Tutoriat 4 SO

Interprocess Communication

- Processes within a system may be ***independent*** or ***cooperating***
- Cooperating process can affect or be affected by other processes, including sharing data
- Reasons for cooperating processes:
  - Information sharing
  - Computation speedup
  - Modularity
  - Convenience
- Cooperating processes need **interprocess communication** (**IPC**)
- Two models of IPC
  - **Shared memory**
  - **Message passing**

Shared Memory

Fisier 1

Cream si deschidem un obiect de memorie partajata cu numele “tutoriat4”, ii modificam dimensiunea, il aducem in spatiul de adresare al procesului curent iar apoi scriem un sir de caractere in acesta.
Apoi, apelam munmap() pentru a sterge maparea din spatiul de adresare curent.

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

#include <sys/mman.h>
#include <sys/stat.h>        /* For mode constants */
#include <fcntl.h>           /* For O_* constants */

#include <unistd.h>
#include <sys/types.h>

#include <sys/mman.h>

#include <string.h>

int main() {

/*

shm_open,  shm_unlink  -  create/open or unlink POSIX shared memory
objects


int shm_open(const char *name, int oflag, mode_t mode);

int shm_unlink(const char *name);

Link with -lrt.

shm_open() creates and opens a new, or opens an existing, POSIX  shared
memory  object.   A  POSIX  shared  memory object is in effect a handle
which can be used by unrelated processes to mmap(2) the same region  of
```

```
shared  memory.  The shm_unlink() function performs the converse opera-
tion, removing an object previously created by shm_open().

- name specifies the shared me    char sir[8];mory object to be created or
opened.
- oflag is a bit mask created by ORing together exactly one of O_RDONLY or
O_RDWR and any of
 O_RDONLY, O_RDONLY, O_CREAT, O_EXCL, O_TRUNC.

The  operation  of shm_unlink() is analogous to unlink(2): it removes a
shared memory object name, and, once all processes  have  unmapped  the
object, de-allocates and destroys the contents of the associated memory
region.  After a successful shm_unlink(), attempts to shm_open() an ob-
ject  with  the  same name fail (unless O_CREAT was specified, in which
case a new, distinct object is created).

Return:
On success, shm_open() returns a nonnegative file descriptor. On failure,
shm_open() returns -1.  shm_unlink() returns 0 on success, or -1
on error.
*/

   int shm_fd = -1;
   shm_fd = shm_open("tutoriat4", O_CREAT | O_RDWR, S_IRUSR | S_IWUSR); //
creeaza o mem partajata (sau deschide) cu numele "tutoriat4"

   if (shm_fd == -1) {
       puts("eroare la shm_open\n");
       return errno;
   }

/*

truncate a file to a specified length

int truncate(const char *path, off_t length);
int ftruncate(int fd, off_t length);

The  truncate()  and ftruncate() functions cause the regular file named
by path or referenced by fd to be truncated  to  a  size  of  precisely
```

```
length bytes.

If  the  file  previously  was larger than this size, the extra data is
lost.  If the file previously was shorter, it is extended, and the  ex-
tended part reads as null bytes ('\0').

On  success,  zero is returned.  On error, -1 is returned, and errno is
set appropriately.
*/

   int shm_size = 8;
   int ret = ftruncate(shm_fd, shm_size);
   if (ret == -1) {
       printf("eroare la truncate\n");
       return errno;
   }

/*

mmap, munmap - map or unmap files or devices into memory

void *mmap(void *addr, size_t length, int prot, int flags,
           int fd, off_t offset);
int munmap(void *addr, size_t length);

mmap()  creates a new mapping in the virtual address space of the call-
ing process.  The starting address for the new mapping is specified  in
addr.   The  length argument specifies the length of the mapping (which
must be greater than 0).

If addr is NULL, then the kernel chooses the (page-aligned) address  at
which to create the mapping; this is the most portable method of creat-
ing a new mapping.

The munmap() system call deletes the mappings for the specified address
range,  and  causes further references to addresses within the range to
generate invalid memory references.  The region is  also  automatically
unmapped  when  the  process is terminated.  On the other hand, closing
the file descriptor does not unmap the region.
```

```
On success, mmap() returns a pointer to the mapped area.  On error, the
value  MAP_FAILED  (that is, (void *) -1) is returned, and errno is set
to indicate the cause of the error.

