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ФАКУЛЬТЕТ «Информатика и системы управления»

КАФЕДРА «Программное обеспечение ЭВМ и информационные технологии»

ОТЧЕТ

По лабораторной работе №4

По курсу: «Операционные системы»

Тема: «Процессы. Системные вызовы fork() и exec()»

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Оценка:	____________

Москва

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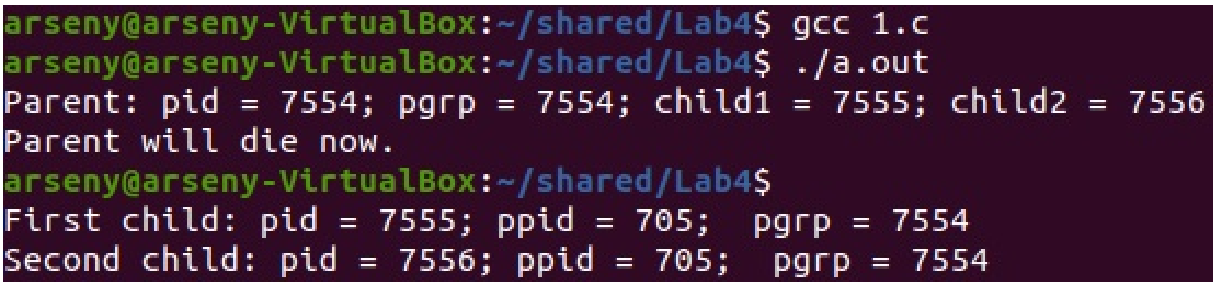
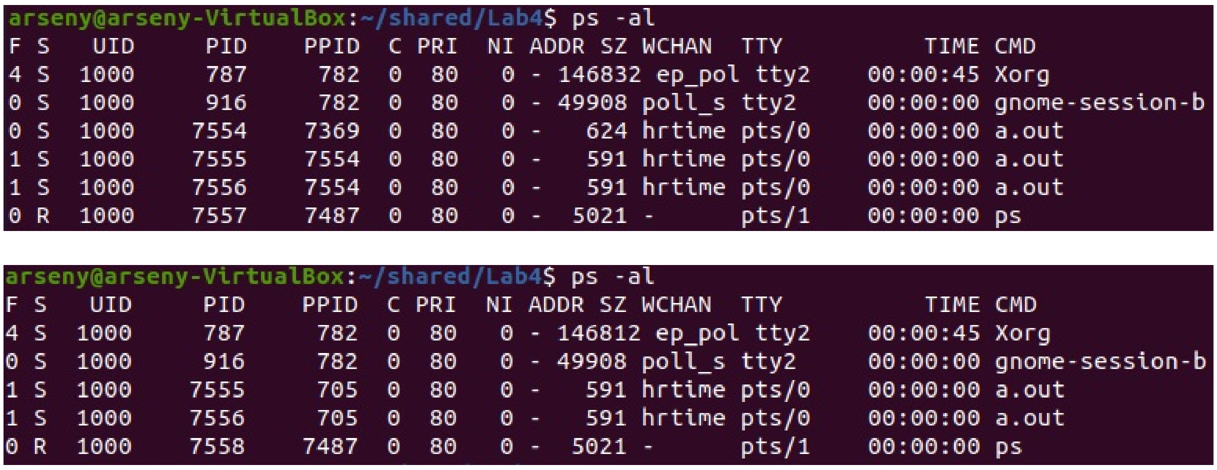
Листинг 1: Программа 1

```c
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>

int main()
{
    int childpid_1, childpid_2;

    if ((childpid_1 = fork()) == -1)
    {
        perror("Can\'t␣fork.\n");
        return EXIT_FAILURE;
    }
    else if (childpid_1 == 0)
    {
        sleep(2);
        printf("\nFirst␣child:␣pid␣=␣%d;␣ppid␣=␣%d;␣␣pgrp␣=␣%d\n", getpid(), getppid(), getpgrp());
        exit(EXIT_SUCCESS);
    }

    if ((childpid_2 = fork()) == -1)
    {
        perror("Can\'t␣fork.\n");
        return EXIT_FAILURE;
    }
    else if (childpid_2 == 0)
    {
        sleep(3);
        printf("Second␣child:␣pid␣=␣%d;␣ppid␣=␣%d;␣␣pgrp␣=␣%d\n", getpid(), getppid(), getpgrp());
        exit(EXIT_SUCCESS);
    }

    printf("Parent:␣pid␣=␣%d;␣pgrp␣=␣%d;␣child1␣=␣%d;␣child2␣=␣%d\n", getpid(), getpgrp(), childpid_1, childpid_2);

    printf("Parent␣will␣die␣now.\n");
    return EXIT_SUCCESS;
}
```



```
arseny@arseny-VirtualBox:~/shared/Lab4$ gcc 1.c
arseny@arseny-VirtualBox:~/shared/Lab4$ ./a.out
Parent: pid = 7554; pgrp = 7554; child1 = 7555; child2 = 7556
Parent will die now.
arseny@arseny-VirtualBox:~/shared/Lab4$
First child: pid = 7555; ppid = 705;  pgrp = 7554
Second child: pid = 7556; ppid = 705;  pgrp = 7554
```

