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//Producer consumer problem- Solution using semaphore
/*
Modify the program as separate client / server process programs to generate 'N'
random numbers in producer, write them into shared memory in producer program.
Consumer program should read them from shared memory and display them in
monitor.
*/
//Program
//Producer program
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
// For semaphore operations sem_init,sem_wait,sem_post
#include <semaphore.h>
#include <pthread.h>
#include <unistd.h>
#include <sys/ipc.h>
#include <sys/shm.h>
#include <sys/sem.h>
#include <sys/wait.h>
#include <sys/errno.h>
#include <sys/types.h>
#include <unistd.h>
extern int errno;
#define SIZE 10 /* size of the shared buffer */
#define VARSIZE 1 /* size of shared variable = 1 byte */
#define INPUTSIZE 20
#define SHMPERM 0666 /* shared memory permissions */
int segid; /* ID for shared memory buffer */
int empty_id;
int full_id;
int mutex_id;
char *buff;
char *input_string;
sem_t *empty;
sem_t *full;
sem_t *mutex;
int p = 0;
int main()
{
    int i = 0;
    pid_t temp_pid;
    segid = shmget(104, SIZE, IPC_CREAT | IPC_EXCL | SHMPERM );
    empty_id=shmget(105, sizeof(sem_t), IPC_CREAT | IPC_EXCL | SHMPERM);
    full_id=shmget(106, sizeof(sem_t), IPC_CREAT | IPC_EXCL | SHMPERM);
    mutex_id=shmget(107,sizeof(sem_t), IPC_CREAT | IPC_EXCL | SHMPERM);
    buff = shmat(segid, (char *)0, 0);
    empty = shmat(empty_id, (char *)0, 0);
    full = shmat(full_id, (char *)0, 0);
    mutex = shmat(mutex_id, (char *)0, 0);
    // Initializing Semaphores Empty, Full & Mutex

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sem_init(&empty, 1, 10);
sem_init(&full, 1, 0);
sem_init(&mutex, 1, 1);
printf("\nProducer Process Started\n");
while (i < 10)
{
    int val = random()%10;
    printf("\nProducer %d trying to acquire Semaphore Empty\n", getpid());
    sem_wait(&empty);
    printf("\nProducer %d successfully acquired Semaphore Empty\n", getpid());
    printf("\nProducer %d trying to acquire Semaphore Mutex\n", getpid());
    sem_wait(&mutex);
    printf("\nProducer %d successfully acquired Semaphore Mutex\n", getpid());
    buff[p] = (char)(val + 48);
    printf("\nProducer %d Produced Item [%d]\n", getpid(), val);
    i++;
    p++;
    printf("\nItems produced: %d\n", p);
    sem_post(&mutex);
    printf("\nProducer %d released Semaphore Mutex\n", getpid());
    sem_post(&full);
    printf("\nProducer %d released Semaphore Full\n", getpid());
    sleep(2);
}
shmdt(buff);
shmdt(empty);
shmdt(full);
shmdt(mutex);
printf("\nProducer Process Ended\n");
return(0);
}

```

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//Consumer program
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
//For semaphore operations - sem_init, sem_wait, sem_post
#include <semaphore.h>
#include <pthread.h>
#include <unistd.h>
#include <sys/ipc.h>
#include <sys/shm.h>
#include <sys/sem.h>
#include <sys/wait.h>
#include <sys/errno.h>
#include <sys/types.h>
#include <unistd.h>
extern int errno;
#define SIZE 10 /* size of the shared buffer */
#define VARSIZE 1 /* size of shared variable = 1 byte */
#define INPUTSIZE 20
#define SHMPERM 0666 /* shared memory permissions */
int segid; /* ID for shared memory buffer */
int empty_id;
int full_id;
int mutex_id;
char *buff;
