avail Mem
0:14.50 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 940.3 avail Mem
0:15.47 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 895.2 avail Mem
0:16.47 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 851.4 avail Mem
0:17.43 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 805.9 avail Mem
0:18.42 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 760.6 avail Mem
0:19.41 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 716.7 avail Mem
0:20.39 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 677.2 avail Mem
0:21.39 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 632.4 avail Mem
0:22.37 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 587.9 avail Mem
0:23.37 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 543.1 avail Mem
0:24.36 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 496.0 avail Mem
0:25.35 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 451.0 avail Mem
0:26.33 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 405.3 avail Mem
0:27.33 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 359.7 avail Mem
0:28.31 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 314.0 avail Mem
0:29.31 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 267.1 avail Mem
0:30.30 MiB Swap: 820.0 total, 731.3 free, 88.7 used. 221.2 avail Mem

[ Read 73 lines ]
^G Get Help ^O Write Out ^W Where Is ^K Cut Text ^J Justify ^C Cur Pos ^I-U Undo
^X Exit ^R Read File ^_ Replace ^U Uncut Text ^T To Spell ^_ Go To Line ^I-E Redo

```

Файл отслеживания параметров процесса mem.bash: proc_membash2.txt

```

0:00.80 1484 user 20 0 241760 22148 2860 R 43.8 1.2 0:00.80 nen2.bash
0:01.80 1484 user 20 0 266048 46436 2860 R 38.9 2.5 0:01.80 nen2.bash
0:02.77 1484 user 20 0 287432 68084 2860 R 38.9 3.6 0:02.77 nen2.bash
0:03.76 1484 user 20 0 309600 89996 2860 R 47.1 4.8 0:03.76 nen2.bash
0:04.72 1484 user 20 0 332708 113228 2860 R 53.3 6.1 0:04.72 nen2.bash
0:05.70 1484 user 20 0 356204 136724 2860 R 50.0 7.3 0:05.70 nen2.bash
0:06.68 1484 user 20 0 379832 160220 2860 R 38.9 8.6 0:06.68 nen2.bash
0:07.67 1484 user 20 0 402668 183188 2860 R 41.2 9.8 0:07.67 nen2.bash
0:08.65 1484 user 20 0 425900 206420 2860 R 36.0 11.0 0:08.65 nen2.bash
0:09.61 1484 user 20 0 448736 229388 2860 R 41.2 12.3 0:09.61 nen2.bash
0:10.60 1484 user 20 0 473156 253676 2860 R 43.0 13.6 0:10.60 nen2.bash
0:11.57 1484 user 20 0 496256 276644 2860 R 41.2 14.8 0:11.57 nen2.bash
0:12.55 1484 user 20 0 519488 300140 2860 R 50.0 16.0 0:12.55 nen2.bash
0:13.52 1484 user 20 0 542984 323372 2860 R 38.9 17.3 0:13.52 nen2.bash
0:14.50 1484 user 20 0 566612 347132 2860 R 42.1 18.6 0:14.50 nen2.bash
0:15.47 1484 user 20 0 589976 370364 2860 R 44.4 19.8 0:15.47 nen2.bash
0:16.47 1484 user 20 0 613208 393860 2860 R 44.4 21.1 0:16.47 nen2.bash
0:17.43 1484 user 20 0 634988 415588 2860 R 41.2 22.2 0:17.43 nen2.bash
0:18.42 1484 user 20 0 658220 438740 2860 R 41.2 23.5 0:18.42 nen2.bash
0:19.41 1484 user 20 0 680396 460916 2860 R 38.9 24.6 0:19.41 nen2.bash
0:20.39 1484 user 20 0 701912 482300 2860 R 35.3 25.8 0:20.39 nen2.bash
0:21.39 1484 user 20 0 724484 505004 2860 R 42.1 27.0 0:21.39 nen2.bash
0:22.37 1484 user 20 0 747452 527972 2860 R 47.1 28.2 0:22.37 nen2.bash
0:23.37 1484 user 20 0 771080 551468 2860 R 47.1 29.5 0:23.37 nen2.bash
0:24.36 1484 user 20 0 794840 575228 2860 R 38.9 30.7 0:24.36 nen2.bash
0:25.35 1484 user 20 0 818336 598724 2860 R 50.0 32.0 0:25.35 nen2.bash
0:26.33 1484 user 20 0 841568 622220 2860 R 41.2 33.3 0:26.33 nen2.bash
0:27.33 1484 user 20 0 865856 646244 2860 R 41.2 34.5 0:27.33 nen2.bash
0:28.31 1484 user 20 0 889484 670004 2860 R 41.2 35.8 0:28.31 nen2.bash
0:29.31 1484 user 20 0 913640 694028 2860 R 38.9 37.1 0:29.31 nen2.bash
0:30.30 1484 user 20 0 937400 717708 2860 R 42.1 38.4 0:30.30 nen2.bash

```

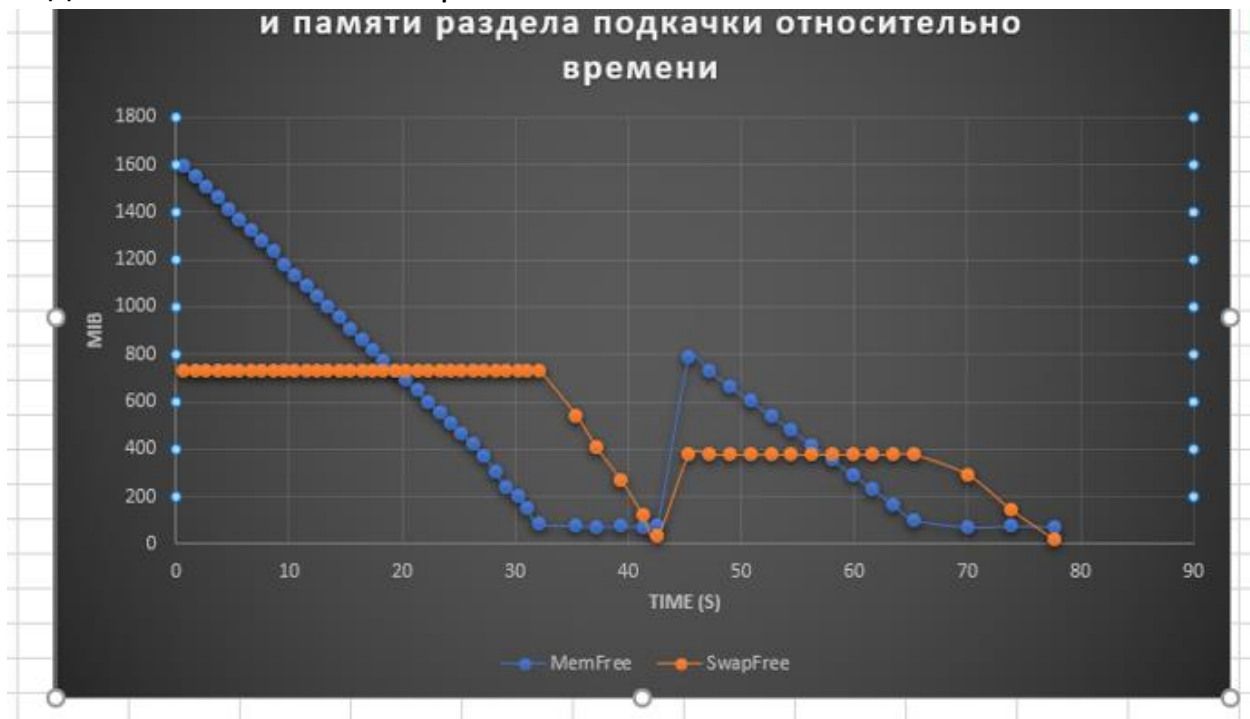
[Read 73 lines]