Рис. 1: Результат работы программы 1



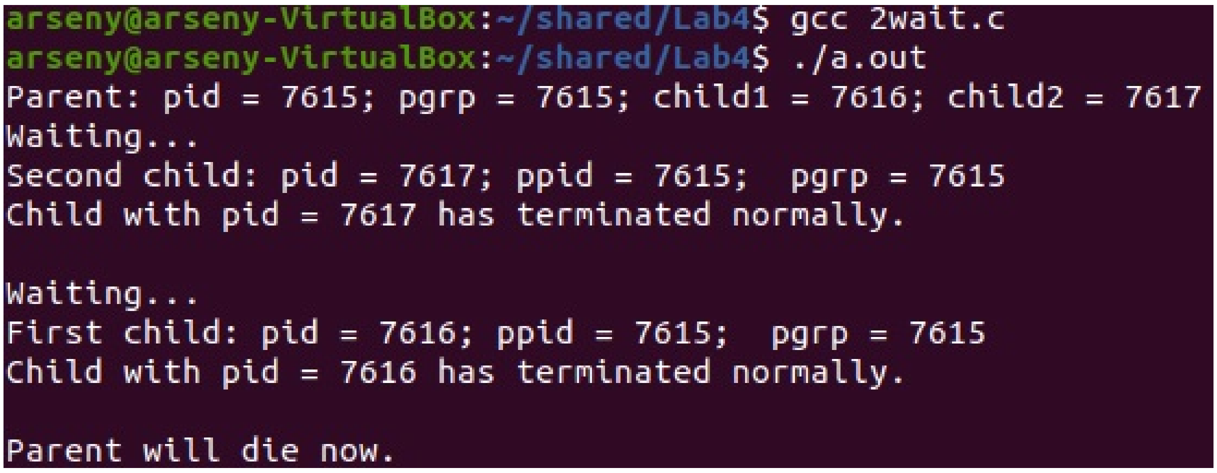
```
arseny@arseny-VirtualBox:~/shared/Lab4$ ps -al
F S   UID     PID    PPID  C PRI  NI ADDR SZ WCHAN  TTY          TIME CMD
4 S  1000     787     782  0  80   0 - 146832 ep_pol tty2    00:00:45 Xorg
0 S  1000     916     782  0  80   0 - 49908 poll_s tty2     00:00:00 gnome-session-b
0 S  1000    7554    7369  0  80   0 -   624 hrtime pts/0    00:00:00 a.out
1 S  1000    7555    7554  0  80   0 -   591 hrtime pts/0    00:00:00 a.out
1 S  1000    7556    7554  0  80   0 -   591 hrtime pts/0    00:00:00 a.out
0 R  1000    7557    7487  0  80   0 -  5021 -      pts/1    00:00:00 ps
```

```
arseny@arseny-VirtualBox:~/shared/Lab4$ ps -al
F S   UID     PID    PPID  C PRI  NI ADDR SZ WCHAN  TTY          TIME CMD
4 S  1000     787     782  0  80   0 - 146812 ep_pol tty2    00:00:45 Xorg
0 S  1000     916     782  0  80   0 - 49908 poll_s tty2     00:00:00 gnome-session-b
1 S  1000    7555     705  0  80   0 -   591 hrtime pts/0    00:00:00 a.out
1 S  1000    7556     705  0  80   0 -   591 hrtime pts/0    00:00:00 a.out
0 R  1000    7558    7487  0  80   0 -  5021 -      pts/1    00:00:00 ps
```