On success, munmap() returns 0.  On failure, it returns -1,  and  errno
is set to indicate the cause of the error (probably to EINVAL).


- addr - adresa la care să fie ı^ncărcată ı^n proces
- len - dimensiunea memoriei ı^ncărcate
- prot - drepturile de acces (PROT READ sau PROT WRITE de obicei)
- flags - tipul de memorie (de obicei MAP SHARED astfel ı^ncât
modificările
 făcute de către proces să fie vizibile s , i ı^n celelalte)
- fd - descriptorul obiectului de memorie
- offset - locul ı^n obiectul de memorie partajată de la care să fie
ı^ncărcat
 ı^n spat , iul procesului

*/

   char* adresa_fisier = mmap(NULL, shm_size, PROT_WRITE, MAP_SHARED,
shm_fd, 0);

/*

NAME
      memcpy - copy memory area

SYNOPSIS
      #include <string.h>

      void *memcpy(void *dest, const void *src, size_t n);

DESCRIPTION
      The  memcpy()  function  copies  n bytes from memory area src to
memory
      area dest.  The memory areas must not overlap.  Use memmove(3)  if
the
      memory areas do overlap.
```

```
RETURN VALUE
      The memcpy() function returns a pointer to dest.

*/

   memcpy(adresa_fisier, "1234567\0", shm_size);
   munmap(adresa_fisier, shm_size);

   return 0;

}
```

Fisier 2

Deschidem obiectul de memorie partajata cu numele “tutoriat4”, il aducem in spatiul de adresare al procesului curent, accesam sirul de caractere din obiectul de memorie partajata. Apoi, apelam munmap() pentru a sterge maparea din spatiul de adresare curent si shm_unlink() pentru a elimina obiectul.

```
#include <stdio.h>
#include <sys/mman.h>
#include <fcntl.h>
#include <sys/stat.h>
#include <unistd.h>
#include <errno.h>

int main()
{
   int shm_fd;
   int shm_size = 8;
   char* adresa_fisier = NULL;

   shm_fd = shm_open("tutoriat4", O_RDWR, 0);
   if(shm_fd == -1)
   {
       puts("Nu am putut deschide sau nu exista mem partajata cu acest
nume\n");
       return errno;
   }
```

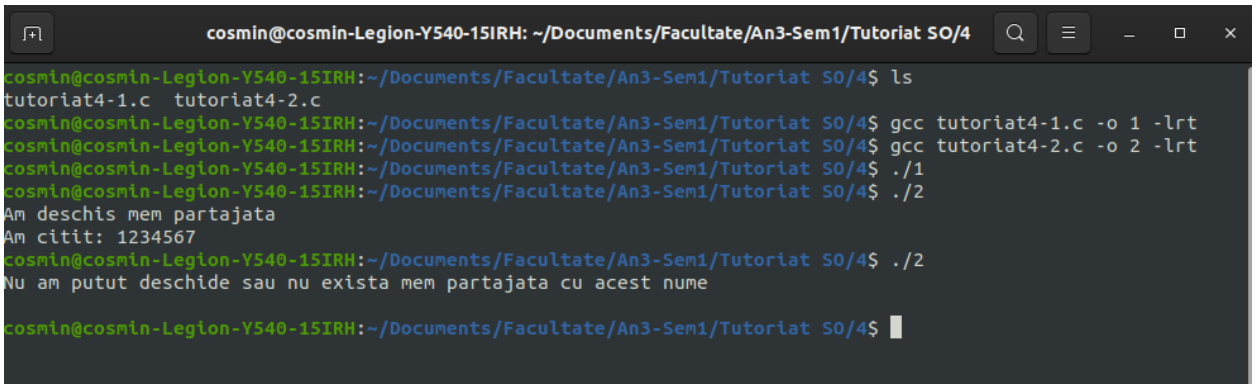
```c
    puts("Am deschis mem partajata");

    adresa_fisier = mmap(NULL, shm_size, PROT_READ, MAP_SHARED, shm_fd, 0);
    printf("Am citit: %s\n", adresa_fisier);

