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Batch: EN-4
Practical No. 9

Title: Program to illustrate need of semaphore

Objectives

- Understand the need of semaphore and its functionality.
- Understand the concept of priority inversion.

What is semaphore?

A semaphore is a protocol mechanism offered by most multitasking kernels. Semaphores are used to:

- Control the access of the shared resources (mutual exclusion);
- Allow two tasks to synchronize the activities.
- Signal the occurrence of an event.

A semaphore is a key that your code acquires in order to continue execution. If semaphore is already in use, the requesting task is suspended until the semaphore is released by its current owner.

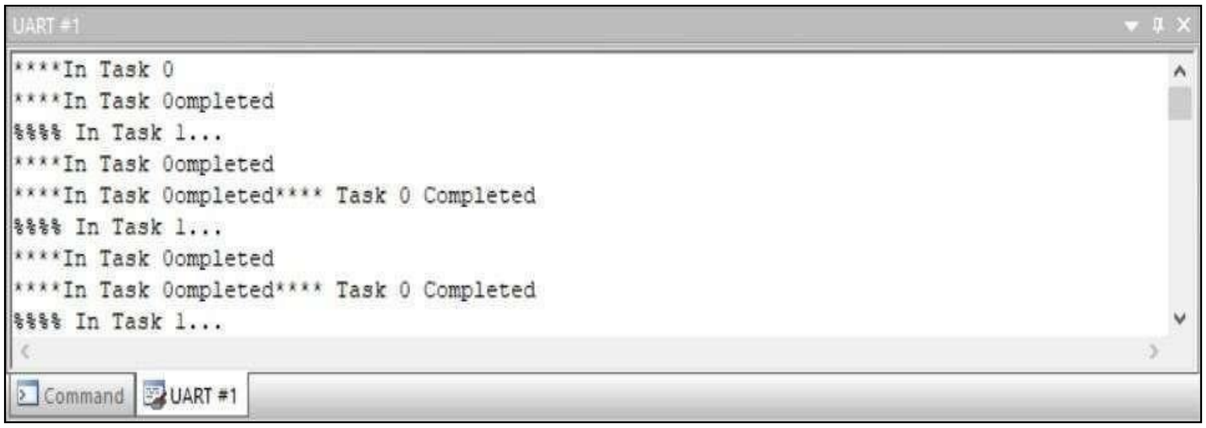
There are two **types of semaphores:**

- **Binary Semaphore:** The binary semaphores are like counting semaphores but their value is restricted to 0 and 1.
- **Counting Semaphore:** These are integer value semaphores and can be any non-negative integer.

1. Code without semaphore:

```
#include "config.h"
#include "stdlib.h"
#include <stdio.h>
#define TaskStkLengh 64 //Define Task stack length
OS_STK TaskStk0 [TaskStkLengh]; //Define the Task0 stack
OS_STK TaskStk1 [TaskStkLengh]; //Define the Task1 stack
// declare the tasks
void Task0(void *pdata);
void Task1(void *pdata);
OS_EVENT *MySem;
unsigned char err;
int main (void){
    LED_init();
    UART0_Init();
    TargetInit();
    OSInit ();
    MySem = OSSemCreate(1);
    OSTaskCreate (Task0,(void *)0, &TaskStk0[TaskStkLengh - 1], 6);
    OSTaskCreate (Task1,(void *)0, &TaskStk1[TaskStkLengh - 1], 7);
    OSStart();
    return 0;
}
void Task0 (void *pdata){
    pdata = pdata;
    while(1){
        //Uncomment pend and post to see semaphores in action
        //OSSemPend(MySem, 0, &err);
        UART0_SendData ("****InTask 0\n");
        OSTimeDly(4);
        UART0_SendData ("**** Task 0 Completed\r");
        //OSSemPost(MySem);
    }
}
void Task1 (void *pdata){
    pdata = pdata;
    while (1){
        //Uncomment pend and post to see semaphores in action
        //OSSemPend(MySem, 0,&err);
        OSTimeDly(4);
        UART0_SendData ("%%%% In Task 1...\n");
        OSTimeDly(4);
        UART0_SendData ("%%%% Task 1 Completed");
        //OSSemPost(MySem);
    }
}
```

Output:

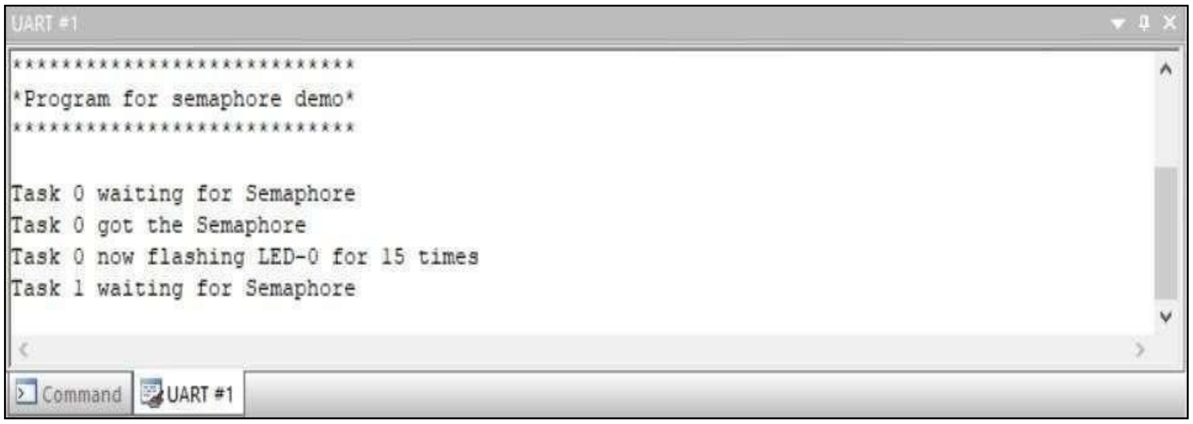


```
****In Task 0
****In Task Oompleted
%%%% In Task 1...
****In Task Oompleted
****In Task Oompleted**** Task 0 Completed
%%%% In Task 1...
****In Task Oompleted
****In Task Oompleted**** Task 0 Completed
%%%% In Task 1...
```

2. Code with semaphore:

```
#include "config.h"
#include "stdlib.h"
#define TaskStkLengh    64  //Define the Task0 stack length
OS_STK TaskStk0 [TaskStkLengh]; //Define the Task0 stack
OS_STK TaskStk1 [TaskStkLengh]; //Define the Task0 stack
void Task0(void *pdata);    // Task0
void Task1(void *pdata);    // Task1
OS_EVENT *MySem;
unsigned char err;

int main (void){
    LED_init(); lcd_init(); UART0_Init();
    UART0_SendData("\n\r****************************\n\r");
    UART0_SendData ("*Program for semaphore demo*\n\r");
    UART0_SendData ("****************************\n\r");
    TargetInit(); OSInit ();
    MySem = OSSemCreate(1);
    OSTaskCreate (Task0,(void *)0, &TaskStk0[TaskStkLengh - 1], 6);
    OSTaskCreate (Task1,(void *)0, &TaskStk1[TaskStkLengh - 1], 7);
    OSStart();
    return 0;
}

void Task0(void *pdata){
    int i;
    pdata = pdata;  /* Dummy data */
    while(1){
        UART0_SendData("\n\rTask 0 waiting for Semaphore");
        lcd_command(0x80);
        LCD_SendData("  "); lcd_command(0x80);
        LCD_SendData("Task 0 waiting");
        OSSemPend(MySem, 0, &err);
        UART0_SendData("\n\rTask 0 got the Semaphore");
        UART0_SendData("\n\rTask 0 now flashing LED-0 for 15 times");
        lcd_command(0x80); LCD_SendData("   ");
        lcd_command(0x80); LCD_SendData("Task 0 got sem");
        for(i=0; i<15;i++){
            LED_on(0); OSTimeDly(10); LED_off(0); OSTimeDly(10);
        }
        UART0_SendData("\n\rTask 0 released Semaphore \n\r");
        lcd_command(0x80); LCD_SendData("   "); lcd_command(0x80);
        LCD_SendData("Task 0 released");
        OSSemPost(MySem);
        //OSTimeDly(150);
    }
}

void Task1(void *pdata){
    int i;
    pdata = pdata;  /* Dummy data */
    while (1){
        UART0_SendData("\n\rTask 1 waiting for Semaphore");
        lcd_command(0xC0); LCD_SendData("   "); lcd_command(0xC0);
        LCD_SendData("Task 1 waiting"); OSSemPend(MySem, 0, &err);
        UART0_SendData("\n\rTask 1 got the Semaphore");
        UART0_SendData("\n\rTask 1 now flashing LED-1 for 10 times");
        lcd_command(0xC0); LCD_SendData("   ");
        lcd_command(0xC0); LCD_SendData("Task 1 got sem");

        for(i=0; i<15;i++){
            LED_on(1); OSTimeDly(10); LED_off(1); OSTimeDly(10);
        }
        UART0_SendData("\n\rTask 1 released Semaphore\n\r");
        lcd_command(0xC0);
        LCD_SendData("  "); lcd_command(0xC0);
        LCD_SendData("Task 1 released"); OSSemPost(MySem);
    }

}
```

Output:



```
****************************
*Program for semaphore demo*
****************************


Task 0 waiting for Semaphore
Task 0 got the Semaphore
Task 0 now flashing LED-0 for 15 times
Task 1 waiting for Semaphore
```

Priority Inversion:

Priority Inversion is an operating system scenario in which a higher priority process is preempted by a lower priority process. This implies the inversion of priorities of the two tasks.
It is not possible to totally avoid it. But it’s effect can be minimized by:

- Priority ceiling
- Disabling interrupts
- Priority inheritance
- No blocking
- Random boosting

Conclusion:

1) When we don’t use semaphore in the code the output will be not in an order. That means any other function will start running before the completion of current function.

2) When we use semaphore, it allows tasks to synchronise their activity.