Рис. 2: Демонстрация "усыновления"

Листинг 2: Программа 2

```c
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>
#include <sys/types.h>
#include <sys/wait.h>

void checkStatus(int child_pid, int status);

int main()
{
    int childpid_1, childpid_2;

    if ((childpid_1 = fork()) == -1)
    {
        perror("Can\'t␣fork.\n");
        return EXIT_FAILURE;
    }
    else if (childpid_1 == 0)
    {
        //sleep(1);
        printf("First␣child:␣pid␣=␣%d;␣ppid␣=␣%d;␣␣pgrp␣=␣%d\n", getpid(), getppid(),
            getpgrp());
        exit(EXIT_SUCCESS);
    }

    if ((childpid_2 = fork()) == -1)
    {
        perror("Can\'t␣fork.\n");
        return EXIT_FAILURE;
    }
    else if (childpid_2 == 0)
    {
        //sleep(2);
        printf("Second␣child:␣pid␣=␣%d;␣ppid␣=␣%d;␣␣pgrp␣=␣%d\n", getpid(), getppid(),
            getpgrp());
        exit(EXIT_SUCCESS);
    }

    printf("Parent:␣pid␣=␣%d;␣pgrp␣=␣%d;␣child1␣=␣%d;␣child2␣=␣%d\n", getpid(),
        getpgrp(), childpid_1, childpid_2);

    int status;
    pid_t child_pid;

    printf("Waiting...\n");
    child_pid = wait(&status);
    checkStatus(child_pid, status);

    printf("Waiting...\n");
    child_pid = wait(&status);
    checkStatus(child_pid, status);

    printf("Parent␣will␣die␣now.\n");
    return EXIT_SUCCESS;
}

void checkStatus(int child_pid, int status)
{
    if (WIFEXITED(status))
        printf("Child␣with␣pid␣=␣%d␣has␣terminated␣normally.\n\n", child_pid);
    else if (WEXITSTATUS(status))
        printf("Child␣with␣pid␣=␣%d␣has␣terminated␣with␣code␣%d.\n", child_pid,
            WIFEXITED(status));
    else if (WIFSIGNALED(status))
    {
        printf("Child␣with␣pid␣=␣%d␣has␣terminated␣with␣an␣un-intercepted␣signal.\n",
            child_pid);
        printf("Signal␣number␣=␣%d.\n", WTERMSIG(status));
    }
    else if (WIFSTOPPED(status))
    {
        printf("Child␣with␣pid␣=␣%d␣has␣stopped.\n", child_pid);
        printf("Signal␣number␣=␣%d.", WSTOPSIG(status));
    }
}
```



```
arseny@arseny-VirtualBox:~/shared/Lab4$ gcc 2wait.c
arseny@arseny-VirtualBox:~/shared/Lab4$ ./a.out
Parent: pid = 7615; pgrp = 7615; child1 = 7616; child2 = 7617
Waiting...
Second child: pid = 7617; ppid = 7615;  pgrp = 7615
Child with pid = 7617 has terminated normally.

Waiting...
First child: pid = 7616; ppid = 7615;  pgrp = 7615
Child with pid = 7616 has terminated normally.

Parent will die now.
```