char *input_string;
sem_t *empty;
sem_t *full;
sem_t *mutex;
int p = 0, c = 0;
int main()
{
    int i = 0;
    pid_t temp_pid;
    segid = shmget (104, SIZE, IPC_EXCL | SHMPERM );
    empty_id = shmget(105, sizeof(sem_t), IPC_EXCL | SHMPERM);
    full_id = shmget(106, sizeof(sem_t), IPC_EXCL | SHMPERM);
    mutex_id=shmget(107, sizeof(sem_t), IPC_EXCL | SHMPERM);
    buff = shmat(segid, (char *)0, 0);
    empty = shmat(empty_id, (char *)0, 0);
    full = shmat(full_id, (char *)0, 0);
    mutex = shmat(mutex_id, (char *)0, 0);
    printf("\nConsumer Process Started\n");
    while (i < 10)
    {
        printf("\nConsumer %d trying to acquire Semaphore Full\n", getpid());
        sem_wait(full);
        printf("\nConsumer %d successfully acquired Semaphore Full\n", getpid());
        printf("\nConsumer %d trying to acquire Semaphore Mutex\n", getpid());
        sem_wait(mutex);
        printf("\nConsumer %d successfully acquired Semaphore Mutex\n", getpid());
    }
}

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printf("\nConsumer %d Consumed Item [%c]\n", getpid(), buff[c]);
buff[c]=' ';
c++;
printf("\nItems consumed: %d\n", i+1);
i++;
sem_post(mutex);
printf("\nConsumer %d released Semaphore Mutex\n", getpid());
sem_post(empty);
printf("\nConsumer %d released Semaphore Empty\n", getpid());
sleep(1);
}
shmdt(buff);
shmdt(empty);
shmdt(full);
shmdt(mutex);
sleep(10);
shmctl(segid, IPC_RMID, NULL);
semctl(empty_id, 0, IPC_RMID, NULL);
semctl(full_id, 0, IPC_RMID, NULL);
semctl(mutex_id, 0, IPC_RMID, NULL);
sem_destroy(empty);
sem_destroy(full);
sem_destroy(mutex);
printf("\nConsumer Process Ended\n");
return(0);
}

```

OUTPUT:

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praveen@praveen-Lenovo-Ideapad-520-15IKB: ~/Operating systems/07. Producer-Consumer/client-server
File Edit View Search Terminal Help

praveen@praveen-Lenovo-Ideapad-520-15IKB:~/Operating systems/07. Producer-Consumer/client-server$ gcc
Producer.c -pthread -o p
praveen@praveen-Lenovo-Ideapad-520-15IKB:~/Operating systems/07. Producer-Consumer/client-server$ ./p
Producer Process Started
Producer 9753 trying to acquire Semaphore Empty
Producer 9753 successfully acquired Semaphore Empty
Producer 9753 trying to acquire Semaphore Mutex
Producer 9753 successfully acquired Semaphore Mutex
Producer 9753 Produced Item [3]
Items produced: 1
Producer 9753 released Semaphore Mutex
Producer 9753 released Semaphore Full
Producer 9753 trying to acquire Semaphore Empty
Producer 9753 successfully acquired Semaphore Empty
Producer 9753 trying to acquire Semaphore Mutex
Producer 9753 successfully acquired Semaphore Mutex
Producer 9753 Produced Item [7]
Items produced: 3
Producer 9753 released Semaphore Mutex
Producer 9753 released Semaphore Full

praveen@praveen-Lenovo-Ideapad-520-15IKB:~/Operating systems/07. Producer-Consumer/client-server$ gcc
Consumer.c -pthread -o c
praveen@praveen-Lenovo-Ideapad-520-15IKB:~/Operating systems/07. Producer-Consumer/client-server$ ./c
Consumer Process Started
Consumer 9754 trying to acquire Semaphore Full
Consumer 9754 successfully acquired Semaphore Full
Consumer 9754 trying to acquire Semaphore Mutex
Consumer 9754 successfully acquired Semaphore Mutex
Consumer 9754 Consumed Item [3]
Items consumed: 1
Consumer 9754 released Semaphore Mutex
Consumer 9754 released Semaphore Empty