```

^G Get Help      ^U Write Out    ^W Where Is     ^K Cut Text     ^J Justify      ^C Cur Pos      ^T-U Undo
^X Exit          ^R Read File    ^_ Replace      ^U Uncut Text   ^T To Spell     ^_ Go To Line    ^T-E Redo

```

График изменения свободной физической памяти и памяти раздела подкачки относительно времени



Вывод: Во втором случае сначала происходит полностью аналогичная ситуация с первым случаем, однако аварийно завершается только одна из программ (на 42-43с). После чего происходит резкий рост свободной физической памяти и памяти раздела подкачки (можно увидеть этот момент на графиках с 43 по 45 секунды). Затем физическая память вновь линейно убывает, а память раздела подкачки пока остается неизменной. После, когда физическая память заканчивается, начинает также убывать память раздела подкачки, пока программа не завершится аварийно по ее истечению

Эксперимент №2

Скрипт newmem.bash:

```
GNU nano 2.9.8 newmem.bash

#!/bin/bash
echo "" > report.log
arr=()
iter=0
while true; do
    arr+=( 1 2 3 4 5 6 7 8 9 10 )
    let iter=iter+1
    if [[ "${#arr[@]}" -ge "$1" ]]; then
        exit 0
    fi
done
```

Скрипт запуска run_newmem.bash:

```
GNU nano 2.9.8 run_newmem.bash

#!/bin/bash
for (( i=0; i < $2; i++ ))
do
    ./newmem.bash $1 $
    sleep 1
done
```

$N(\max) = 30\,000\,000$ (из эксперимента 1)

При значении N в 10 раз меньше, чем критическое (3 000 000) и при K=10, ни один из процессов не завершается аварийно:

```
[user@localhost 2nd_experiment] $ ./run_newmem.bash 3000000 10
```

При запуске же $N = 3\,000\,000$ и $K = 30$, часть процессов завершилась аварийно. Процессор стал тратить больше времени на межстраничный обмен, чем на непосредственное выполнение программ.