Рис. 3: Результат работы программы 2

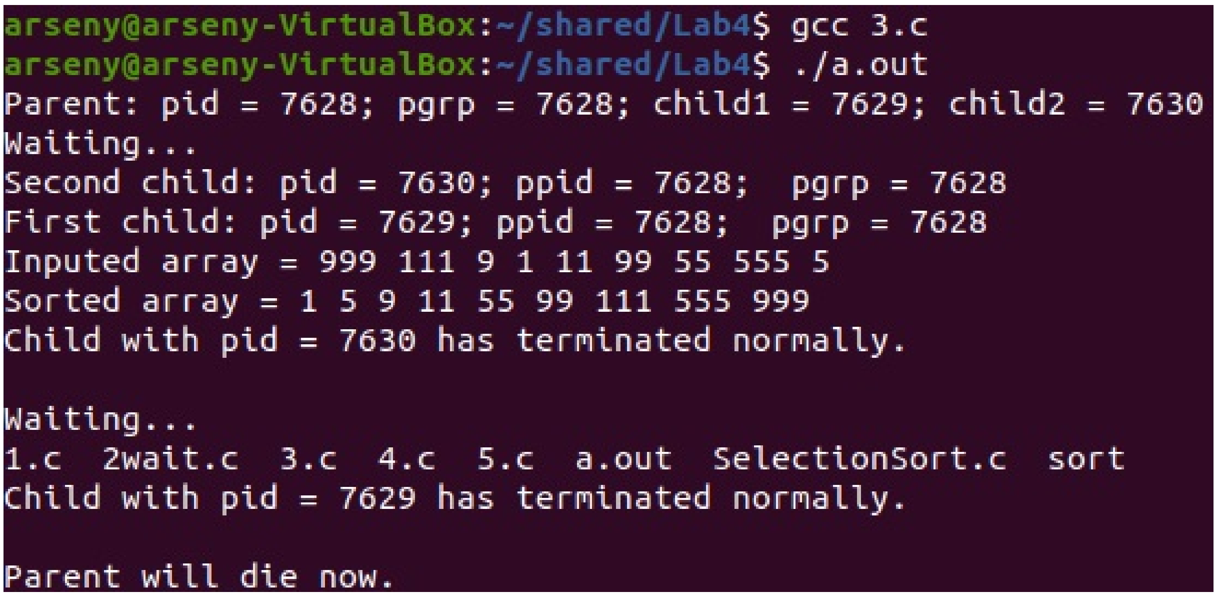
Листинг 3: Программа 3

```c
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>
#include <sys/types.h>
#include <sys/wait.h>

void checkStatus(int child_pid, int status);

int main()
{
    int childpid_1, childpid_2;

    if ((childpid_1 = fork()) == -1)
    {
        perror("Can\'t␣fork.\n");
        return EXIT_FAILURE;
    }
    else if (childpid_1 == 0)
    {
        printf("First␣child:␣pid␣=␣%d;␣ppid␣=␣%d;␣␣pgrp␣=␣%d\n", getpid(), getppid(),
            getpgrp());
        if (execlp("ls", "ls", NULL) == -1)
        {
            perror("First␣child␣can\'t␣exec");
            exit(EXIT_FAILURE);
        }
        exit(EXIT_SUCCESS);
    }

    if ((childpid_2 = fork()) == -1)
    {
        perror("Can\'t␣fork.\n");
        return EXIT_FAILURE;
    }
    else if (childpid_2 == 0)
    {
        printf("Second␣child:␣pid␣=␣%d;␣ppid␣=␣%d;␣␣pgrp␣=␣%d\n", getpid(), getppid(),
            getpgrp());
        if (execl("sort", "sort", "999", "111", "9", "1", "11", "99", "55", "555",
            "5", NULL) == -1)
        {
            perror("Second␣child␣can\'t␣exec");
            exit(EXIT_FAILURE);
        }
        exit(EXIT_SUCCESS);
    }

    printf("Parent:␣pid␣=␣%d;␣pgrp␣=␣%d;␣child1␣=␣%d;␣child2␣=␣%d\n", getpid(),
        getpgrp(), childpid_1, childpid_2);

    int status;
    pid_t child_pid;

    printf("Waiting...\n");
    child_pid = wait(&status);
    checkStatus(child_pid, status);

    printf("Waiting...\n");
    child_pid = wait(&status);
    checkStatus(child_pid, status);

    printf("Parent␣will␣die␣now.\n");
    return EXIT_SUCCESS;
}

void checkStatus(int child_pid, int status)
{
    if (WIFEXITED(status))
        printf("Child␣with␣pid␣=␣%d␣has␣terminated␣normally.\n\n", child_pid);
    else if (WEXITSTATUS(status))
        printf("Child␣with␣pid␣=␣%d␣has␣terminated␣with␣code␣%d.\n", child_pid,
            WIFEXITED(status));
    else if (WIFSIGNALED(status))
    {
        printf("Child␣with␣pid␣=␣%d␣has␣terminated␣with␣an␣un-intercepted␣signal.\n",
            child_pid);
        printf("Signal␣number␣=␣%d.\n", WTERMSIG(status));
    }
    else if (WIFSTOPPED(status))
    {
        printf("Child␣with␣pid␣=␣%d␣has␣stopped.\n", child_pid);
        printf("Signal␣number␣=␣%d.", WSTOPSIG(status));
    }
}
```

