

Sinkronisasi Thread

Praktikum Sistem Operasi

Ilmu Komputer IPB

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Critical Section

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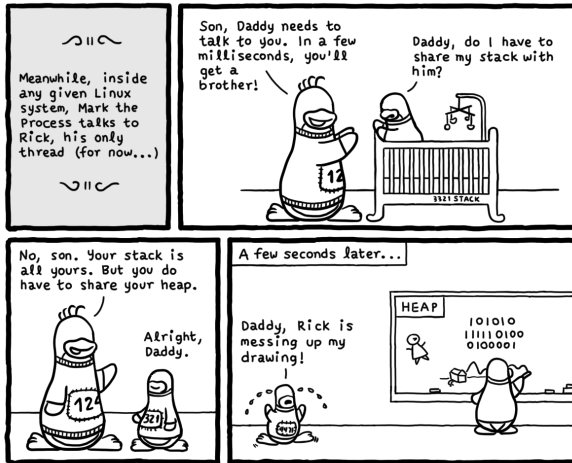
*A **critical section** is a section of code that can be executed by at most **one process at a time**. The critical section exists to protect shared resources from multiple access.¹*

- ▶ contoh: mengubah variabel global, menulis ke *file*, dll.
- ▶ solusi: sinkronisasi

¹Jones (2008), *GNU/Linux Application Programming*, hlm 264.

Sinkronisasi

- ▶ untuk melindungi (mengunci) sebuah *critical section*
 - ▶ hanya satu proses/*thread* dalam satu waktu yang dapat masuk
- ▶ menggunakan *mutex lock* atau *semaphore*



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Gambar 1: *Don't share mutable state*

Mutual Exclusion

Mutex

Mutex is a key to a variable. One thread can have the key—modify the variable—at the time. When finished, the thread gives (frees) the key to the next thread in the group.²

²<http://koti.mbnet.fi/niclasw/MutexSemaphore.html>

Fungsi Mutex

```
#include <pthread.h>
```

```
int pthread_mutex_init(pthread_mutex_t *mutex,  
                        const pthread_mutexattr_t *attr);  
int pthread_mutex_lock(pthread_mutex_t *mutex);  
int pthread_mutex_unlock(pthread_mutex_t *mutex);  
int pthread_mutex_destroy(pthread_mutex_t *mutex);
```

- ▶ init: inisialisasi mutex
- ▶ lock: mengunci *critical section*
- ▶ unlock: melepaskan kunci *critical section*
- ▶ destroy: menghapus mutex

Latihan

Apa yang salah dengan kode berikut ini? Perbaiki dengan menggunakan *mutex*!

```
// counting to one million
#include <stdio.h>
#include <pthread.h>

#define N 1000000
#define T 4

int count = 0;
```

```
void *counting(void *arg)
{
    int i;
    for (i = 0; i < N/T; i++)
        count++;           // critical section

    pthread_exit(NULL);
}
```

```
int main()
{
    pthread_t t[T];
    int i;

    for (i = 0; i < T; i++)
        pthread_create(&t[i], NULL, counting, NULL);

    for (i = 0; i < T; i++)
        pthread_join(t[i], NULL);

    printf("%d\n", count);      // 1000000, no?
    return 0;
}
```

Semaphore

Semaphore

- ▶ nilai *semaphore* S diinisialisasi dengan bilangan non-negatif
- ▶ terdapat dua operasi atomik yang bisa dilakukan pada *semaphore*, yaitu wait dan post³

```
wait(S) {  
    while (S == 0)  
        ; // busy wait  
    S--;
```

```
post(S) {  
    S++;  
}
```

³Silberschatz et al. (2013), *Operating System Concepts*, hlm 214.

Jenis Semaphore

1. *Counting semaphore*, nilai awal *semaphore* lebih dari 1
2. *Binary semaphore*, nilai awal *semaphore* adalah 1 (sama fungsinya dengan *mutex*)

Fungsi Semaphore

```
#include <semaphore.h>
```

```
int sem_init(sem_t *sem, int pshared, unsigned int value);  
int sem_wait(sem_t *sem);  
int sem_post(sem_t *sem);  
int sem_destroy(sem_t *sem);
```

- ▶ init: inisialisasi sem dengan nilai awal value
- ▶ wait:
 - ▶ jika sem = 0 → *block*
 - ▶ jika sem > 0 → sem--, *continue*
- ▶ post: sem++
- ▶ destroy: menghapus sem

Latihan

Perbaiki latihan sebelumnya dengan menggunakan *semaphore*!

Tugas

Array Sum

Identifikasi *critical section* dan perbaiki kode berikut ini supaya hasilnya benar.

```
#include <stdio.h>
#include <pthread.h>
#include <stdlib.h>
```

```
#define N 100000
#define T 4
```

```
int sum = 0;
```

```
void *array_sum(void *arg)
{
    int *array = (int*)arg;    // cast void* --> int*
    int i;

    for (i = 0; i < N/T; i++)
        sum += array[i];

    pthread_exit(NULL);
}
```

```
int main()
{
    pthread_t t[T];
    int A[N], i;

    for (i = 0; i < N; i++)
        A[i] = rand()%10;

    for (i = 0; i < T; i++)
        pthread_create(&t[i], NULL, array_sum, &A[i*N/T]);

    for (i = 0; i < T; i++)
        pthread_join(t[i], NULL);

    printf("%d\n", sum);    // 448706
    return 0;
}
```