# User Thread Implementation

COMP755

Advanced OS

*"America is not a blanket woven from one thread, one color, one cloth."*

Jesse Jackson

# Thread Implementations

- You can implement the concept of threads at the system level or at the user level.
- The system level has several advantages:
  - Access to all the hardware and CPUs
  - Ability to respond to interrupts
  - Ability to preempt a thread

# User Threads

- This is an example of how you might implement threads at the user level.
- It is difficult to preempt a thread. Threads can voluntarily allow another thread to run.
- The yield method allows the thread system to consider scheduling another thread. It does not directly do anything for the calling thread.

# Example using User Threads

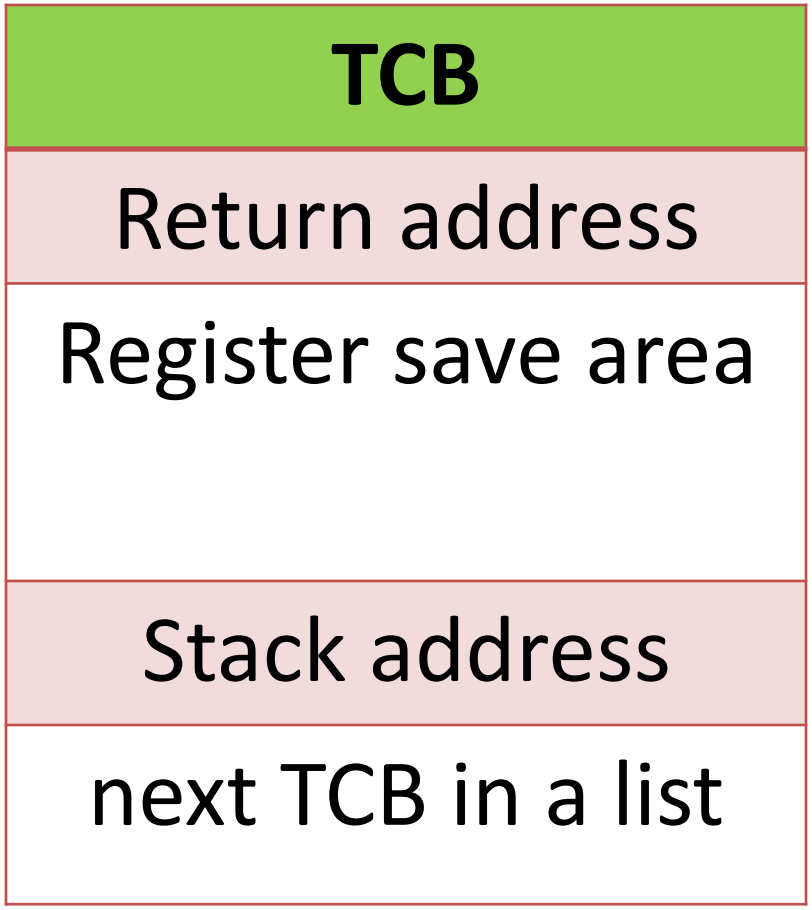
```
void main () {
        .
        .
spawn( printit );
        .
do {
    …
yield( );
    …
} until whatever;
        .
}
```

```
void printit(void) {
do {
        print a line;
        yield( );
        } until end of data;
terminate( );
}
```