Листинг 4: Программа sort для потомка

```c
#include <stdio.h>
#include <stdlib.h>

void printMas(const int *mas, int size);
void selectionSort(int *l, int *r);

int main(int argc, char *argv[])
{
    int n = argc - 1;
    int mas[n];

    for (int i = 0; i < n; i++)
        mas[i] = atoi(argv[i + 1]);

    printf("Inputed array = ");
    printMas(mas, n);

    selectionSort(&mas[0], &mas[n-1]);
    printf("Sorted array = ");
    printMas(mas, n);

    return 0;
}

void printMas(const int *mas, int size)
{
    for (int i = 0; i < size; i++)
    {
        printf("%d ", mas[i]);
    }
    printf("\n");
}

void swap(int *el1, int *el2)
{
    int temp = *el1;
    *el1 = *el2;
    *el2 = temp;
}
```

```c
void selectionSort(int *l, int *r)
{
    for (int *i = l; i <= r; i++)
    {
        int minz = *i, *ind = i;
        for (int *j = i + 1; j <= r; j++)
        {
            if (*j < minz)
            {
                minz = *j;
                ind = j;
            }
        }
        swap(i, ind);
    }
}
```

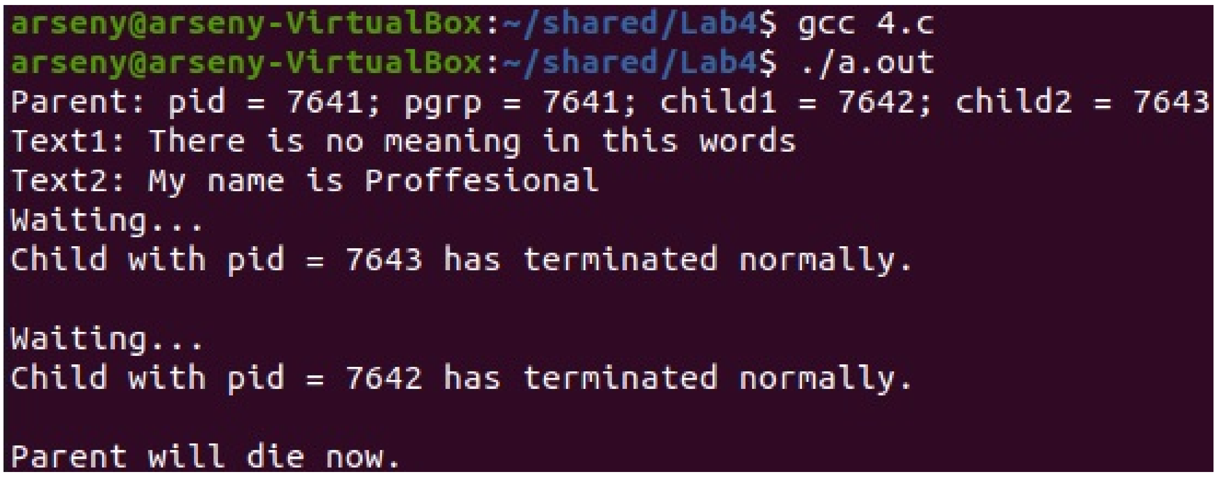


```
arseny@arseny-VirtualBox:~/shared/Lab4$ gcc 3.c
arseny@arseny-VirtualBox:~/shared/Lab4$ ./a.out
Parent: pid = 7628; pgrp = 7628; child1 = 7629; child2 = 7630
Waiting...
Second child: pid = 7630; ppid = 7628;  pgrp = 7628
First child: pid = 7629; ppid = 7628;  pgrp = 7628
Inputed array = 999 111 9 1 11 99 55 555 5
Sorted array = 1 5 9 11 55 99 111 555 999
Child with pid = 7630 has terminated normally.

Waiting...
1.c  2wait.c  3.c  4.c  5.c  a.out  SelectionSort.c  sort
Child with pid = 7629 has terminated normally.

Parent will die now.
```

