

CSGE602055 Operating Systems

CSF2600505 Sistem Operasi

Minggu 07: Synchronization

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<http://rms46.vlsm.org/2/207.html>

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Minggu 00	29 Aug - 05 Sep 2017	Intro & Review
Minggu 01	07 Sep - 12 Sep 2017	IPR, SED, AWK, REGEX, & Scripting
Minggu 02	14 Sep - 19 Sep 2017	Protection, Security, Privacy, & C-language
Minggu 03	26 Sep - 30 Sep 2017	BIOS, Loader, Systemd, & I/O
Minggu 04	03 Okt - 07 Okt 2017	Addressing, Shared Lib, Pointer & I/O Programming
Minggu 05	10 Okt - 14 Okt 2017	Virtual Memory
Ming. UTS	15 Okt - 24 Okt 2017	
Minggu 06	26 Okt - 31 Okt 2017	Concurrency: Processes & Threads
Minggu 07	02 Nov - 07 Nov 2017	Synchronization
Minggu 08	09 Nov - 14 Nov 2017	Scheduling & Network Sockets Programming
Minggu 09	16 Nov - 21 Nov 2017	File System & Persistent Storage
Minggu 10	23 Nov - 28 Nov 2017	Special Topic: Blockchain
Cadangan	30 Nov - 09 Des 2017	
Ming. UAS	10 Des - 23 Des 2017	

Agenda I

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Week 07: Synchronization

- Reference: (OSCE2e ch5) (UCB 7/8) (UDA P3L3/4) (OLD 04)
- The Critical Section Problem
- Race Condition
- Peterson's Solution
- Semaphores
- Classical Problems
 - Bounded-Buffer Problem
 - Readers and Writers Problem
 - Dining-Philosophers Problem
- Deadlock and Starvation
- Deadlock Characterization
- Banker's Algorithm
- Resource Graph

Peterson's Solution

Process 0

flag[0]=

turn=

```
do {  
    flag[0] = true  
    turn = 1  
    while (flag[1] && turn == 1)  
        (do nothing);  
    [CRITICAL SECTION];  
    flag[0] = false  
    [REMAINDER SECTION];  
} while(true);
```

Process 1

flag[1]=

```
do {  
    flag[1] = true  
    turn = 0  
    while (flag[0] && turn == 0)  
        (do nothing);  
    [CRITICAL SECTION];  
    flag[1] = false  
    [REMAINDER SECTION];  
} while(true);
```

99-myutils.h

```
/**
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 */

#define MAX_THREAD 256
#define BUFFER_SIZE 5
#define TRUE 1
#define FALSE 0

typedef struct {
    int    buffer[BUFFER_SIZE];
    int    in;
    int    out;
    int    count;
} bbuf_t;

void daftar_trit    (void* trit);           // mempersiapkan "trit"
void jalankan_trit  (void);                 // menjalankan dan menunggu hasil dari
                                           // "daftar_trit"
void beberes_trit   (char* pesan);          // beberes menutup "jalankan_trit"

void rehat_acak     (long max_mdetik);      // istirahat acak "0-max_mdetik" (ms)

void init_buffer    (void);                 // init buffer
void enter_buffer   (int entry);            // enter an integer item
void remove_buffer  (void);                 // remove the item

void init_rw        (void);                 // init readers writers
int  startRead      (void);                 // start reading
int  endRead        (void);                 // end reading
void startWrite     (void);                 // start writing
void endWrite       (void);                 // end writing
```

```

/*
 * (c) 2011-2016 Rahmat M. Samik-Ibrahim -- This is free software
 * Feel free to copy and/or modify and/or distribute it,
 * provided this notice, and the copyright notice, are preserved.
 * REV01 Wed Nov 2 11:49:55 WIB 2016
 * REV00 Xxx Sep 30 XX:XX:XX UTC 2015
 * START Xxx Mar 30 02:13:01 UTC 2011
 */

#include <pthread.h>
#include <semaphore.h>
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

#include "99-myutils.h"
sem_t mutex, db, empty, full, rmutex, wmutex;

/* TRIT *****/
int jumlah_trit = 0;

void* trits [MAX_THREAD];
pthread_t trit_id[MAX_THREAD];

void daftar_trit(void *trit) {
    if(jumlah_trit >= MAX_THREAD) {
        printf("\n ERROR MAX daftar_trit %d\n", jumlah_trit);
        exit(1);
    }
    trits[jumlah_trit++] = trit;
}

