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высшего образования
«НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ УНИВЕРСИТЕТ ИТМО»

Лабораторная работа №5

по дисциплине **«Операционные системы»**

Управление памятью в ОС Linux

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Данные о текущей конфигурации OS:

- Общий объём оперативной памяти: 2048 Мб
- Объём раздела подкачки: 820 Мб
- Размер страницы виртуальной памяти: 4 Кб
- Объём свободной физической памяти в ненагруженной системе: 1618.5 Мб
- Объём свободного пространства в разделе подкачки в ненагруженной системе: 820 Мб

Эксперимент №1

Подготовительный этап:

1. Написал скрипт mem.sh, который в бесконечном цикле добавляет в конец массива последовательность из 100 элементов (для ускорения процесса исследования) и каждую 10000 итерацию записывает его длину в файл report.log.

```
1  #!/bin/bash
2
3  report="/home/user/OS/lab5/exp1/report.log"
4  cnt=0
5
6  declare -a array
7  declare -a numbers=(1,2,3,4,5,6,7,8,9,10,11,
8
9  rm $report
10
11  while :
12  do
13      array+=(${numbers[@]})
14      cnt=$((cnt+1))
15      if [[ $cnt -eq 10000 ]]
16      then
17          echo "${#array[@]}" >> $report
18          cnt=0
19      fi
20  done
```

Первый этап:

1. Последняя запись журнала – значения параметров, с которыми произошла аварийная остановка.

```
CentOS8 [Работает] - Oracle VM VirtualBox
Файл  Машина  Вид  Ввод  Устройства  Справка
[ 3522.427499] [ 847] 997 847 4935 38 73728 0 0 lsmd
[ 3522.427807] [ 848] 0 848 4573 38 65536 0 0 mcelog
[ 3522.428120] [ 853] 0 853 107192 13 454656 500 0 sssd
[ 3522.428417] [ 854] 70 854 21332 80 167936 27 0 avahi-daemon
[ 3522.428703] [ 861] 70 861 21299 64 147456 43 0 avahi-daemon
[ 3522.429000] [ 870] 991 870 40039 98 212992 106 0 rngd
[ 3522.429280] [ 872] 0 872 109353 136 458752 535 0 sssd_be
[ 3522.429556] [ 876] 0 876 126583 1 487424 5566 0 firewalld
[ 3522.429814] [ 877] 0 877 109698 377 466944 42 0 sssd_nss
[ 3522.430081] [ 901] 0 901 26458 237 237568 326 0 systemd-logind
[ 3522.430570] [ 910] 0 910 170515 263 401408 373 0 NetworkManager
[ 3522.431056] [ 919] 0 919 23083 104 200704 120 -1000 sshd
[ 3522.431290] [ 920] 0 920 156601 942 442368 2380 0 tuned
[ 3522.431514] [ 929] 0 929 77891 81 172032 84 0 gssproxy
[ 3522.431743] [ 1143] 0 1143 30767 101 262144 122 0 login
[ 3522.431981] [ 1145] 0 1145 11001 48 118784 4 0 atd
[ 3522.432208] [ 1146] 0 1146 61679 122 118784 96 0 crond
[ 3522.432423] [ 1565] 0 1565 137037 88 167936 47 0 VBoxService
[ 3522.432639] [ 1580] 0 1580 25178 174 233472 180 0 systemd
[ 3522.432879] [ 1585] 0 1585 39934 0 307200 1218 0 (sd-pam)
[ 3522.433104] [ 1591] 0 1591 59333 225 90112 273 0 bash
[ 3522.433331] [ 1657] 0 1657 30767 99 270336 123 0 login
[ 3522.433553] [ 1663] 0 1663 59366 1 90112 509 0 bash
[ 3522.433783] [ 13052] 0 13052 55629 38 73728 28 0 recorder.sh
[ 3522.434015] [ 13053] 0 13053 658226 412422 4898816 190252 0 mem.sh
[ 3522.434226] [ 14233] 0 14233 11624 59 126976 0 0 top
[ 3522.434443] [ 14234] 0 14234 54271 18 65536 0 0 head
[ 3522.434648] [ 14235] 0 14235 54277 17 61440 0 0 tail
[ 3522.434862] oom-kill:constraint=CONSTRAINT_NONE,nodemask=(null),cpuset=/,mems_allowed=0,global_oom,task_memcg=/user.slice/user-0.slice/session-3.scope,task=mem.sh,pid=13053,uid=0
[ 3522.435206] Out of memory: Killed process 13053 (mem.sh) total-vm:2632904kB, anon-rss:1649680kB,
file-rss:0kB, shmem-rss:0kB, UID:0 pgtables:4784kB oom_score_adj:0
[ 3522.503156] oom_reaper: reaped process 13053 (mem.sh), now anon-rss:0kB, file-rss:0kB, shmem-rss:0kB
```

2. Значение в последней строке report.log – 7 010 000

3. Данные, полученные в процессе выполнения mem.sh записаны в файл parameters.log
12:51:48

System parameters:

```
MiB Mem : 1817.3 total, 1618.5 free, 136.0 used, 62.9 buff/cache
MiB Swap: 820.0 total, 776.0 free, 44.0 used. 1573.0 avail Mem
```

mem.sh parameters:

```
13053 root 20 0 230708 11348 2964 R 99.9 0.6 0:00.55 mem.sh
```

Top 5 processes parameters:

```
13053 root 20 0 234164 14804 2964 R 88.2 0.8 0:00.78 mem.sh
1 root 20 0 186376 2780 0 S 0.0 0.1 0:00.74 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
```

12:51:50

System parameters:

```
MiB Mem : 1817.3 total, 1590.3 free, 164.1 used, 62.9 buff/cache
MiB Swap: 820.0 total, 776.0 free, 44.0 used. 1544.8 avail Mem
```

mem.sh parameters:

```
13053 root 20 0 259512 40024 2964 R 99.9 2.2 0:02.42 mem.sh
```