Рис. 4: Результат работы программы 3

Листинг 5: Программа 4

```c
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>
#include <string.h>
#include <sys/types.h>
#include <sys/wait.h>

#define LEN 50
#define TEXT1 "My name is Proffesional\n"
#define TEXT2 "There is no meaning in this words\n"

void checkStatus(int child_pid, int status);

int main()
{
    int childpid_1, childpid_2;
    int fd[2];

    if (pipe(fd) == -1)
    {
        perror("Can\'t␣pipe.\n");
        return EXIT_FAILURE;
    }

    if ((childpid_1 = fork()) == -1)
    {
        perror("Can\'t␣fork.\n");
        return EXIT_FAILURE;
    }
    else if (childpid_1 == 0)
    {
        close(fd[0]);
        write(fd[1], TEXT1, strlen(TEXT1) + 1);
        exit(EXIT_SUCCESS);
    }

    if ((childpid_2 = fork()) == -1)
    {
        perror("Can\'t␣fork.\n");
        return EXIT_FAILURE;
    }
    else if (childpid_2 == 0)
    {
        close(fd[0]);
        write(fd[1], TEXT2, strlen(TEXT2) + 1);
        exit(EXIT_SUCCESS);
    }

    printf("Parent:␣pid␣=␣%d;␣pgrp␣=␣%d;␣child1␣=␣%d;␣child2␣=␣%d\n", getpid(),
        getpgrp(), childpid_1, childpid_2);

    char text1[LEN], text2[LEN];

    close(fd[1]);
    read(fd[0], text1, LEN);
    read(fd[0], text2, LEN);

    printf("Text1:␣%s", text1);
    printf("Text2:␣%s", text2);

    int status;
    pid_t child_pid;

    printf("Waiting...\n");
    child_pid = wait(&status);
    checkStatus(child_pid, status);

    printf("Waiting...\n");
    child_pid = wait(&status);
    checkStatus(child_pid, status);

    printf("Parent␣will␣die␣now.\n");
    return EXIT_SUCCESS;
}

void checkStatus(int child_pid, int status)
{
    if (WIFEXITED(status))
        printf("Child␣with␣pid␣=␣%d␣has␣terminated␣normally.\n\n", child_pid);
    else if (WEXITSTATUS(status))
        printf("Child␣with␣pid␣=␣%d␣has␣terminated␣with␣code␣%d.\n", child_pid,
            WIFEXITED(status));
    else if (WIFSIGNALED(status))
    {
        printf("Child␣with␣pid␣=␣%d␣has␣terminated␣with␣an␣un-intercepted␣signal.\n",
            child_pid);
        printf("Signal␣number␣=␣%d.\n", WTERMSIG(status));
    }
    else if (WIFSTOPPED(status))
    {
        printf("Child␣with␣pid␣=␣%d␣has␣stopped.\n", child_pid);
        printf("Signal␣number␣=␣%d.", WSTOPSIG(status));
    }
}
```

