Implementing Threads

CS520
Dept. of Computer Science
Univ. of New Hampshire

Goal

Provide illusion of multiple threads executing when there is only a single processor.

```
long thread_create(void (*work)(void *), void *info);

void thread_yield(void);
```

Thread State

What is a thread?

PC +

other registers +

stack

Thread Control Block (TCB)

contains thread state when it is not running

Keep list of TCBs for ready-to-run threads

↳ the ready list

my convention: head of ready list is the current running thread

thread_yield

rotate TCBs on ready list

First becomes last

second becomes first

save state of running thread

into its TCB

restore state of next thread

from its TCB

changing stacks

when you restore the stack pointer of the next thread, you change from running on one stack to running on a second stack

this is the magic moment

└ cool, cool, cool!

complication

we can create a TCB for a thread
when we create it

but we don't create the main thread

so first time a thread primitive is
called, create a TCB for the
main thread and make it the
sole node on the ready list

saving/restoring thread state

need to access registers
so code needs to be in assembly language

```
void asm_yield(TCB *cur, TCB *next);
```

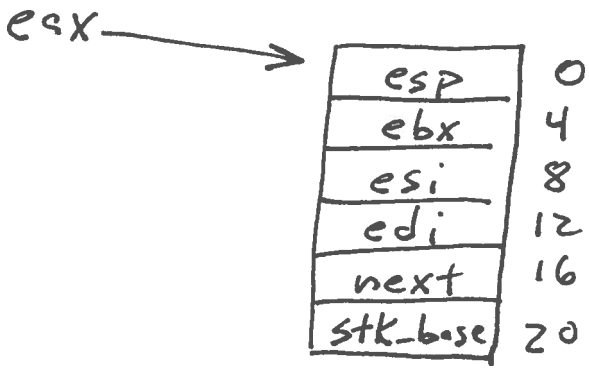
which registers need to be saved?

esp
ebx
esi
edi
} callee saved

why not the ebp?

why not the eip?

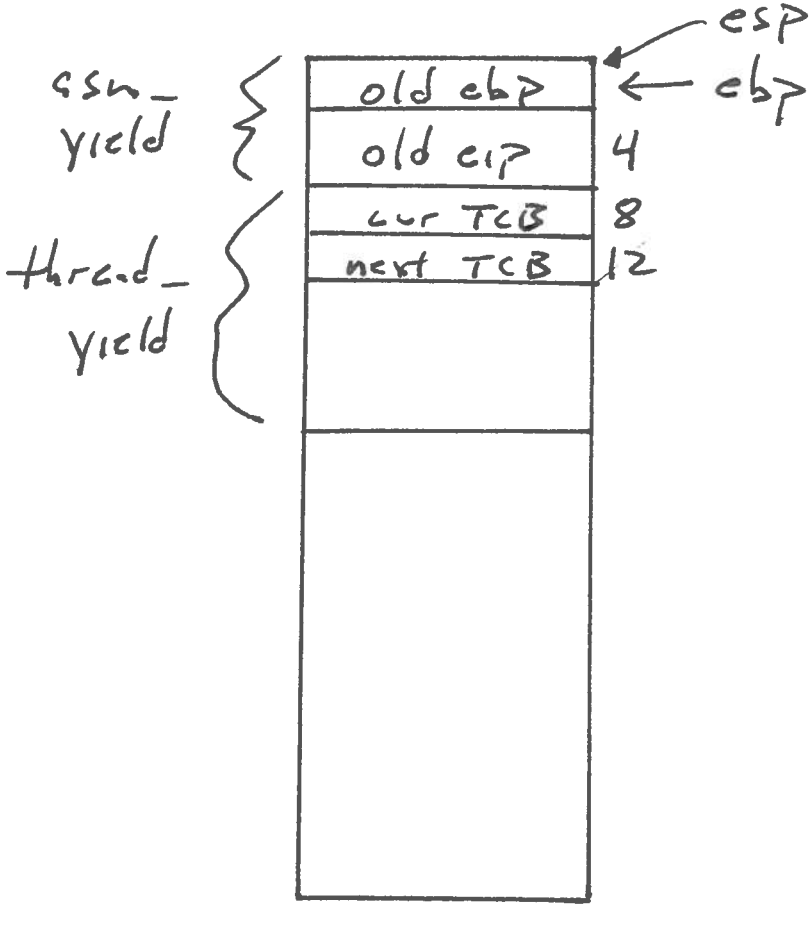
accessing a struct from assembly language