Consumer 9754 trying to acquire Semaphore Full
Consumer 9754 successfully acquired Semaphore Full
Consumer 9754 trying to acquire Semaphore Mutex
Consumer 9754 successfully acquired Semaphore Mutex
Consumer 9754 Consumed Item [6]
Items consumed: 2
Consumer 9754 released Semaphore Mutex
Consumer 9754 released Semaphore Empty
Consumer 9754 trying to acquire Semaphore Full
Consumer 9754 successfully acquired Semaphore Full
Consumer 9754 trying to acquire Semaphore Mutex
Consumer 9754 successfully acquired Semaphore Mutex
Consumer 9754 Consumed Item [7]
Items consumed: 3
Consumer 9754 released Semaphore Mutex
Consumer 9754 released Semaphore Empty
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File Edit View Search Terminal Help
Items produced: 3
Producer 9753 released Semaphore Mutex
Producer 9753 released Semaphore Full
Producer 9753 trying to acquire Semaphore Empty
Producer 9753 successfully acquired Semaphore Empty
Producer 9753 trying to acquire Semaphore Mutex
Producer 9753 successfully acquired Semaphore Mutex
Producer 9753 Produced Item [5]
Items produced: 4
Producer 9753 released Semaphore Mutex
Producer 9753 released Semaphore Full
Producer 9753 trying to acquire Semaphore Empty
Producer 9753 successfully acquired Semaphore Empty
Producer 9753 trying to acquire Semaphore Mutex
Producer 9753 successfully acquired Semaphore Mutex
Producer 9753 Produced Item [3]
Items produced: 5
Producer 9753 released Semaphore Mutex
Producer 9753 released Semaphore Full
Producer 9753 trying to acquire Semaphore Empty
Producer 9753 successfully acquired Semaphore Empty
Producer 9753 trying to acquire Semaphore Mutex
Producer 9753 successfully acquired Semaphore Mutex
Producer 9753 Produced Item [5]
Items produced: 6
Producer 9753 released Semaphore Mutex
Producer 9753 released Semaphore Full
Producer 9753 trying to acquire Semaphore Empty
Producer 9753 successfully acquired Semaphore Empty
Producer 9753 trying to acquire Semaphore Mutex
Producer 9753 successfully acquired Semaphore Mutex
Producer 9753 Produced Item [5]
Items consumed: 3
Consumer 9754 released Semaphore Mutex
Consumer 9754 released Semaphore Empty
Consumer 9754 trying to acquire Semaphore Full
Consumer 9754 successfully acquired Semaphore Full
Consumer 9754 trying to acquire Semaphore Mutex
Consumer 9754 successfully acquired Semaphore Mutex
Consumer 9754 Consumed Item [5]
Items consumed: 4
Consumer 9754 released Semaphore Mutex
Consumer 9754 released Semaphore Empty
Consumer 9754 trying to acquire Semaphore Full
Consumer 9754 successfully acquired Semaphore Full
Consumer 9754 trying to acquire Semaphore Mutex
Consumer 9754 successfully acquired Semaphore Mutex
Consumer 9754 Consumed Item [3]
Items consumed: 5
Consumer 9754 released Semaphore Mutex
Consumer 9754 released Semaphore Empty
Consumer 9754 trying to acquire Semaphore Full
Consumer 9754 successfully acquired Semaphore Full
Consumer 9754 trying to acquire Semaphore Mutex
Consumer 9754 successfully acquired Semaphore Mutex
Consumer 9754 Consumed Item [5]
Items consumed: 6
Consumer 9754 released Semaphore Mutex
Consumer 9754 released Semaphore Empty
Consumer 9754 trying to acquire Semaphore Full
Consumer 9754 successfully acquired Semaphore Full
Consumer 9754 trying to acquire Semaphore Mutex
Consumer 9754 successfully acquired Semaphore Mutex
Consumer 9754 Consumed Item [5]