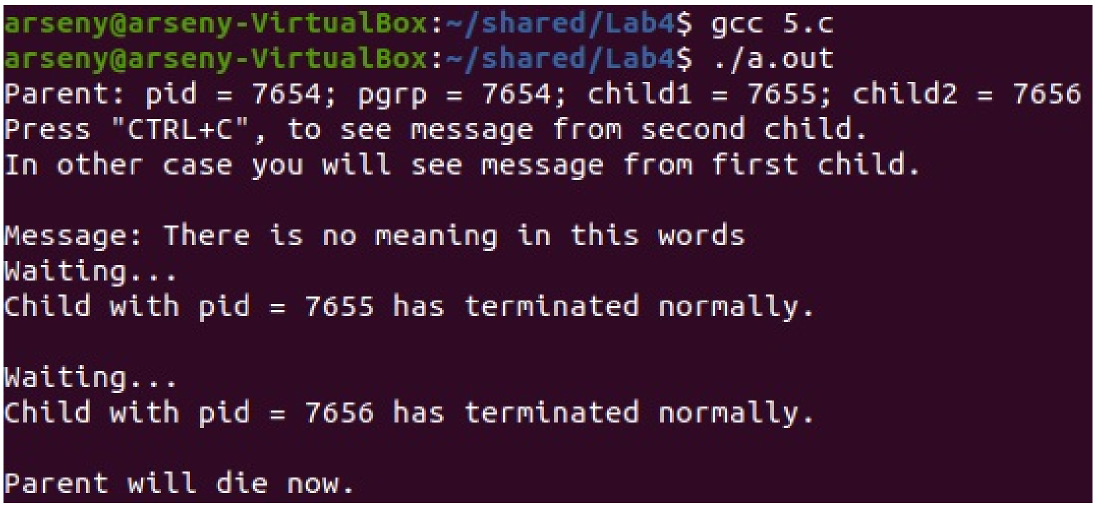


```
arseny@arseny-VirtualBox:~/shared/Lab4$ gcc 4.c
arseny@arseny-VirtualBox:~/shared/Lab4$ ./a.out
Parent: pid = 7641; pgrp = 7641; child1 = 7642; child2 = 7643
Text1: There is no meaning in this words
Text2: My name is Proffesional
Waiting...
Child with pid = 7643 has terminated normally.

Waiting...
Child with pid = 7642 has terminated normally.

Parent will die now.
```