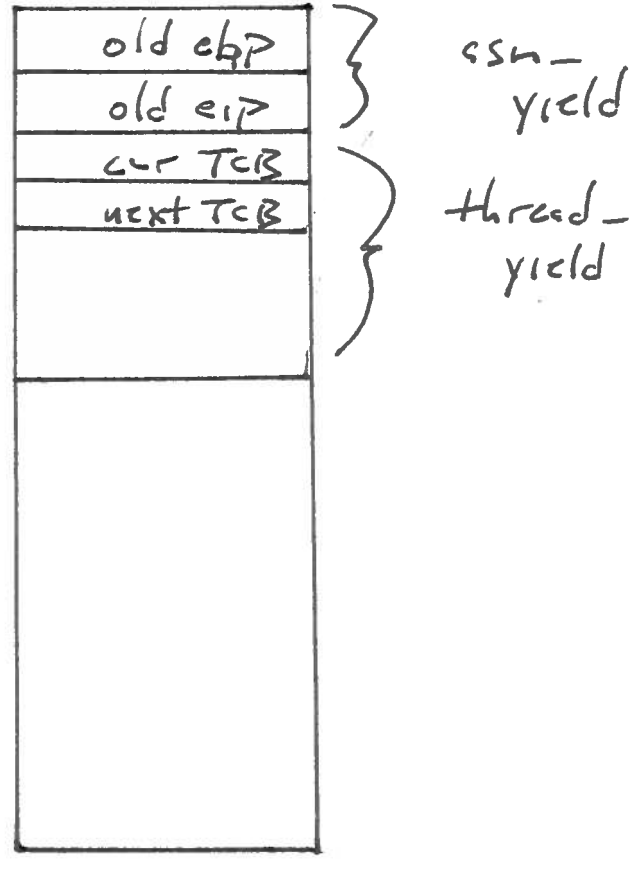

```
movl %edi, 12(%eax)   // save

movl 12(%eax), %edi   // restore
```

The Magic Moment

```
gsm_yield:  pushl %ebp
            movl  %esp, %ebp
              :
            movl (%ecx) %esp   <-- HERE!
            popl %ebp
            ret
```



stack for current



stack for next

thread_create (work, info)

