CS 153 Lab4 and 5

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Outline

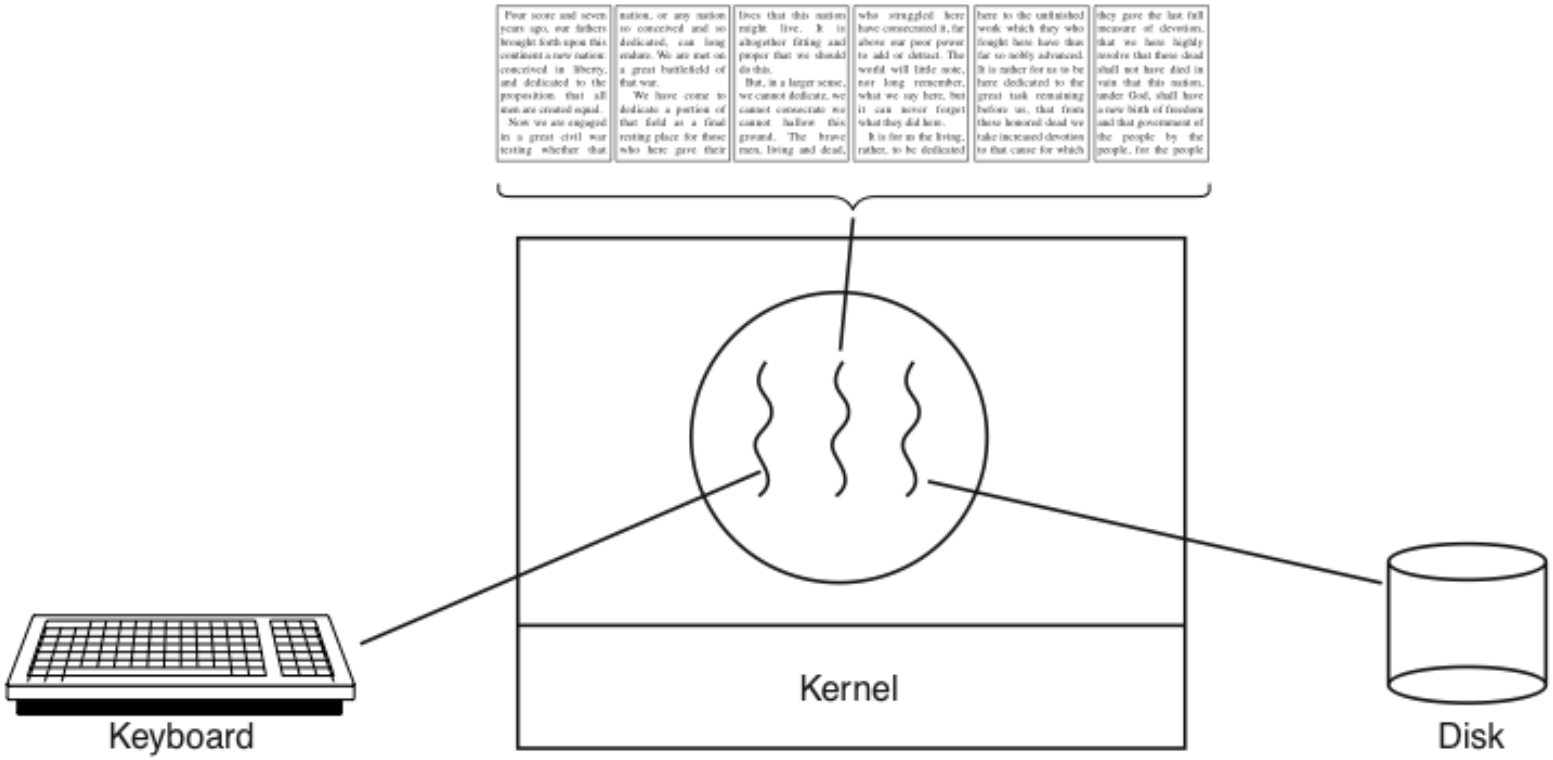
Introduction
Why threads?
POSIX Threads
Synchronization

- A “thread” is a straightforward concept : a single sequential flow of control.
- In traditional operating systems, each process has an address space and a single thread of control.
- Threads run in the same address space.
- In a high-level language you normally program a thread using procedures, where the procedure calls follow the traditional stack discipline.
- Within a single thread, there is at any instant a single point of execution.
- Having “multiple threads” in a program means that at any instant the program has multiple points of execution, one in each of its threads.