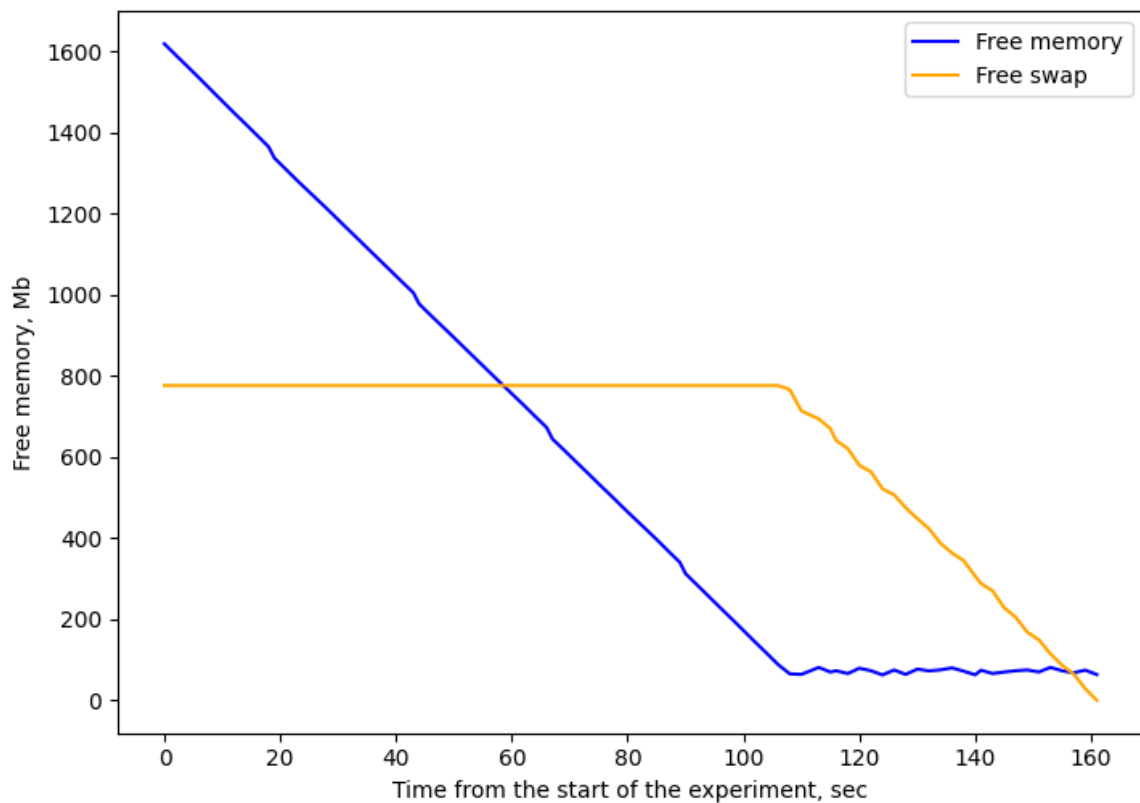
Top 5 processes parameters:

```
13053 root 20 0 262840 43480 2964 R 93.8 2.3 0:02.65 mem.sh
1 root 20 0 186376 2780 0 S 0.0 0.1 0:00.74 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
```

4. Записи о скрипте в системном журнале

```
[ 2931.421389] [ 9132] 0 9132 660754 406729 4935680 198457 0 mem.sh
[ 2931.422443] oom-kill:constraint=CONSTRAINT_NONE,nodemask=(null),cpuset=/,
mems_allowed=0,global_oom,task_memcg=/user.slice/user-0.slice/session-3.scope,task=mem.sh,pid=9132,uid=0
[ 2931.422866] Out of memory: Killed process 9132 (mem.sh) total-vm:2643016kB,
anon-rss:1626916kB, file-rss:0kB, shmem-rss:0kB, UID:0 pgtables:4820kB oom_score_adj:0
[ 2931.491438] oom_reaper: reaped process 9132 (mem.sh), now anon-rss:0kB, file-rss:0kB, shmem-rss:0kB
[ 3522.434015] [ 13053] 0 13053 658226 412422 4898816 190252 0 mem.sh
[ 3522.434862] oom-kill:constraint=CONSTRAINT_NONE,nodemask=(null),cpuset=/,mems_allowed=0,
global_oom,task_memcg=/user.slice/user-0.slice/session-3.scope,task=mem.sh,pid=13053,uid=0
[ 3522.435286] Out of memory: Killed process 13053 (mem.sh) total-vm:2632904kB,
anon-rss:1649688kB, file-rss:0kB, shmem-rss:0kB, UID:0 pgtables:4784kB oom_score_adj:0
[ 3522.503156] oom_reaper: reaped process 13053 (mem.sh), now anon-rss:0kB, file-rss:0kB, shmem-rss:0kB
```

5. График зависимости свободной памяти от времени по данным п3, построен с помощью matplotlib python 3.



Второй этап:

1. Последняя запись журнала – значения параметров, с которыми произошла аварийная остановка.

```
CentOS8 [Работает] - Oracle VM VirtualBox
Файл  Машина  Вид  Ввод  Устройства  Справка
[ 278.250926] [ 856] 70 856 21299 95 147456 12 0 avahi-daemon
[ 278.251204] [ 867] 991 867 40039 179 208896 26 0 rngd
[ 278.251484] [ 870] 0 870 109351 633 442368 37 0 sssd_be
[ 278.251766] [ 873] 0 873 126583 3221 487424 2284 0 firewallld
[ 278.252026] [ 874] 0 874 109698 417 475136 0 0 sssd_nss
[ 278.252283] [ 897] 0 897 26458 408 229376 140 0 systemd-login
[ 278.252784] [ 909] 0 909 170529 704 409600 439 0 NetworkManager
[ 278.253260] [ 918] 0 918 156601 2373 438272 1455 0 tuned
[ 278.253500] [ 920] 0 920 23083 189 192512 35 -1000 sshd
[ 278.253729] [ 926] 0 926 77891 103 176128 62 0 gssproxy
[ 278.253971] [ 1139] 0 1139 61679 193 110592 23 0 crond
[ 278.254195] [ 1140] 0 1140 11001 51 114688 0 0 atd
[ 278.254414] [ 1141] 0 1141 30767 181 270336 42 0 login
[ 278.254638] [ 1565] 0 1565 137037 110 167936 24 0 VBoxService
[ 278.254872] [ 1583] 0 1583 25175 336 229376 16 0 systemd
[ 278.255101] [ 1588] 0 1588 60416 36 327680 1190 0 (sd-pam)
[ 278.255322] [ 1594] 0 1594 59333 1 86016 474 0 bash
[ 278.255549] [ 1622] 0 1622 55629 38 81920 29 0 recorder.sh
[ 278.255787] [ 1623] 0 1623 55629 38 77824 28 0 recorder2.sh
[ 278.256010] [ 1624] 0 1624 358255 213440 2494464 89235 0 mem.sh
[ 278.256234] [ 1626] 0 1626 358255 192458 2498560 110225 0 mem2.sh
[ 278.256443] [ 3928] 0 3928 11624 59 118784 0 0 top
[ 278.256658] [ 3929] 0 3929 54271 18 69632 0 0 head
[ 278.256876] [ 3930] 0 3930 54277 17 65536 0 0 tail
[ 278.257076] [ 3931] 0 3931 11624 58 126976 0 0 top
[ 278.257281] [ 3932] 0 3932 54271 17 73728 0 0 head
[ 278.257477] [ 3933] 0 3933 54277 18 65536 0 0 tail
[ 278.257676] oom-kill:constraint=CONSTRAINT_NONE,nodemask=(null),cpuset=/,mems_allowed=0,global_oom,task_memcg=/user.slice/user-0.slice/session-1.scope,task=mem2.sh,pid=1626,uid=0
[ 278.258096] Out of memory: Killed process 1626 (mem2.sh) total-vm:1433020kB, anon-rss:769832kB, f
file-rss:0kB, shmem-rss:0kB, UID:0 pgtables:2440kB oom_score_adj:0
[ 278.298471] oom_reaper: reaped process 1626 (mem2.sh), now anon-rss:0kB, file-rss:0kB, shmem-rss:
0kB
./recorder2.sh: line 20: 1626 Killed ./mem2.sh

CentOS8 [Работает] - Oracle VM VirtualBox
Файл  Машина  Вид  Ввод  Устройства  Справка
[ 483.003930] [ 859] 991 859 40039 0 217088 718 0 rngd
[ 483.004209] [ 860] 70 860 21299 63 151552 44 0 avahi-daemon
[ 483.004502] [ 867] 0 867 109352 153 462048 517 0 sssd_be
[ 483.004767] [ 873] 0 873 126583 1648 483328 3859 0 firewallld
[ 483.005032] [ 874] 0 874 109698 416 491520 0 0 sssd_nss
[ 483.005298] [ 885] 0 885 26457 264 225280 296 0 systemd-login
[ 483.005792] [ 909] 0 909 170516 289 401408 348 0 NetworkManager
[ 483.006280] [ 919] 0 919 156601 1231 438272 2605 0 tuned
[ 483.006516] [ 924] 0 924 23083 116 208896 108 -1000 sshd
[ 483.006752] [ 926] 0 926 77891 82 176128 84 0 gssproxy
[ 483.006976] [ 1132] 0 1132 61680 138 114688 81 0 crond
[ 483.007221] [ 1133] 0 1133 30767 113 266240 110 0 login
[ 483.007443] [ 1134] 0 1134 11001 46 110592 4 0 atd
[ 483.007666] [ 1564] 0 1564 137037 91 176128 43 0 VBoxService
[ 483.007887] [ 1579] 0 1579 25178 192 233472 161 0 systemd
[ 483.008107] [ 1584] 0 1584 39934 0 307200 1220 0 (sd-pam)
[ 483.008349] [ 1590] 0 1590 59333 1 94208 473 0 bash
[ 483.008571] [ 1632] 0 1632 55629 38 77824 29 0 recorder.sh
[ 483.008803] [ 1633] 0 1633 55662 80 77824 26 0 recorder2.sh
[ 483.009026] [ 1634] 0 1634 663437 414919 4943872 192958 0 mem.sh
[ 483.009299] [ 4385] 0 4385 56587 29 65536 0 0 agetty
[ 483.009514] [ 5063] 0 5063 65354 98 143360 0 0 top
[ 483.009723] [ 5064] 0 5064 54271 18 69632 0 0 head
[ 483.009939] [ 5065] 0 5065 54277 17 69632 0 0 tail
[ 483.010140] [ 5066] 0 5066 65354 97 151552 0 0 top
[ 483.010361] [ 5067] 0 5067 54271 17 61440 0 0 head
[ 483.010559] [ 5068] 0 5068 54277 17 69632 0 0 tail
[ 483.010753] oom-kill:constraint=CONSTRAINT_NONE,nodemask=(null),cpuset=/,mems_allowed=0,global_oom,task_memcg=/user.slice/user-0.slice/session-1.scope,task=mem.sh,pid=1634,uid=0
[ 483.011173] Out of memory: Killed process 1634 (mem.sh) total-vm:2653748kB, anon-rss:1659676kB, f
file-rss:0kB, shmem-rss:0kB, UID:0 pgtables:4828kB oom_score_adj:0
[ 483.108029] oom_reaper: reaped process 1634 (mem.sh), now anon-rss:0kB, file-rss:0kB, shmem-rss:0
kB
./recorder.sh: line 20: 1634 Killed ./mem.sh
```

2. Значение в последней строке report.log – 7 000 000, report2.log – 3 520 000.
3. Данные, полученные в процессе исполнения mem.sh записаны в файл parameters.log, для mem2.sh аналогично в parameters2.log

14:25:54

System parameters:

MiB Mem : 1817.3 total, 1282.1 free, 167.6 used, 367.6 buff/cache
MiB Swap: 820.0 total, 820.0 free, 0.0 used. 1490.1 avail Mem

mem.sh parameters:

1624 root 20 0 227636 8084 2904 R 41.2 0.4 0:00.32 mem.sh

Top 5 processes parameters:

1624 root 20 0 229428 10004 2904 R 43.8 0.5 0:00.44 mem.sh
1626 root 20 0 229300 9856 2884 R 43.8 0.5 0:00.43 mem2.sh
1 root 20 0 186376 14336 9672 S 0.0 0.8 0:00.71 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

14:25:54

System parameters:

MiB Mem : 1817.3 total, 1282.7 free, 167.0 used, 367.6 buff/cache
MiB Swap: 820.0 total, 820.0 free, 0.0 used. 1489.3 avail Mem

mem2.sh parameters:

1626 root 20 0 227508 7936 2884 R 52.9 0.4 0:00.32 mem2.sh

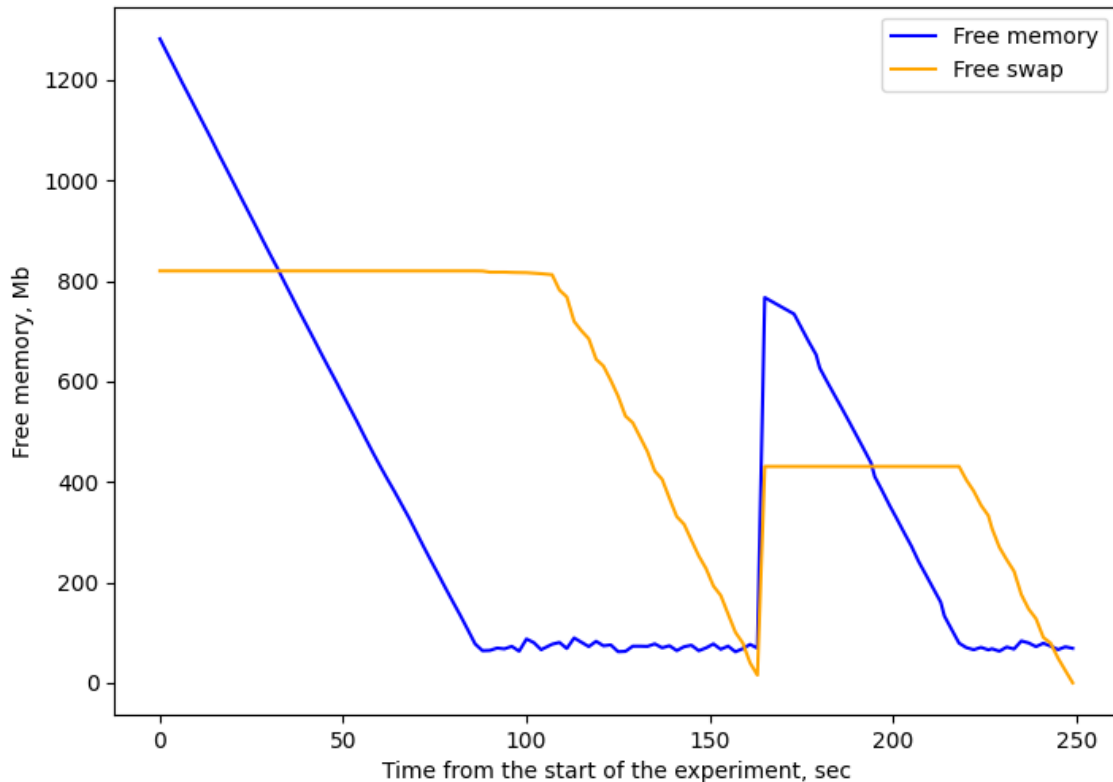
Top 5 processes parameters:

1624 root 20 0 229300 9876 2904 R 43.8 0.5 0:00.43 mem.sh
1626 root 20 0 229044 9600 2884 R 43.8 0.5 0:00.42 mem2.sh
1 root 20 0 186376 14336 9672 S 0.0 0.8 0:00.71 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. Записи о скрипте в системном журнале

```
[ 278.256010] [ 1624] 0 1624 358255 213440 2494464 89235 0 mem.sh
[ 380.083131] [ 1624] 0 1624 657842 409027 4894720 193240 0 mem.sh
[ 380.084615] oom-kill:constraint=CONSTRAINT_NONE,nodemask=(null),cpuset=/,mems_allowed=0,
global_oom,task_memcg=/user.slice/user-0.slice/session-1.scope,task=mem.sh,pid=1624,uid=0
[ 380.085056] Out of memory: Killed process 1624 (mem.sh) total-vms:2631368kB,
anon-rss:1636108kB, file-rss:0kB, shmem-rss:0kB, UID:0 pgtables:4780kB oom_score_adj:0
[ 380.159956] oom_reaper: reaped process 1624 (mem.sh), now anon-rss:0kB, file-rss:0kB, shmem-rss:0kB
[ 278.256234] [ 1626] 0 1626 358255 192458 2498560 110225 0 mem2.sh
[ 278.257676] oom-kill:constraint=CONSTRAINT_NONE,nodemask=(null),cpuset=/,mems_allowed=0,
global_oom,task_memcg=/user.slice/user-0.slice/session-1.scope,task=mem2.sh,pid=1626,uid=0
[ 278.258096] Out of memory: Killed process 1626 (mem2.sh) total-vms:1433020kB, anon-rss:769832kB,
file-rss:0kB, shmem-rss:0kB, UID:0 pgtables:2440kB oom_score_adj:0
[ 278.298471] oom_reaper: reaped process 1626 (mem2.sh), now anon-rss:0kB, file-rss:0kB, shmem-rss:0kB
```


5. График зависимости свободной памяти от времени по данным п3, построен с помощью matplotlib python 3.



Выводы по эксперименту №1:

- В случае запуска одного скрипта, при малых значениях свободной физической памяти (в моём случае <60 Мб) система переходит на использование файлов подкачки. В момент, когда их свободное значение падает до 0, происходит аварийное завершение процесса.
- В случае запуска двух скриптов сразу, в начале на графике можно увидеть картину, схожую с п1. Далее, в момент ~160 секунд от запуска скриптов, mem2.sh аварийно завершает свою работу, освобождая как физическую память, так и файлы подкачки. После чего ситуация для mem.sh аналогична п1.

Эксперимент №2

Подготовительный этап:

1. Изменён скрипт mem.sh, который теперь завершает своё исполнение при определённом размере массива.

