CECS 326-01 Assignment 4 (10 points)

Due: 10/26/2021 by class time on BeachBoard

Cooperating processes need to communicate between them. Linux supports shared memory for interprocess communication in two different implementations: POSIX and System V. A System V shared memory segment can be created and controlled using system calls **shmget**, **shmctl**, **shmat**, **shmdt**, and a C library function **memcpy**. Please consult the man pages of these system calls for details. This assignment is designed to illustrate a critical problem with processes executing concurrently that try to access shared data.

For this assignment you need to copy the following two C++ programs (named *shmp2.cpp* and *shmc2.cpp*)and a header file *booking.h* into your Linux directory, compile the two programs into *shmp2*, and *shmc2*, respectively. Then run *shmp2* and observe what happens. Run *shmp2* at least 5 times and observe, report the results and explain what may have caused the peculiarities in the outcome. Your observations and explanation should be reported on the cover page, along with the program description.

BE AWARE that blank lines in a Word document may have extra special characters that gnu compilers don’t recognize. Should you encounter errors due to this problem, delete each blank line and put it back while on the Linux text editor.

The program must run successfully on Linux.

Do the following for this assignment:

1. Compile *shmp2.cpp* and *shmc2.cpp* into *shmp2* and *shmc2*, respectively, and run *shmp2*. Document what the programs are designed to do on the cover page.
2. Annotate the programs with adequate amount of comments throughout the program to explain what the program does. System calls require especially detailed comments and must be in your own words. Simply copying the text from the man pages are not acceptable.
3. Run *shmp2* at least 5 times and observe the results. Explain the problems you have observed in these runs and explain what may be causing the peculiar outcomes on the cover page.
4. Submit on BeachBoard the annotated *shmp2.cpp* and *shmc2.cpp*, a screenshot that shows successful compile of the two programs as well as results of 5 runs, and a cover page that provides your name, your student ID, course # and section, assignment #, due date, submission date, a clear program description, and your observations & explanation of the run results. Format of the cover page should follow the cover page template on BeachBoard.
5. The programs must be properly formatted and adequately commented to enhance readability and understanding.

/\* booking.h \*/

/\* Header file to be used with

\* shmp2.cpp and shmc2.cpp

\*/

struct BUS {

char bus\_number[6];

char date[9];

char title[50];

int seats\_left;

};

/\* shmp2.cpp \*/

#include "booking.h"

#include <sys/types.h>

#include <sys/ipc.h>

#include <sys/shm.h>

#include <sys/wait.h>

#include <unistd.h>

#include <stdlib.h>

#include <iostream>

#include <stdio.h>

#include <memory.h>

using namespace std;

BUS mybus = { "4321", "11262021", "Grand Canyon Tour", 20 };

#define NCHILD 3

int shm\_init( void \* );

void wait\_and\_wrap\_up( int [], void \*, int );

void rpterror( char \*, char \* );

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

{

int child[NCHILD], i, shmid;

void \*shm\_ptr;

char ascshmid[10], pname[14];

shmid = shm\_init(shm\_ptr);

sprintf (ascshmid, "%d", shmid);

cout << "Bus " << mybus.bus\_number << " for "

<< mybus.title << " on " << mybus.date << ", "

<< mybus.seats\_left << " seats available. " << endl;

cout << "Booking begins: " << endl << endl;

for (i = 0; i < NCHILD; i++) {

child[i] = fork();

switch (child[i]) {

case -1:

sprintf (pname, "child%d", i+1);

rpterror ((char \*)"fork failed", pname);

exit(1);

case 0:

sprintf (pname, "shmc%d", i+1);

execl("shmc2", pname, ascshmid, (char \*)0);

rpterror ((char \*)"execl failed", pname);

exit (2);

}

}

wait\_and\_wrap\_up (child, shm\_ptr, shmid);

}

int shm\_init(void \*shm\_ptr)

{

int shmid;

shmid = shmget(ftok(".",'u'), sizeof(BUS), 0600 | IPC\_CREAT);

if (shmid == -1) {

perror ("shmget failed");

exit(3);

}

shm\_ptr = shmat(shmid, (void \* ) 0, 0);

if (shm\_ptr == (void \*) -1) {

perror ("shmat failed");

exit(4);

}

memcpy (shm\_ptr, (void \*) &mybus, sizeof(BUS) );

return (shmid);

}

void wait\_and\_wrap\_up(int child[], void \*shm\_ptr, int shmid)

{

int wait\_rtn, w, ch\_active = NCHILD;

while (ch\_active > 0) {

wait\_rtn = wait( (int \*)0 );

for (w = 0; w < NCHILD; w++)

if (child[w] == wait\_rtn) {

ch\_active--;

break;

}

}

cout << "Parent removing shm" << endl;

shmdt (shm\_ptr);

shmctl (shmid, IPC\_RMID, (struct shmid\_ds \*) 0);

exit (0);

}

void rpterror(char \*string, char \*pname)

{

char errline[50];

sprintf (errline, "%s %s", string, pname);

perror (errline);

}

/\* shmc2.cpp \*/

#include "booking.h"

#include <sys/types.h>

#include <sys/ipc.h>

#include <sys/shm.h>

#include <sys/wait.h>

#include <unistd.h>

#include <stdlib.h>

#include <iostream>

#include <stdio.h>

#include <memory.h>

using namespace std;

BUS \*bus\_ptr;

void \*memptr;

char \*pname;

int shmid, ret;

void rpterror(char \*), srand(), perror(), sleep();

void sell\_seats();

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

{

if (argc < 2) {

fprintf (stderr, "Usage:, %s shmid\n", argv[0]);

exit(1);

}

pname = argv[0];

sscanf (argv[1], "%d", &shmid);

memptr = shmat (shmid, (void \*)0, 0);

if (memptr == (char \*)-1 ) {

rpterror ((char \*)"shmat failed");

exit(2);

}

bus\_ptr = (struct BUS \*)memptr;

sell\_seats();

ret = shmdt(memptr);

exit(0);

}

void sell\_seats()

{

int all\_out = 0;

srand ( (unsigned) getpid() );

while ( !all\_out) { /\* loop to sell all seats \*/

if (bus\_ptr->seats\_left > 0) {

sleep ( (unsigned)rand()%2 + 1);

bus\_ptr->seats\_left--;

sleep ( (unsigned)rand()%5 + 1);

cout << pname << " SOLD SEAT -- "

<< bus\_ptr->seats\_left << " left" << endl;

}

else {

all\_out++;

cout << pname << " sees no seats left" << endl;

}

sleep ( (unsigned)rand()%5 + 1);

}

}

void rpterror(char\* string)

{

char errline[50];

sprintf (errline, "%s %s", string, pname);

perror (errline);

}