Why concurrency?

- In many applications multiple activities are going on at once. Some of these may block from time to time.
- By decomposing such an application into multiple sequential threads that run quasi-parallel, the programming model becomes simple.
- Threads are lighter weight than processes, they are easier (i.e. faster) to create and destroy than processes.
- In many systems, creating a thread goes 10-100 times faster than creating a process.

word processor



cont...

- The programmer can mostly view the threads as executing simultaneously.
- The programmer is required to decide when and where to create multiple threads.
- Additionally, the programmer must occasionally be aware that the computer might not in fact execute all his threads simultaneously.
- Having the threads execute within a “single address space” means that the computer’s addressing hardware is configured so as to permit the threads to read and write the same memory locations.

Processes vs Threads

Per process items	Per thread items
Address space	Program counter
Global variables	Registers
Open files	Stack
Child processes	State
Pending alarms	
Signals and signal handlers	
Accounting information	

cont...

- Each thread executes on a separate call stack with its own separate local variables, but the off-stack (global) variables are shared among all the threads of the program.
- The programmer is responsible for using the synchronization mechanisms of the thread facility to ensure that the shared memory is accessed in a manner that will give the correct answer.

What about protection between threads ?

POSIX Threads

- To make it possible to write portable threaded programs, IEEE has defined a standard for threads in IEEE standard 1003.1c.
- The thread package it defines is called Pthreads.
- The standard defined 60 function calls.

Thread call	Description
Pthread_create	Create a new thread
Pthread_exit	Terminate the calling thread
Pthread_join	Wait for a specific thread to exit
Pthread_yield	Release the CPU to let another thread run
Pthread_attr_init	Create and initialize a thread's attribute structure
Pthread_attr_destroy	Remove a thread's attribute structure

```
int pthread_create (
pthread_t * thread,
const pthread_attr_t * attr,
void * (*start_routine)(void *),
void *arg );

returns the thread id.
attr - Set to NULL if default thread attributes are used.
Thread attributes: scheduling parameter, stack address etc
void * (*start_routine) -
pointer to the function to be threaded.
*arg - pointer to argument of function.
To pass multiple arguments, send a pointer to a structure.

void pthread_exit(void *retval);
retval - Return value of thread.
```

program using pthreads

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

#define NUMBER_OF_THREADS     10

void *print_hello_world(void *tid)
{
        /* This function prints the thread's identifier and then exits. */
        printf("Hello World. Greetings from thread %d0, tid);
        pthread_exit(NULL);
}

int main(int argc, char *argv[])
{
        /* The main program creates 10 threads and then exits. */
        pthread_t threads[NUMBER_OF_THREADS];
        int status, i;

        for(i=0; i < NUMBER_OF_THREADS; i++) {
                printf("Main here. Creating thread %d0, i);
                status = pthread_create(&threads[i], NULL, print_hello_world, (void *)i);

                if (status != 0) {
                        printf("Oops. pthread_create returned error code %d0, status);
                        exit(-1);
                }
        }
        exit(NULL);
}
```

- -lpthread
- When a thread is created, it prints a one-line message announcing itself, then it exits.
- The order in which the various messages are interleaved is nondeterminate, and may vary on consecutive runs of the program.
- Study prog1.c and prog2.c

mutex

- Why we need mutual exclusion ?
- A mutex, which stands for mutual exclusion is the most basic form of synchronization.
- A mutex is used to protect a critical region, to make certain that only one thread at a time executes the code within the region.
- Since only one thread at a time can lock a given mutex, this guarantees that only one thread at a time can be executing the instructions within a critical region.

cont...

lock_the_mutex(...);
critical region
unlock_the_mutex(...);
Study prog3.c and prog4.c


Thaaaank
Yoooouuu!!!