Introduction to C

Threads

Instructor: Yin Lou

02/16/2011

Processes vs. Threads

Processes

- Multiple simultaneous programs
- Independent memory space
- Independent open file-descriptors

Threads

- Multiple simultaneous functions
- Shared memory space
- Shared open file-descriptors

Threads Examples

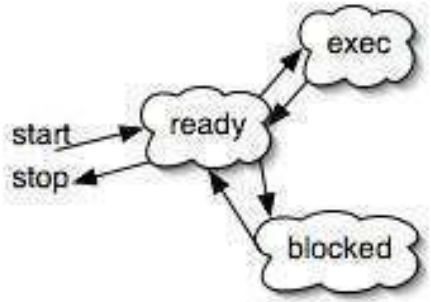
- Graphical User Interfaces (GUIs)
  - The GUI is usually put on a separate thread from the "app engine"
  - GUI remains responsive even if app blocks for processing
- Web Browser Tabs
  - Each tab is managed by a separate thread for rendering
  - Web pages render "simultaneously"
  - Note: Google Chrome actually uses a separate process per tab

Threads

- One copy of the heap
- One copy of the code
- Multiple stacks

Threads

- One copy of the heap
- One copy of the code
- Multiple stacks
- Life Cycle



pthread

- #include <pthread.h>

pthread

- #include <pthread.h>
- Define a worker function

pthread

- #include <pthread.h>
- Define a worker function
  - void *foo(void *args) { }

pthread

- #include <pthread.h>
- Define a worker function
  - void *foo(void *args) { }
- Initialize pthread_attr_t

pthread

- #include <pthread.h>
- Define a worker function
  - void *foo(void *args) { }
- Initialize pthread_attr_t
  - pthread_attr_t attr;
  - pthread_attr_init(attr);

pthread

- #include <pthread.h>
- Define a worker function
  - void *foo(void *args) { }
- Initialize pthread_attr_t
  - pthread_attr_t attr;
  - pthread_attr_init(attr);
- Create a thread

pthread

- #include <pthread.h>
- Define a worker function
  - void *foo(void *args) { }
- Initialize pthread_attr_t
  - pthread_attr_t attr;
  - pthread_attr_init(attr);
- Create a thread
  - pthread_t thread;
  - pthread_create(&thread, &attr, worker_function, arg);

pthread

- #include <pthread.h>
- Define a worker function
  - void *foo(void *args) { }
- Initialize pthread_attr_t
  - pthread_attr_t attr;
  - pthread_attr_init(attr);
- Create a thread
  - pthread_t thread;
  - pthread_create(&thread, &attr, worker_function, arg);
- Exit current thread

pthread

- #include <pthread.h>
- Define a worker function
  - void *foo(void *args) { }
- Initialize pthread_attr_t
  - pthread_attr_t attr;
  - pthread_attr_init(attr);
- Create a thread
  - pthread_t thread;
  - pthread_create(&thread, &attr, worker_function, arg);
- Exit current thread
  - pthread_exit(status)

Example

```
#include <stdio.h>
#include <pthread.h>
#define NUM_THREADS     5

void *print_hello(void *threadid)
{
    long tid;
    tid = (long) threadid;
    printf("Hello World! It's me, thread #%ld!\n", tid);
    pthread_exit(NULL);
}

int main (int argc, char *argv[])
{
    pthread_t threads[NUM_THREADS];
    int rc;
    long t;
    for (t = 0; t < NUM_THREADS; t++)
    {
        printf("In main: creating thread %ld\n", t);
        rc = pthread_create(threads + t, NULL, print_hello, (void *) t);
        if (rc)
        {
            printf("ERROR; return code from pthread_create() is %d\n", rc);
            exit(-1);
        }
    }
    pthread_exit(NULL);
}
```

Thread Management

- pthread_join(threadid, status)
- pthread_detach(threadid)

Example

```
#include <stdio.h>
#include <pthread.h>
#define NUM_THREADS     5

void *print_hello(void *threadid) {
    long tid;
    tid = (long) threadid;
    printf("Hello World! It's me, thread #%ld!\n", tid);
    pthread_exit(NULL);
}

int main (int argc, char *argv[]) {
    pthread_t threads[NUM_THREADS];
    int rc;
    long t;
    for (t = 0; t < NUM_THREADS; t++) {
        printf("In main: creating thread %ld\n", t);
        rc = pthread_create(threads + t, NULL, print_hello, (void *) t);
        if (rc) {
            printf("ERROR; return code from pthread_create() is %d\n", rc);
            exit(-1);
        }
    }
    /* wait for all threads to complete */
    for (t = 0; t < NUM_THREADS; t++) {
        pthread_join(threads[t], NULL);
    }
    pthread_exit(NULL);
}
```

Compiling

- Use “-pthread”

Compiling

- Use "-pthread"

Makefile

```
CC:=gcc
OPTIONS:=-O2
LIB_PATH:=-pthread

SRC_DIR:=src
DST_DIR:=bin

default:
    $(CC) $(OPTIONS) $(LIB_PATH) \
    $(SRC_DIR)/*.c -o $(DST_DIR)/test
clean:
    cd $(DST_DIR); rm test
```