create TCB and put it on the end
of the ready list

use malloc to allocate a stack

↳ save base of stack in the TCB
so it can be freed later

initialize TCB & stack so that the
thread will execute this function

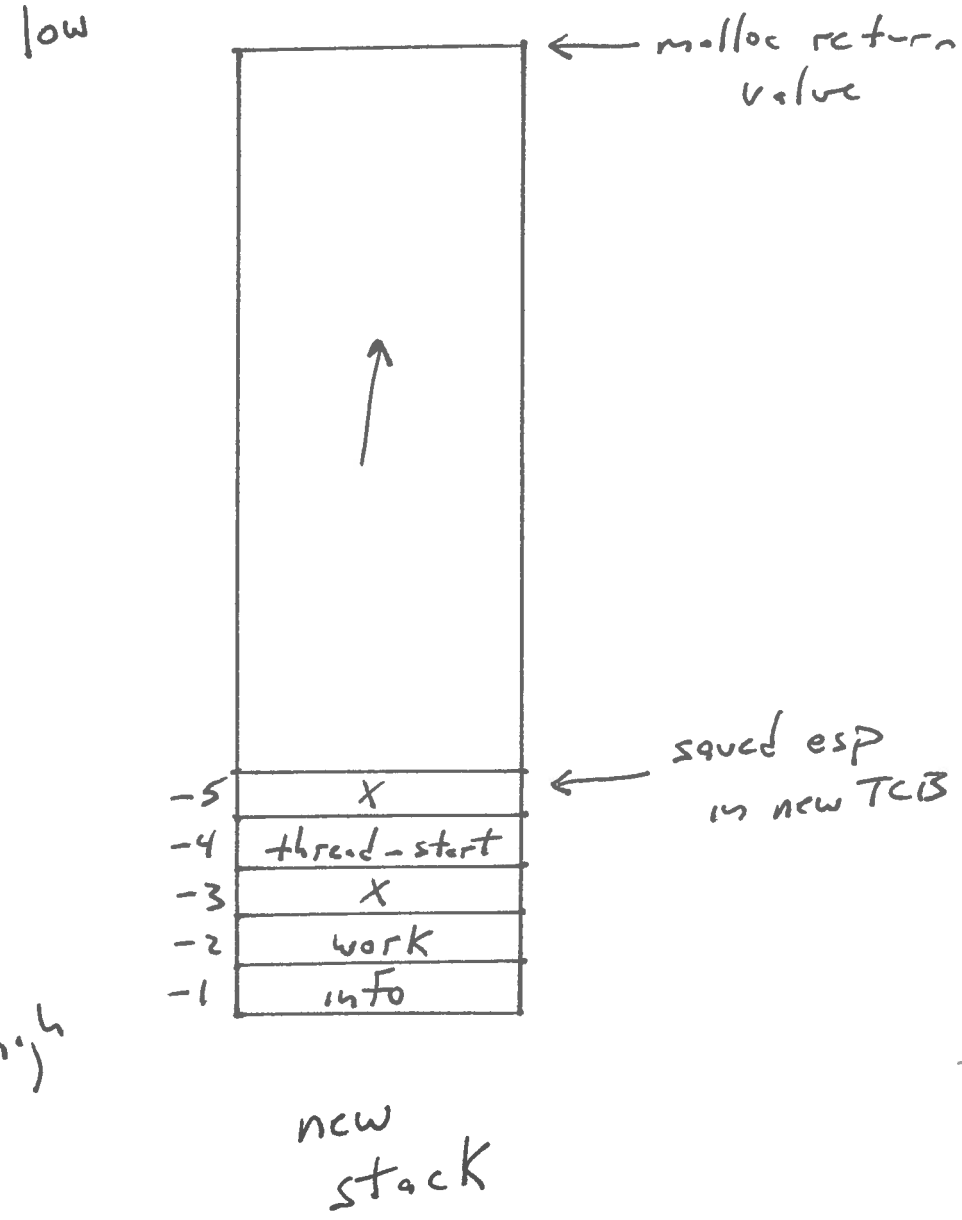
```
void thread_start (void (*work)(void*), void *info)
{
    work(info);
    thread_cleanup();
}
```

thread_create return value

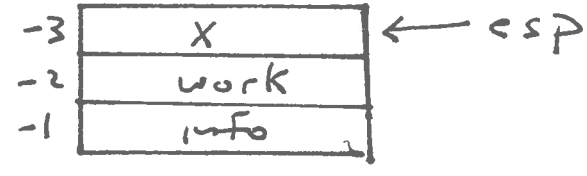
address of TCB

serves as "thread ID"

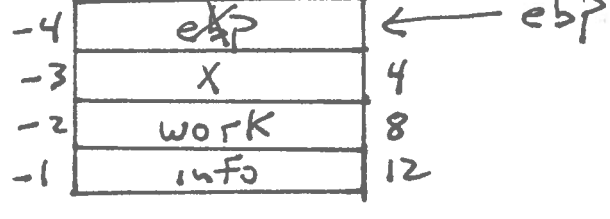
TCB & stack initialization



asm_yield:
⋮
popl %ebp
ret



thread_start:
pushl %ebp
movl %esp, %ebp



This is amazing stuff!

thread_cleanup

remove TCB from front of ready list

Free stack*

Free TCB

call asm_yield(NULL, next)

next: TCB now on front of ready list

* dangerous to free stack that we are still executing on.

probably should defer frees of stack by one call

↳ Free this stack the next time thread_cleanup executes

Is your heart pumping?

It is even more exciting to code it up and see it work!

Preemptive Scheduling

"hide" calls to thread_yield

ask O.S. to generate timer signals
at regular intervals

install handler function for signal
that will call thread_yield

must disable signal handler at
critical points

↳ when creating thread
when thread is being cleaned up
etc