```

File Edit View Search Terminal Help	
Items produced: 6	Items consumed: 6
Producer 9753 released Semaphore Mutex	Consumer 9754 released Semaphore Mutex
Producer 9753 released Semaphore Full	Consumer 9754 released Semaphore Empty
Producer 9753 trying to acquire Semaphore Empty	Consumer 9754 trying to acquire Semaphore Full
Producer 9753 successfully acquired Semaphore Empty	Consumer 9754 successfully acquired Semaphore Full
Producer 9753 trying to acquire Semaphore Mutex	Consumer 9754 trying to acquire Semaphore Mutex
Producer 9753 successfully acquired Semaphore Mutex	Consumer 9754 successfully acquired Semaphore Mutex
Producer 9753 Produced Item [6]	Consumer 9754 Consumed Item [6]
Items produced: 7	Items consumed: 7
Producer 9753 released Semaphore Mutex	Consumer 9754 released Semaphore Mutex
Producer 9753 released Semaphore Full	Consumer 9754 released Semaphore Empty
Producer 9753 trying to acquire Semaphore Empty	Consumer 9754 trying to acquire Semaphore Full
Producer 9753 successfully acquired Semaphore Empty	Consumer 9754 successfully acquired Semaphore Full
Producer 9753 trying to acquire Semaphore Mutex	Consumer 9754 trying to acquire Semaphore Mutex
Producer 9753 successfully acquired Semaphore Mutex	Consumer 9754 successfully acquired Semaphore Mutex
Producer 9753 Produced Item [2]	Consumer 9754 Consumed Item [2]
Items produced: 8	Items consumed: 8
Producer 9753 released Semaphore Mutex	Consumer 9754 released Semaphore Mutex
Producer 9753 released Semaphore Full	Consumer 9754 released Semaphore Empty
Producer 9753 trying to acquire Semaphore Empty	Consumer 9754 trying to acquire Semaphore Full
Producer 9753 successfully acquired Semaphore Empty	Consumer 9754 successfully acquired Semaphore Full
Producer 9753 trying to acquire Semaphore Mutex	Consumer 9754 trying to acquire Semaphore Mutex
Producer 9753 successfully acquired Semaphore Mutex	Consumer 9754 successfully acquired Semaphore Mutex
Producer 9753 Produced Item [9]	Consumer 9754 Consumed Item [9]
Items produced: 9	Items consumed: 9
Producer 9753 released Semaphore Mutex	Consumer 9754 released Semaphore Mutex
Producer 9753 released Semaphore Full	Consumer 9754 released Semaphore Empty

Items produced: 9	Items consumed: 9
Producer 9753 released Semaphore Mutex	Consumer 9754 released Semaphore Mutex
Producer 9753 released Semaphore Full	Consumer 9754 released Semaphore Empty
Producer 9753 trying to acquire Semaphore Empty	Consumer 9754 trying to acquire Semaphore Full
Producer 9753 successfully acquired Semaphore Empty	Consumer 9754 successfully acquired Semaphore Full
Producer 9753 trying to acquire Semaphore Mutex	Consumer 9754 trying to acquire Semaphore Mutex
Producer 9753 successfully acquired Semaphore Mutex	Consumer 9754 successfully acquired Semaphore Mutex
Producer 9753 Produced Item [1]	Consumer 9754 Consumed Item [1]
Items produced: 10	Items consumed: 10
Producer 9753 released Semaphore Mutex	Consumer 9754 released Semaphore Mutex
Producer 9753 released Semaphore Full	Consumer 9754 released Semaphore Empty
Producer Process Ended	Consumer Process Ended
praveen@praveen-Lenovo-IdeaPad-520-15IKB:~/Operting systems/07. Producer-Consumer/client-server\$ <input type="checkbox"/>	praveen@praveen-Lenovo-IdeaPad-520-15IKB:~/Operting systems/07. Producer-Consumer/client-server\$ <input type="checkbox"/>