```

99-myutils.c (2)

```
void beberes_trit(char* pesan) {
    if (pesan != NULL)
        printf("%s\n", pesan);
    pthread_exit(NULL);
}

/* REHAT *****/
int pertamax = TRUE;

void rehat_acak(long max_mdetik) {
    struct timespec tim;
    long ndetik;

    if (pertamax) {
        pertamax = FALSE;
        srandom((unsigned int) time (NULL));
    }
    ndetik = random() % max_mdetik;
    tim.tv_sec = ndetik / 1000L;
    tim.tv_nsec = ndetik % 1000L * 1000000L;
    nanosleep(&tim, NULL);
}
```


99-myutils.c (3)

```
/* BOUNDED BUFFER *****/
bbuf_t buf;
void init_buffer(void) {
    buf.in    = 0;
    buf.out   = 0;
    buf.count = 0;
    sem_init (&mutex, 0, 1);
    sem_init (&empty, 0, BUFFER_SIZE);
    sem_init (&full, 0, 0);
}

void enter_buffer(int entry) {
    sem_wait(&empty);
    sem_wait(&mutex);
    buf.count++;
    buf.buffer[buf.in] = entry;
    buf.in = (buf.in+1) % BUFFER_SIZE;
    sem_post(&mutex);
    sem_post(&full);
}

int remove_buffer(void) {
    int item;
    sem_wait(&full);
    sem_wait(&mutex);
    buf.count--;
    item = buf.buffer[buf.out];
    buf.out = (buf.out+1) % BUFFER_SIZE;
    sem_post(&mutex);
    sem_post(&empty);
    return item;
}
```

99-myutils.c (4)

```
/* READERS WRITERS *****/
int readerCount;
void init_rw(void) {
    readerCount = 0;
    sem_init (&mutex, 0, 1);
    sem_init (&rmutex, 0, 1);
    sem_init (&wmutex, 0, 1);
    sem_init (&db, 0, 1);
}

int startRead(void) {
    sem_wait(&mutex);
    if (++readerCount == 1 )
        sem_wait(&db);
    sem_post(&mutex);
    return readerCount;
}

int endRead(void) {
    sem_wait(&mutex);
    if (--readerCount == 0 )
        sem_post(&db);
    sem_post(&mutex);
    return readerCount;
}

void startWrite(void) {
    sem_wait(&db);
}

void endWrite(void) {
    sem_post(&db);
}
```

00-thread

```
/* (c) 2015-2017 Rahmat M. Samik-Ibrahim
 * http://rahmatm.samik-ibrahim.vlsm.org/
 * This is free software.
 * REV03 Wed Nov 1 15:17:08 WIB 2017
 * REV02 Tue Apr 18 15:28:19 WIB 2017
 * REV01 Wed Nov 2 11:49:30 WIB 2016
 * START Xxx Sep 30 XX:XX:XX UTC 2015
 */
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <semaphore.h>
#include "99-myutils.h"
#define LOOP0 10
#define LOOP1 500
#define LOOP2 1000
#define LOOP3 10000

volatile int loop = LOOP0;
int share;
```

00-thread (2)

```
void* thread1 (void* a) {
    int ii, jj, kk;
    printf("I am a thread no 1\n");
    sleep(1);
    share = 1000;
    while (loop > 0) {
        for (ii=0;ii<LOOP1;ii++) {
            for (jj=0;jj<LOOP2;jj++) {
                ;
            }
        }
        share++;
    }
}
```

```
void* thread2 (void* a) {
    int ii, jj, kk;
    printf("I am a thread no 2\n");
    sleep(1);
    share = 2000;
    while (loop > 0) {
        for (ii=0;ii<LOOP1;ii++) {
            for (jj=0;jj<LOOP2;jj++) {
                ;
            }
        }
        share--;
    }
}
```

00-thread (3)

```
void* thread3 (void* a) {
    int ii, jj, kk;
    printf("I am a thread no 3\n");
    sleep(1);
    while (loop-- > 0) {
        for (ii=0;ii<LOOP3;ii++) {
            for (jj=0;jj<LOOP3;jj++) {
                ;
            }
        }
        printf("SHARE = %4.4d\n", share);
    }
}

void main(void) {
    daftar_trit    (thread1);
    daftar_trit    (thread2);
    daftar_trit    (thread3);
    jalankan_trit ();
    printf         ("I am MAIN\n");
    beberes_trit   ("Done...");
}
```