```
[ 272.216928] [ 1525] 1000 1525 57932 2374 86016 0 0 newnen.bash
[ 272.217211] [ 1527] 1000 1527 57965 2417 86016 0 0 newnen.bash
[ 272.217525] [ 1529] 1000 1529 57668 2116 86016 0 0 newnen.bash
[ 272.217822] [ 1531] 1000 1531 57470 1912 86016 0 0 newnen.bash
[ 272.218095] [ 1533] 1000 1533 57305 1710 94208 0 0 newnen.bash
[ 272.218402] [ 1535] 1000 1535 57239 1649 98304 0 0 newnen.bash
[ 272.218672] [ 1537] 1000 1537 58955 3383 94208 0 0 newnen.bash
[ 272.218959] [ 1539] 1000 1539 58163 2586 94208 0 0 newnen.bash
[ 272.219258] [ 1541] 1000 1541 57833 2279 90112 0 0 newnen.bash
[ 272.219527] [ 1543] 1000 1543 56975 1396 98304 0 0 newnen.bash
[ 272.220015] [ 1545] 1000 1545 56909 1335 77824 0 0 newnen.bash
[ 272.220461] [ 1547] 1000 1547 56843 1267 86016 0 0 newnen.bash
[ 272.221297] [ 1549] 1000 1549 56414 798 81920 0 0 newnen.bash
[ 272.222058] [ 1551] 1000 1551 56348 802 81920 0 0 newnen.bash
[ 272.222446] [ 1553] 1000 1553 56183 596 77824 0 0 newnen.bash
[ 272.222891] [ 1555] 1000 1555 56216 658 81920 0 0 newnen.bash
[ 272.223210] [ 1557] 1000 1557 56051 462 81920 0 0 newnen.bash
[ 272.223470] [ 1559] 1000 1559 55919 331 81920 0 0 newnen.bash
[ 272.223751] [ 1561] 1000 1561 55721 170 77824 0 0 newnen.bash
[ 272.224003] [ 1563] 1000 1563 55622 61 61440 0 0 run.bash
[ 272.224302] Out of memory: Killed process 1452 (newnen.bash) total-vm:350000kB, anon-rss:56976kB,
file-rss:0kB, shmem-rss:0kB, UID:1000
[ 272.333079] oom_reaper: reaped process 1452 (newnen.bash), now anon-rss:0kB, file-rss:0kB, shmem-
rss:0kB
```

При снижении до $N = 2\,000\,000$, $K = 30$ запусков успешно завершаются

При значении в $N = 2\,400\,000$ происходит аварийное завершение части программ.

```
[ 270.384751] [ 1556] 1000 1556 62420 6870 131072 0 0 newnen.bash
[ 270.385088] [ 1558] 1000 1558 62618 6990 139264 0 0 newnen.bash
[ 270.385366] [ 1560] 1000 1560 61958 6403 126976 0 0 newnen.bash
[ 270.385640] [ 1562] 1000 1562 61529 5944 122880 0 0 newnen.bash
[ 270.385931] [ 1564] 1000 1564 61034 5466 118784 0 0 newnen.bash
[ 270.386196] [ 1566] 1000 1566 61067 5534 122880 0 0 newnen.bash
[ 270.386504] [ 1568] 1000 1568 61067 5478 114688 0 0 newnen.bash
[ 270.386830] [ 1570] 1000 1570 61232 5657 126976 0 0 newnen.bash
[ 270.387104] [ 1572] 1000 1572 60902 5351 126976 0 0 newnen.bash
[ 270.387522] [ 1574] 1000 1574 60869 5273 118784 0 0 newnen.bash
[ 270.388091] [ 1576] 1000 1576 60407 4824 110592 0 0 newnen.bash
[ 270.388400] [ 1578] 1000 1578 60374 4797 114688 0 0 newnen.bash
[ 270.388790] [ 1580] 1000 1580 61331 5758 122880 0 0 newnen.bash
[ 270.389049] [ 1583] 1000 1583 60209 4617 114688 0 0 newnen.bash
[ 270.389305] [ 1586] 1000 1586 59648 4068 114688 0 0 newnen.bash
[ 270.389559] [ 1588] 1000 1588 59219 3635 98304 0 0 newnen.bash
[ 270.389868] [ 1590] 1000 1590 59417 3843 102400 0 0 newnen.bash
[ 270.390123] [ 1593] 1000 1593 59912 4357 114688 0 0 newnen.bash
[ 270.390502] [ 1595] 1000 1595 58724 3157 102400 0 0 newnen.bash
[ 270.390806] Out of memory: Killed process 1487 (newnen.bash) total-vm:317000kB, anon-rss:45352kB,
file-rss:0kB, shmem-rss:0kB, UID:1000
```

Таким образом, максимальное значение $N \approx 2\,300\,000$

```
[user@localhost 2nd_experiment]$ ./run_newmem.bash 2300000 30  
[user@localhost 2nd_experiment]$
```