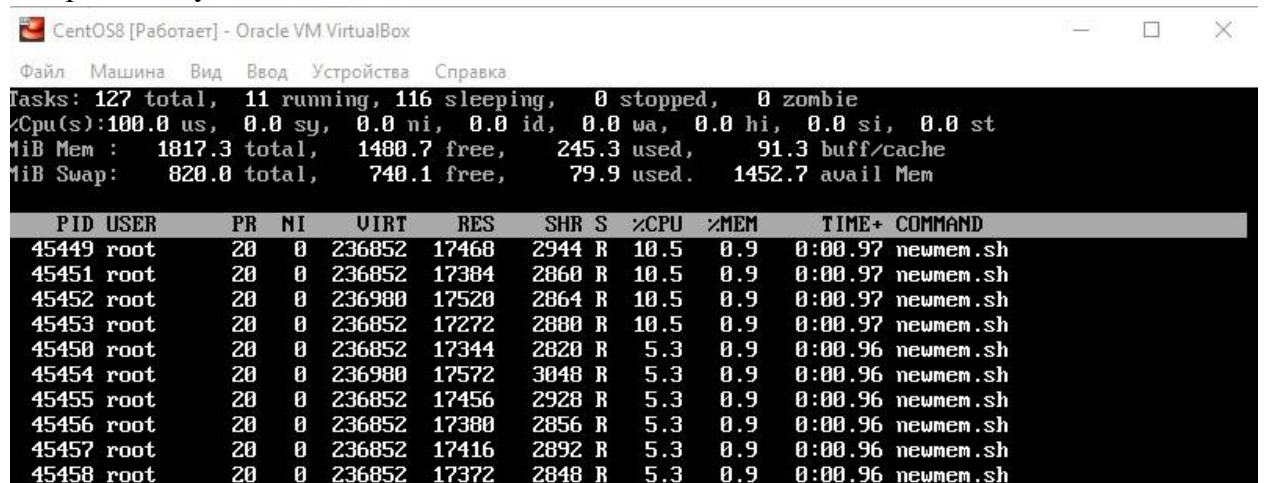
```
1  #!/bin/bash
2
3  report="/home/user/OS/lab5/exp2/report.log"
4  N=$1
5
6  declare -a array
7  declare -a numbers=(1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,
8
9  #rm $report
10
11  while :
12  do
13      array+=(${numbers[@]})
14      if [[ "${#array[@]}" -gt "$N" ]]
15      then
16          echo "Successfully finished with array size - $N" >> $report
17          exit 0
18      fi
19  done
```

Основной этап:

1. Написан скрипт для запуска newmem.sh в количестве K с заданным N.

```
1  #!/bin/bash
2
3  K=$1
4  N=$2
5
6  for i in $(seq 1 $K)
7  do
8      ./newmem.sh $N&
9  done
```

2. Произведён запуск 10 newmem.sh с заданным $N = 7\,000\,000 / 10 = 700\,000$, все процессы завершились успешно.



The screenshot shows a terminal window titled "CentOS8 [Работает] - Oracle VM VirtualBox". The terminal output includes system statistics and a list of running processes.

System Statistics:

```
Tasks: 127 total, 11 running, 116 sleeping, 0 stopped, 0 zombie
Cpu(s): 100.0 us, 0.0 sy, 0.0 ni, 0.0 id, 0.0 wa, 0.0 hi, 0.0 si, 0.0 st
MiB Mem : 1817.3 total, 1480.7 free, 245.3 used, 91.3 buff/cache
MiB Swap: 820.0 total, 740.1 free, 79.9 used, 1452.7 avail Mem
```

Running Processes:

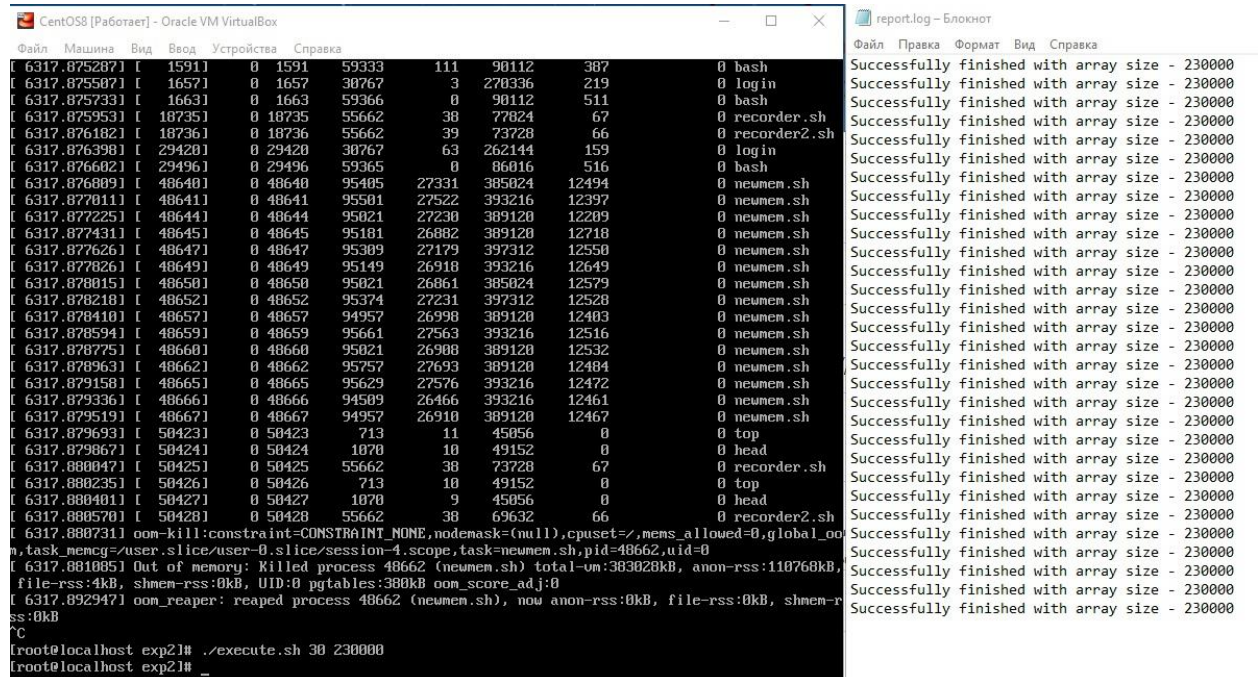
PID	USER	PR	NI	UIRT	RES	SHR	S	%CPU	%MEM	TIME+	COMMAND
45449	root	20	0	236852	17468	2944	R	10.5	0.9	0:00.97	newmem.sh
45451	root	20	0	236852	17384	2860	R	10.5	0.9	0:00.97	newmem.sh
45452	root	20	0	236980	17520	2864	R	10.5	0.9	0:00.97	newmem.sh
45453	root	20	0	236852	17272	2880	R	10.5	0.9	0:00.97	newmem.sh
45450	root	20	0	236852	17344	2820	R	5.3	0.9	0:00.96	newmem.sh
45454	root	20	0	236980	17572	3048	R	5.3	0.9	0:00.96	newmem.sh
45455	root	20	0	236852	17456	2928	R	5.3	0.9	0:00.96	newmem.sh
45456	root	20	0	236852	17380	2856	R	5.3	0.9	0:00.96	newmem.sh
45457	root	20	0	236852	17416	2892	R	5.3	0.9	0:00.96	newmem.sh
45458	root	20	0	236852	17372	2848	R	5.3	0.9	0:00.96	newmem.sh


```
report.log - Блокнот
Файл  Правка  Формат  Вид  Справка
Successfully finished with array size - 700000
Successfully finished with array size - 700000
Successfully finished with array size - 700000
Successfully finished with array size - 700000
Successfully finished with array size - 700000
Successfully finished with array size - 700000
Successfully finished with array size - 700000
Successfully finished with array size - 700000
Successfully finished with array size - 700000
Successfully finished with array size - 700000
```