    munmap(adresa_fisier, shm_size);
    shm_unlink("tutoriat4");

    return 0;
}
```

Executare:



Observatii:

1. Pentru compilare, trebuie sa folosim flag-ul *-lrt*
2. Procesul 2 apeleaza shm_unlink(), distrugand obiectul de memorie partajata, motiv pentru care daca executam din nou al doilea program, nu mai exista un obiect de memorie partajata cu numele “tutoriat4” pe care sa il putem deschide.

Exercitiu:

Transformati problema cu sirurile Fibonacci de la tutoriatul 3 astfel incat procesul parinte sa adune rezultatele fiecarui proces din obiectul de memorie partajata.

```c
#include <stdio.h>
#include <stdlib.h>
#include <sys/mman.h>
#include <fcntl.h>
#include <sys/stat.h>
```

```c
#include <unistd.h>
#include <errno.h>
#include <sys/wait.h>
#include <string.h>

int main(int argc, char* argv[])
{

   int shm_fd;
   char* shm_name = "shm_fibo";

   shm_fd = shm_open(shm_name, O_CREAT | O_RDWR, S_IRUSR | S_IWUSR);

   if (shm_fd == -1) {
       perror("Eroare la shm_open\n");
       return errno;
   }

   int page_size = getpagesize();
   int total_size = argc * page_size; // ii alocam un spatiu de page_size
fiecaruit proces

   if (ftruncate(shm_fd, total_size) == -1) {
       perror("Eroare la truncate\n");
       shm_unlink(shm_name); // stergem obiectul
       return errno;
   }

   printf("Starting parent %d\n",getpid());
   for (int i = 1; i < argc; i++) {
       pid_t child = fork(); // un copil pt fiecare task
       if (child < 0) {
           perror("Eroare la fork");
           return -1;
       }
       else if(child == 0)
       {
           char* shm_ptr;
           shm_ptr = mmap(NULL, page_size, PROT_WRITE, MAP_SHARED, shm_fd,
(i - 1) * page_size);
```

```
            // copilului i i se va mapa o bucata de lungime egala cu
page_size
            // mai exact, de la (i-1)*page_size la i*page_size
            if (shm_ptr == MAP_FAILED) {
                perror("Eroare la mmap, din procesul copil");
                shm_unlink(shm_name);
                return errno;
            }
            int n = atoi(argv[i]);
            int car_scrise;
            car_scrise = sprintf(shm_ptr, "%d: ", n);
            shm_ptr += car_scrise; // deplasam pointerul cu nr de caractere
scrise
            if (n < 1) {
                car_scrise = sprintf(shm_ptr, "n has to be > 0\n"); // aici
am facut direct
                shm_ptr += car_scrise;
            }
            else {
                int f1 = 0, f2 = 1, i;
                shm_ptr += sprintf(shm_ptr, "%d ", f1);
                for (i = 1; i < n; i++) {
                    shm_ptr += sprintf(shm_ptr, "%d ", f2);
                    int next = f1 + f2;
                    f1 = f2;
                    f2 = next;
                }
                shm_ptr += sprintf(shm_ptr, "\n");
            }
            printf("Done. Parent = %d, Me = %d\n", getppid(), getpid());
            munmap(shm_ptr, page_size);
            exit(0); //normal process termination
        }
    }
    for (int i = 1; i < argc; i++) {
        wait(NULL);
    }
    for (int i = 1; i < argc; i++) {
        // incarcam pe rand in memorie "bucatica" fiecarui proces copil
```

```
        char* shm_ptr = mmap(NULL, page_size, PROT_READ, MAP_SHARED,
shm_fd, (i-1)*page_size);
        if(shm_ptr == MAP_FAILED)
        {
            perror("Eroare la mmap din parinte\n");
            shm_unlink(shm_name);
            return errno;
        }
        printf("%s", shm_ptr);
        munmap(shm_ptr, page_size);
    }
    printf("Parent done. Parent = %d, Me = %d\n", getppid(), getpid());

    shm_unlink(shm_name);

    return 0;
}
```

Pipes:
https://www.usna.edu/Users/cs/wcbrown/courses/IC221/classes/L13/Class.html
https://www.tutorialspoint.com/inter_process_communication/inter_process_communication_pipes.htm