CSGE602055 Operating Systems
CSF2600505 Sistem Operasi
Minggu 07: Synchronization

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

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Agenda

Week 07: Synchronization

- Reference: (OSCE2e ch5) (UCB 7/8) (UDA P3L3/4) (OLD 04)
- The Critical Section Problem
- Race Condition
- Peterson's Solution
- Semaphores
- Deadlock and Starvation
- Deadlock Characterization
- 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);
```

myutils.h 1

```
/*
 * (c) 2011-2016 Rahmat M. Samik-Ibrahim
   -- This is free software
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 * distribute it, provided this notice, and
 * the copyright notice, are preserved.
 * REV02 Mon Nov  7 14:33:08 WIB 2016
 * REV01 Wed Nov  2 11:50:14 WIB 2016
 * REV00 Xxx Sep 30 XX:XX:XX UTC 2015
 * START Xxx Mar 30 02:13:01 UTC 2011
 */

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

myutils.h 2

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

// mempersiapkan "trit"
void daftar_trit   (void* trit);

// menjalankan dan menunggu hasil dari "daftar_trit"
void jalankan_trit (void);

// beberes menutup "jalankan_trit"
void beberes_trit  (char* pesan);
```

myutils.h 3

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

void init_buffer   (void);      // init buffer
void enter_buffer  (int entry); // enter an integer item
int 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
```

myutils.c

```
/*
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 * 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"
```

daftar_trit()

```
sem_t      mutex, db, empty, full, rmutex, wmutex;
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;
}
void beberes_trit(char* pesan) {
   if (pesan != NULL)
      printf("%s\n",pesan);
   pthread_exit(NULL);
}
```

jalankan_trit()

```
void jalankan_trit(void){
    int ii;
    for (ii=0;ii<jumlah_trit;ii++) {
        if(pthread_create(&trit_id[ii], NULL, trits[ii], NULL))
            printf("\n ERROR pthread_creat: %d\n",ii);
            exit(1);
        }
    }
    for (ii=0;ii<jumlah_trit;ii++){
        if(pthread_join(trit_id[ii], NULL)) {
            printf("\n ERROR pthread_join: %d\n",ii);
            exit(1);
        }
    }
}
```

rehat_acak()

```
/* 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);
}
```

init_buffer()

```
/* 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);
}
```

enter_buffer()

```
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);
}
```

remove_buffer()

```
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;
}
```

init_rw()

```
/* 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);
}
```

startRead() — endRead()

```
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;
}
```

startWrite() — endWrite()

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

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

Rock Paper Scissors Lizard Spock

```
/*
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 * 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
```

RPSLS 2

```
#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"
};
```

RPSLS 3

```
// '-' = 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);
}
```

RPSLS 4

```
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);
}
```

RPSLS 5

```
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");
}
```

RPSLS 6

```
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...");
}
```

Lab

- semaphores()
- pthread()

The End

- This is the end of the presentation.