3. Произведён запуск 30 newmem.sh с заданным N = 700 000, процессы после 10 были завершены аварийно с соответствующим сообщением, ниже приведён пример одного из них.

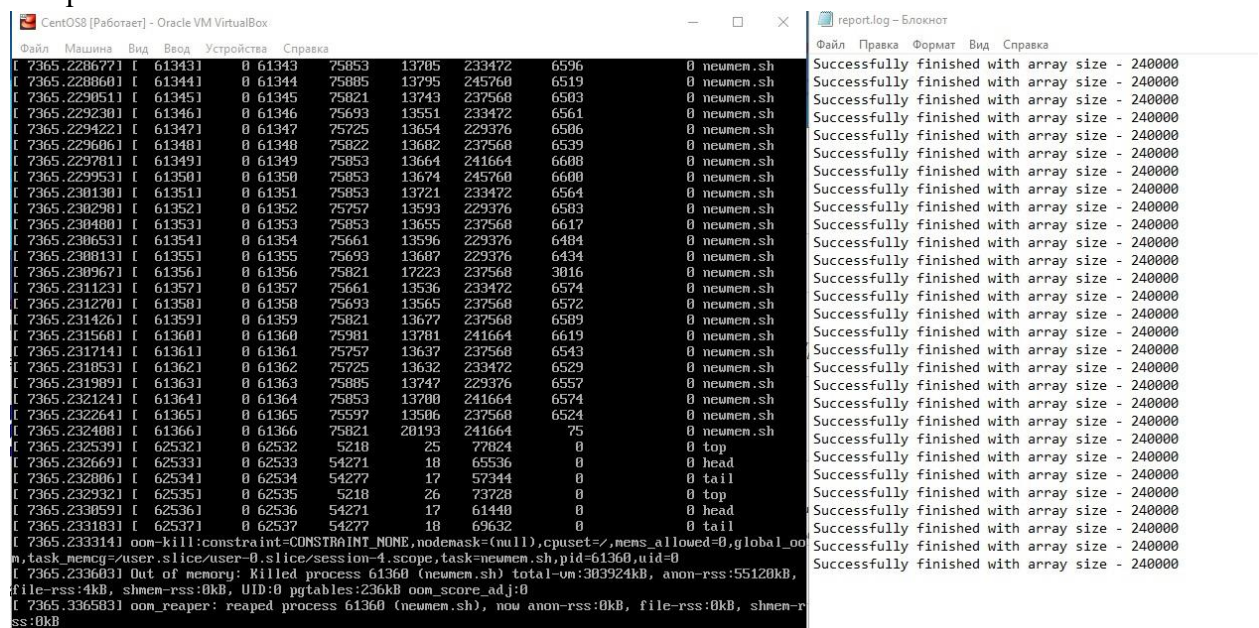
```
CentOS8 [Работает] - Oracle VM VirtualBox
Файл  Машина  Вид  Ввод  Устройства  Справка
[ 6363.871648] [ 29496] 0 29496 59365 0 86016 516 0 bash
[ 6363.871854] [ 48640] 0 48640 105517 34436 466944 15501 0 newmem.sh
[ 6363.872068] [ 48644] 0 48644 105101 33256 471040 16264 0 newmem.sh
[ 6363.872268] [ 48645] 0 48645 104781 33588 462848 15612 0 newmem.sh
[ 6363.872473] [ 48647] 0 48647 104845 33710 475136 15555 0 newmem.sh
[ 6363.872667] [ 48649] 0 48649 109773 38584 512000 15608 0 newmem.sh
[ 6363.872857] [ 48650] 0 48650 104493 33455 462848 15457 0 newmem.sh
[ 6363.873075] [ 48652] 0 48652 109901 38984 512000 15336 0 newmem.sh
[ 6363.873264] [ 48657] 0 48657 105005 34064 466944 15362 0 newmem.sh
[ 6363.873456] [ 48660] 0 48660 105197 34164 471040 15452 0 newmem.sh
[ 6363.873641] [ 48665] 0 48665 105069 34074 471040 15414 0 newmem.sh
[ 6363.873821] [ 48666] 0 48666 108781 37862 507904 15338 0 newmem.sh
[ 6363.874024] [ 48667] 0 48667 104461 33507 466944 15374 0 newmem.sh
[ 6363.874207] [ 50692] 0 50692 6277 29 81920 0 0 top
[ 6363.874387] [ 50693] 0 50693 54271 17 65536 0 0 head
[ 6363.874573] [ 50694] 0 50694 54277 17 65536 0 0 tail
[ 6363.874750] [ 50695] 0 50695 6277 28 86016 0 0 top
[ 6363.874924] [ 50696] 0 50696 54271 17 65536 0 0 head
[ 6363.875118] [ 50697] 0 50697 54277 17 61440 0 0 tail
[ 6363.875286] oom-kill:constraint=CONSTRAINT_NONE,nodemask=(null),cpuset=/,mems_allowed=0,global_oo
n,task_memcg=/user.slice/user-0.slice/session-4.scope,task=newmem.sh,pid=48652,uid=0
[ 6363.875643] Out of memory: Killed process 48652 (newmem.sh) total-vm:439604kB, anon-rss:155932kB,
file-rss:4kB, shmem-rss:0kB, UID:0 pgtables:500kB oom_score_adj:0
[ 6363.889162] oom_reaper: reaped process 48652 (newmem.sh), now anon-rss:0kB, file-rss:0kB, shmem-r
ss:0kB
[ 6380.010855] newmem.sh invoked oom-killer: gfp_mask=0x6200ca(GFP_HIGHUSER_MOVABLE), order=0, oom_s
core_adj=0
[ 6380.011314] CPU: 0 PID: 48645 Comm: newmem.sh Kdump: loaded Tainted: G OE -----r
- 4.18.0-305.25.1.el8_4.x86_64 #1
[ 6380.011771] Hardware name: innotek GmbH VirtualBox/VirtualBox, BIOS VirtualBox 12/01/2006
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4. Вычислим такое значение N, что при K = 30, все скрипты будут завершены успешно. Логично, что для этого необходимо $7\,000\,000 / 30 = 230\,000$ с округлением в меньшую сторону. Проверим запуском при K = 30, N = 230 000. Наши расчёты оказались верны.



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CentOS8 [Рабочий] - Oracle VM VirtualBox
Файл Машина Вид Ввод Устройства Справка
[ 6317.875287] [ 15911] 0 15911 59333 111 90112 387 0 bash Successfully finished with array size - 230000
[ 6317.875507] [ 16571] 0 16571 30767 3 270336 219 0 login Successfully finished with array size - 230000
[ 6317.875733] [ 16631] 0 16631 59366 0 90112 511 0 bash Successfully finished with array size - 230000
[ 6317.875953] [ 187351] 0 187351 55662 38 77824 67 0 recorder.sh Successfully finished with array size - 230000
[ 6317.876182] [ 187361] 0 187361 55662 39 73728 66 0 recorder2.sh Successfully finished with array size - 230000
[ 6317.876398] [ 294201] 0 294201 30767 63 262144 159 0 login Successfully finished with array size - 230000