# Implementation Details

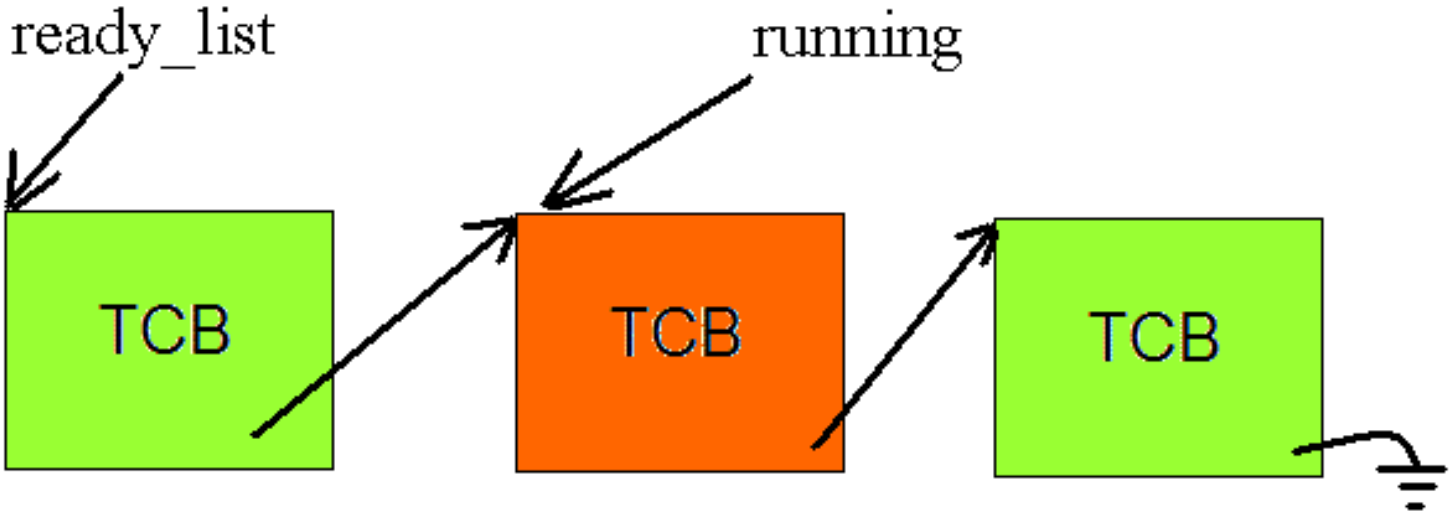
- My example thread system would probably have to be implemented in assembler.
- You have to be able to save the registers and set the stack address
- This user thread implementation does not attempt to use multiple processors

# Thread Control Block



# Thread System Data

- ready_list – a linked list of thread control blocks
- running – the currently executing thread's TCB



# Scheduling a Thread to Run

```
private void schedule() {  /* internal function */
    Select one of the control blocks from the ready list;
    Set running to the selected thread control block;
    Load the registers from the save area;
    Jump to the return address;
}
```

- Note that the schedule function does not return to the caller in the usual sense

# Starting a New Thread

**public void spawn(function) {**

In running thread's control block, save registers and return address;

Create a new control block;

Copy the running thread's control block to the new control block;

Set return address to the address of the function;

Acquire memory for a stack;

Put the stack address in the new control block;

Put return address of terminate() on the stack;

Put the new control block on the ready list;

schedule();

}

# Terminating a Thread

```
public void terminate() {
    Remove the current TCB from the running list;
    Release the stack memory for the running thread;
    Release the control block for the running thread;
    If no TCBs left on the ready list
       exit(); to terminate the process
    else
       schedule();
}
```

- Note that the terminate function never returns to the caller

# Giving Up Control

- Can be called by a user to allow some other thread the change to run.
- This thread might resume immediately.

**public void yield() {**

In running thread's control block, save registers and return address;

schedule();

}

# Implement Semaphores

- In a group of no more than three students, write P() and V() methods to implement semaphores

- Turn your implementation in before the end of class
- Include the names of the students in your group

```
public class Semaphore {
        int counter = 0;
        public Semaphore(int initial) {
                counter = initial;
        }
        public synchronized void V() {
                counter++;
                notify();
        }
        public synchronized void P() {
                while (counter == 0) wait();
                counter--;
        }
}
```

# Semaphore Objects

```
public class Semaphore {
    int     counter;
    TCB    waiting;  /* list of suspended threads */
    public Semaphore(int initialValue) {
        counter = initialValue;
    }
}
```

# Wait method

```
public void P() {
    if (counter <= 0) {
        save registers and return address in TCB;
        remove TCB from ready list;
        put TCB on waiting list;
        schedule();
    }
    counter--;
}
```

# Signal method

```
public void V() {
    counter++;
    if (waiting != null) {
        Remove one TCB from waiting list;
        put TCB on ready_list;
        yield();
    }
}
```

# User and System Threads