00-thread (4)

```
>>>> $ 00-thread
I am a thread no 1
I am a thread no 2
I am a thread no 3
SHARE = 1994
SHARE = 1989
SHARE = 1985
SHARE = 1977
SHARE = 1966
SHARE = 1954
SHARE = 1944
SHARE = 1933
SHARE = 1923
SHARE = 1923
I am MAIN
Done...
>>>> $ 00-thread
I am a thread no 2
I am a thread no 1
I am a thread no 3
SHARE = 0992
SHARE = 0985
SHARE = 0987
SHARE = 0994
SHARE = 0991
SHARE = 0982
SHARE = 0974
SHARE = 0967
SHARE = 0959
SHARE = 0959
I am MAIN
Done...
>>>> $
```

XXX

Rock Paper Scissors Lizard Spock

```
/*  
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 * -- This is free software  
 * Feel free to copy and/or modify and/or  
 * distribute it, provided this notice, and  
 * the copyright notice, are preserved.  
 * REV01 Wed Nov 2 11:20:30 WIB 2016  
 * REV00 Xxx Sep 30 XX:XX:XX UTC 2015  
 * START Xxx Oct 19 XX:XX:XX UTC 2014  
 */
```


RPSLS 1

```
// *Rock*Paper*Scissors*Lizard*Spock*  
// Invented by Sam Kass and Karen Bryla  
// Rock crushes Scissors  
// Rock crushes Lizard  
// Paper covers Rock  
// Paper disproves Spock  
// Scissors cut Paper  
// Scissors decapitate Lizard  
// Lizard eats Paper  
// Lizard poisons Spock  
// Spock vaporizes Rock  
// Spock smashes Scissors
```

```
#include <semaphore.h>
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#include <unistd.h>
#include "99-myutils.h"
#define nPlayers 2
#define nWeapons 5
int      playerSEQ=1;
int      myWeapon[nPlayers+1];
sem_t    mutex, sync1, sync2;

// (0=Rock) (1=Paper) (2=Scissors) (3=Lizard) (4=Spock)
char* weaponName[nWeapons]= {
    "Rock", "Paper", "Scissors", "Lizard", "Spock"
};
```

```
// '-' = draw  'v' = win  'x' = lose
char weaponTable[nWeapons][nWeapons] = {
    {'-', 'x', 'v', 'v', 'x'},
    {'v', '-', 'x', 'x', 'v'},
    {'x', 'v', '-', 'v', 'x'},
    {'x', 'v', 'x', '-', 'v'},
    {'v', 'x', 'v', 'x', '-'}
};

void waitPlayers() {
    for (int ii=0; ii < nPlayers; ii++)
        sem_wait(&sync1);
}

void postPlayers() {
    for (int ii=0; ii < nPlayers; ii++)
        sem_post(&sync2);
}
```

```
void* playerThread (void* a) {  
    int      playerID;  
    sem_wait (&mutex);  
    playerID=playerSEQ++;  
    sem_post (&mutex);  
    printf("Player[%d]: READY\n",playerID);  
    sem_post (&sync1);  
    sem_wait (&sync2);  
    myWeapon[playerID] = rand() % nWeapons;  
    printf("Player[%d]: %s\n",  
        playerID, weaponName[myWeapon[playerID]]);  
    sem_post (&sync1);  
}
```

```
void* refereeThread (void* a) {
    waitPlayers();
    printf("Referee:    ALL READY!\n");
    postPlayers();
    waitPlayers();
    char result =
        weaponTable[myWeapon[1]][myWeapon[2]];
    if (result == '-')
        printf("Referee:    DRAW!\n");
    else if (result == 'v')
        printf("Referee:    Player[1] WINS!\n");
    else
        printf("Referee:    Player[2] WINS!\n");
}
```

```
void main() {  
    // randomize with a time seed  
    srand(time(NULL));  
    sleep(1);  
    // init semaphore mutex = 1 syncx = 0  
    sem_init (&mutex, 0, 1);  
    sem_init (&sync1, 0, 0);  
    sem_init (&sync2, 0, 0);  
    // register and execute threads  
    daftar_trit (refereeThread);  
    for (int ii=0; ii<nPlayers; ii++)  
        daftar_trit (playerThread);  
    jalankan_trit ();  
    beberes_trit ("Goodbye...");  
}
```

X

XXX

The End

- This is the end of the presentation.