[ 6317.876602] [ 294961] 0 294961 59365 0 86016 516 0 bash Successfully finished with array size - 230000
[ 6317.876809] [ 486401] 0 486401 95485 27331 385024 12494 0 newmem.sh Successfully finished with array size - 230000
[ 6317.877011] [ 486411] 0 486411 95501 27522 393216 12397 0 newmem.sh Successfully finished with array size - 230000
[ 6317.877225] [ 486441] 0 486441 95021 27230 389120 12209 0 newmem.sh Successfully finished with array size - 230000
[ 6317.877431] [ 486451] 0 486451 95181 26882 389120 12718 0 newmem.sh Successfully finished with array size - 230000
[ 6317.877626] [ 486471] 0 486471 95309 27179 397312 12550 0 newmem.sh Successfully finished with array size - 230000
[ 6317.877826] [ 486491] 0 486491 95149 26918 393216 12649 0 newmem.sh Successfully finished with array size - 230000
[ 6317.878015] [ 486501] 0 486501 95021 26861 385024 12579 0 newmem.sh Successfully finished with array size - 230000
[ 6317.878218] [ 486521] 0 486521 95734 27231 397312 12528 0 newmem.sh Successfully finished with array size - 230000
[ 6317.878410] [ 486571] 0 486571 94957 26998 389120 12403 0 newmem.sh Successfully finished with array size - 230000
[ 6317.878594] [ 486591] 0 486591 95661 27563 393216 12516 0 newmem.sh Successfully finished with array size - 230000
[ 6317.878775] [ 486601] 0 486601 95021 26908 389120 12532 0 newmem.sh Successfully finished with array size - 230000
[ 6317.878963] [ 486621] 0 486621 95757 27693 389120 12484 0 newmem.sh Successfully finished with array size - 230000
[ 6317.879158] [ 486651] 0 486651 95629 27576 393216 12472 0 newmem.sh Successfully finished with array size - 230000
[ 6317.879336] [ 486661] 0 486661 94509 26466 393216 12461 0 newmem.sh Successfully finished with array size - 230000
[ 6317.879519] [ 486671] 0 486671 94957 26910 389120 12467 0 newmem.sh Successfully finished with array size - 230000
[ 6317.879693] [ 504231] 0 504231 713 11 45056 0 0 top Successfully finished with array size - 230000
[ 6317.879867] [ 504241] 0 504241 1070 10 49152 0 0 head Successfully finished with array size - 230000
[ 6317.880047] [ 504251] 0 504251 55662 38 73728 67 0 recorder.sh Successfully finished with array size - 230000
[ 6317.880235] [ 504261] 0 504261 713 10 49152 0 0 top Successfully finished with array size - 230000
[ 6317.880401] [ 504271] 0 504271 1070 9 45056 0 0 head Successfully finished with array size - 230000
[ 6317.880570] [ 504281] 0 504281 55662 38 69632 66 0 recorder2.sh Successfully finished with array size - 230000
[ 6317.880731] oom-kill:constraint=CONSTRAINT_NONE,nodemask=(null),cpuset=/,mems_allowed=0,global_oom,task_memcg=/user.slice/user-0.slice/session-4.scope,task=newmem.sh,pid=48662,uid=0 Successfully finished with array size - 230000
[ 6317.881085] Out of memory: Killed process 48662 (newmem.sh) total-vm:383028kB, anon-rss:110768kB, file-rss:4kB, shmem-rss:0kB, UID:0 pgtables:380kB oom_score_adj:0 Successfully finished with array size - 230000
[ 6317.892947] oom_reaper: reaped process 48662 (newmem.sh), now anon-rss:0kB, file-rss:0kB, shmem-rss:0kB Successfully finished with array size - 230000
root@localhost exp21# ./execute.sh 30 230000
root@localhost exp21# _
```

5. Проверим, что мы действительно нашли максимальное значение – сделаем тестовый запуск при K = 30, N = 240 000. Действительно, последний скрипт newmem.sh завершается аварийно с соответствующей ошибкой. В журнале лишь 29 записей об успешном завершении.



