CSc 360
Operating Systems
Pthreads

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Review: threads

- Threads
  - a basic unit of CPU utilization
  - thread vs process
- User vs kernel-level threads
  - thread models
- Issues with threading
  - fork(), exec()
  - kill()

Pthread library

- Create a thread
  - int **pthread_create** (thread, attributes, start_routine, arguments);
  - PC: start_routine(arguments);
  - default attributes: joinable and non-realtime
- Exit from a (created) thread
  - void **pthread_exit** (return_value);
  - cleanup handlers by **pthread_cleanup_push** ();
    - stack-like “reverse” execution order

thread vs process system calls/diagram on board

Pthread library: more

- Wait a target thread to exit: *synchronize*
  - int **pthread_join** (thread, return_value);
  - release resource allocated to the target thread
- Put a target thread in detached state
  - int **pthread_detach** (thread);
  - no other threads can “join” this one
    - no “pthread_attach”
  - resource released once the thread exits
    - thread can be created in detached state

Pthread: further more

- Cancel another thread
  - int **pthread_cancel** (thread);
  - calling thread: send a request
  - target thread: **pthread_setcancelstate** ();
    - ignore the request
    - terminate immediately
      - asynchronous cancellation
    - check whether it should be cancelled periodically
      - deferred cancellation

Example: producer-consumer

- Multi-process
  - shared memory solution
  - message passing solution
- Single-process, multi-thread

```
#i ncl ude  <pt hr ead. h>
...

void *producer (void *args);
void *consumer (void *args);

typedef struct {...} queue;
```


* with a fifo queue instead of (ring) array

Main thread

```
queue *queueInit (void);
void queueDelete (queue *q);
void queueAdd (queue *q, int in);
void queueDel (queue *q, int *out);

int main ()
{
    queue *fifo;
    pthread_t pro, con;

    fifo = queueInit ();
    if (fifo == NULL) {
        fprintf (stderr, "main: Queue Init failed.\n");
        exit (1);
    }
    pthread_create (&pro, NULL, producer, fifo);
    pthread_create (&con, NULL, consumer, fifo);
    pthread_join (pro, NULL);
    pthread_join (con, NULL);
    queueDelete (fifo);

    return 0;
}
```

Producer thread

```
void *producer (void *q)
{
     queue *fifo;
     int i;

     fifo = (queue *)q;

     for (i = 0; i < LOOP; i++) {
          /* produce LOOP items, inserting them into
                    * the “fifo” queue.
                    */
          ...
     }
     return (NULL);
}
```

Consumer thread

```
void *consumer (void *q)
{
     queue *fifo;
     int i, d;

     fifo = (queue *)q;

     for (i = 0; i < LOOP; i++) {
          /* Consumer LOOP items from the
           * "fifo" queue.
           */
          ...
     }
     return (NULL);
}
```

This lecture

- Pthread library
  - create and terminate threads
    - passing arguments: start_routine (arguments);
  - join and detach threads
    - synchronize
- Explore further

  Pthread tutorial this ~~*Friday*~~ Thursday

  http://www.llnl.gov/computing/tutorials/pthreads/

Next lecture

- Pthread
  - threads: sharing data in a process
    - read-write, write-write conflicts
  - mutex and condition variables
    http://www.llnl.gov/computing/tutorials/pthreads/