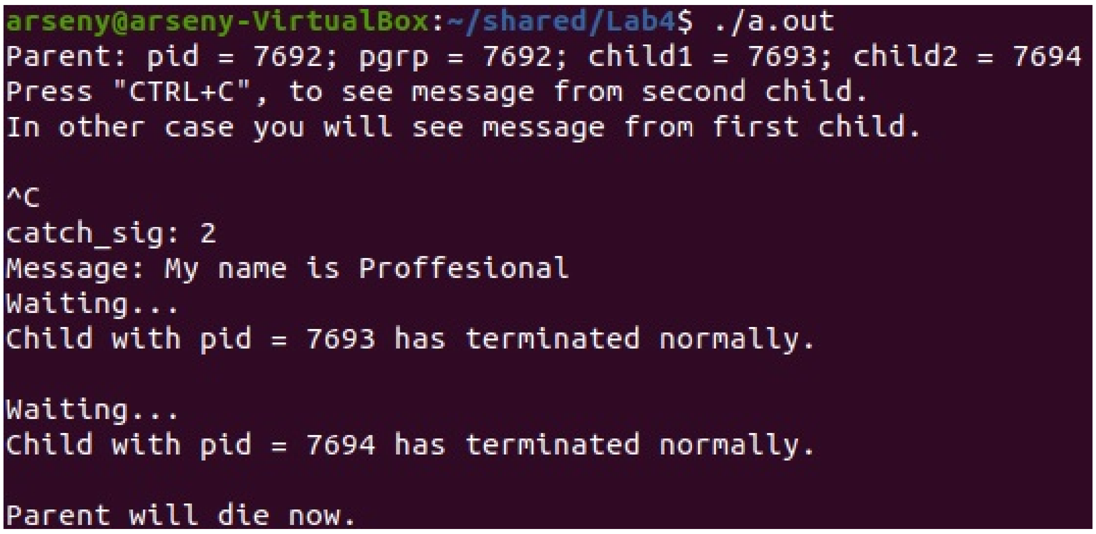
Рис. 5: Результат работы программы 4

Листинг 6: Программа 5

```c
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>
#include <string.h>
#include <signal.h>
#include <sys/types.h>
#include <sys/wait.h>

#define LEN 50
#define TEXT1 "My name is Proffesional\n"
#define TEXT2 "There is no meaning in this words\n"

void checkStatus(int child_pid, int status);
void catch_sig(int sig_numb);

int flag = 0;

int main()
{
    signal(SIGINT, catch_sig);

    int childpid_1, childpid_2;
    int fd[2];

    if (pipe(fd) == -1)
    {
        perror("Can\'t␣pipe.\n");
        return EXIT_FAILURE;
    }

    if ((childpid_1 = fork()) == -1)
    {
        perror("Can\'t␣fork.\n");
        return EXIT_FAILURE;
    }
    else if (childpid_1 == 0)
    {
        close(fd[0]);
        write(fd[1], TEXT1, strlen(TEXT1) + 1);
        exit(EXIT_SUCCESS);
    }

    if ((childpid_2 = fork()) == -1)
    {
        perror("Can\'t␣fork.\n");
        return EXIT_FAILURE;
    }
    else if (childpid_2 == 0)
    {
        close(fd[0]);
        write(fd[1], TEXT2, strlen(TEXT2) + 1);
        exit(EXIT_SUCCESS);
    }

    printf("Parent:␣pid␣=␣%d;␣pgrp␣=␣%d;␣child1␣=␣%d;␣child2␣=␣%d\n", getpid(),
        getpgrp(), childpid_1, childpid_2);
    printf("Press␣\"CTRL+C\",␣to␣see␣message␣from␣second␣child.\n");
    printf("In␣other␣case␣you␣will␣see␣message␣from␣first␣child.\n\n");

    char text1[LEN], text2[LEN];

    close(fd[1]);
    read(fd[0], text1, LEN);
    read(fd[0], text2, LEN);

    sleep(2);

    if (flag)
        printf("Message:␣%s", text2);
    else
        printf("Message:␣%s", text1);

    int status;
    pid_t child_pid;

    printf("Waiting...\n");
    child_pid = wait(&status);
    checkStatus(child_pid, status);

    printf("Waiting...\n");
    child_pid = wait(&status);
    checkStatus(child_pid, status);

    printf("Parent␣will␣die␣now.\n");
    return EXIT_SUCCESS;
}

void checkStatus(int child_pid, int status)
{
    if (WIFEXITED(status))
        printf("Child␣with␣pid␣=␣%d␣has␣terminated␣normally.\n\n", child_pid);
    else if (WEXITSTATUS(status))
        printf("Child␣with␣pid␣=␣%d␣has␣terminated␣with␣code␣%d.\n", child_pid,
            WIFEXITED(status));

    else if (WIFSIGNALED(status))
    {
        printf("Child with pid = %d has terminated with an un-intercepted signal.\n",
            child_pid);
        printf("Signal number = %d.\n", WTERMSIG(status));
    }
    else if (WIFSTOPPED(status))
    {
        printf("Child with pid = %d has stopped.\n", child_pid);
        printf("Signal number = %d.", WSTOPSIG(status));
    }
}

void catch_sig(int sig_numb)
{
    flag = 1;
    printf("\ncatch_sig: %d\n", sig_numb);
}
```



```
arseny@arseny-VirtualBox:~/shared/Lab4$ gcc 5.c
arseny@arseny-VirtualBox:~/shared/Lab4$ ./a.out
Parent: pid = 7654; pgrp = 7654; child1 = 7655; child2 = 7656
Press "CTRL+C", to see message from second child.
In other case you will see message from first child.

Message: There is no meaning in this words
Waiting...
Child with pid = 7655 has terminated normally.

Waiting...
Child with pid = 7656 has terminated normally.

Parent will die now.
```



```
arseny@arseny-VirtualBox:~/shared/Lab4$ ./a.out
Parent: pid = 7692; pgrp = 7692; child1 = 7693; child2 = 7694
Press "CTRL+C", to see message from second child.
In other case you will see message from first child.

^C
catch_sig: 2
Message: My name is Proffesional
Waiting...
Child with pid = 7693 has terminated normally.

Waiting...
Child with pid = 7694 has terminated normally.

Parent will die now.
```

Рис. 6: Результат работы программы 5