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Файл Машина Вид Ввод Устройства Справка
[ 7365.228677] [ 613431] 0 613431 75853 13705 233472 6596 0 newmem.sh Successfully finished with array size - 240000
[ 7365.228860] [ 613441] 0 613441 75885 13795 245760 6519 0 newmem.sh Successfully finished with array size - 240000
[ 7365.229051] [ 613451] 0 613451 75821 13743 237568 6503 0 newmem.sh Successfully finished with array size - 240000
[ 7365.229230] [ 613461] 0 613461 75693 13551 233472 6561 0 newmem.sh Successfully finished with array size - 240000
[ 7365.229422] [ 613471] 0 613471 75725 13654 229376 6506 0 newmem.sh Successfully finished with array size - 240000
[ 7365.229606] [ 613481] 0 613481 75822 13682 237568 6539 0 newmem.sh Successfully finished with array size - 240000
[ 7365.229781] [ 613491] 0 613491 75853 13664 241664 6608 0 newmem.sh Successfully finished with array size - 240000
[ 7365.229953] [ 613501] 0 613501 75853 13674 245760 6600 0 newmem.sh Successfully finished with array size - 240000
[ 7365.230130] [ 613511] 0 613511 75853 13721 233472 6564 0 newmem.sh Successfully finished with array size - 240000
[ 7365.230298] [ 613521] 0 613521 75757 13593 229376 6583 0 newmem.sh Successfully finished with array size - 240000
[ 7365.230480] [ 613531] 0 613531 75853 13655 237568 6617 0 newmem.sh Successfully finished with array size - 240000
[ 7365.230653] [ 613541] 0 613541 75661 13596 229376 6484 0 newmem.sh Successfully finished with array size - 240000
[ 7365.230813] [ 613551] 0 613551 75693 13687 229376 6434 0 newmem.sh Successfully finished with array size - 240000
[ 7365.230967] [ 613561] 0 613561 75821 12223 237568 3016 0 newmem.sh Successfully finished with array size - 240000
[ 7365.231123] [ 613571] 0 613571 75661 13536 233472 6574 0 newmem.sh Successfully finished with array size - 240000
[ 7365.231270] [ 613581] 0 613581 75693 13565 237568 6572 0 newmem.sh Successfully finished with array size - 240000
[ 7365.231426] [ 613591] 0 613591 75821 13677 237568 6589 0 newmem.sh Successfully finished with array size - 240000
[ 7365.231568] [ 613601] 0 613601 75981 13781 241664 6619 0 newmem.sh Successfully finished with array size - 240000
[ 7365.231714] [ 613611] 0 613611 75757 13637 237568 6543 0 newmem.sh Successfully finished with array size - 240000
[ 7365.231853] [ 613621] 0 613621 75725 13632 233472 6529 0 newmem.sh Successfully finished with array size - 240000
[ 7365.231989] [ 613631] 0 613631 75885 13747 229376 6557 0 newmem.sh Successfully finished with array size - 240000
[ 7365.232124] [ 613641] 0 613641 75853 13700 241664 6574 0 newmem.sh Successfully finished with array size - 240000
[ 7365.232264] [ 613651] 0 613651 75597 13506 237568 6524 0 newmem.sh Successfully finished with array size - 240000
[ 7365.232408] [ 613661] 0 613661 75821 20193 241664 75 0 newmem.sh Successfully finished with array size - 240000
[ 7365.232539] [ 625321] 0 625321 5218 25 77824 0 0 top Successfully finished with array size - 240000
[ 7365.232669] [ 625331] 0 625331 54271 18 65536 0 0 head Successfully finished with array size - 240000
[ 7365.232806] [ 625341] 0 625341 54277 17 57344 0 0 tail Successfully finished with array size - 240000
[ 7365.232932] [ 625351] 0 625351 5218 26 73728 0 0 top Successfully finished with array size - 240000
[ 7365.233059] [ 625361] 0 625361 54271 17 61440 0 0 head Successfully finished with array size - 240000
[ 7365.233183] [ 625371] 0 625371 54277 18 69632 0 0 tail Successfully finished with array size - 240000
[ 7365.233314] oom-kill:constraint=CONSTRAINT_NONE,nodemask=(null),cpuset=/,mems_allowed=0,global_oom,task_memcg=/user.slice/user-0.slice/session-4.scope,task=newmem.sh,pid=61360,uid=0 Successfully finished with array size - 240000
[ 7365.233603] Out of memory: Killed process 61360 (newmem.sh) total-vm:303924kB, anon-rss:55120kB, file-rss:4kB, shmem-rss:0kB, UID:0 pgtables:236kB oom_score_adj:0 Successfully finished with array size - 240000
[ 7365.233683] oom_reaper: reaped process 61360 (newmem.sh), now anon-rss:0kB, file-rss:0kB, shmem-rss:0kB Successfully finished with array size - 240000
```

Вывод по эксперименту №2:

Найденное экспериментально значение $N = 230\,000 = 7\,000\,000 / 30$.

Вывод:

В ходе работы я на практике убедился, что во время работы с оперативной памятью в системе Linux данные заполняют физическую память, пока она не дойдёт до критически низкого значения. После этого, OS начинает заполнять файлы подкачки. Если и этого оказалось недостаточно, происходит аварийная остановка процесса.