

~~ Welcome to the **Critical Section Problem** game show! ~~

Example Critical Section

```
if( data[i] > data[j] {
    temp=data[i]; data[i] = data[j]; data[j] = temp
}
```

The Critical Section Problem

while(running) {

1. Wait to enter the critical section if another thread is in the CS.
2. Critical Section Code; Only one thread/process in here at a time!
3. Leave critical section. Allow another waiting thread to enter.
4. // do other stuff most of the time

}

Today's prizes:

Mutual exclusion

Bounded wait

Progress

Candidate #1. Use a single, boolean "flag"

boolean flag

<i>Thread A</i>	<i>Thread B</i>
wait while the flag is up	wait while the flag is up
raise the flag!	raise the flag!
<i>Critical Section</i> code here	<i>Critical Section</i> code here
lower the flag!	lower the flag!
...	...

// Then each thread does other work but will repeat this again sometime in the future. Problems?

Candidate #2. Give each thread its own a flag.

boolean flagA, flagB

wait while B's flag is up	wait while A's flag is up
raise A flag	raise B flag
<i>Critical Section</i> code here	<i>Critical Section</i> code here
lower A flag	lower B flag

Problems?

Candidate #3. Change the sequence order

raise A flag	raise B flag
wait until B flag is down	wait until A flag is down
<i>Critical Section</i> code here	<i>Critical Section</i> code here
lower A flag	lower B flag

Problems?

Candidate #4. Try a single turn-based shared variable.

turn=1

while(turn == 2) { }	while(turn == 1) { }
<i>Critical Section</i> code here	<i>Critical Section</i> code here
turn = 2	turn = 1

Problems?

Dekker's N=2 solution (1962) to the Critical Section Problem.

```
raise my flag
while(your flag is raised) :
    if it's your turn to win :
        lower my flag
        wait while your turn
        raise my flag

// Do Critical Section stuff here

set your turn to win
lower my flag
```

Peterson's N=2 solution to the Critical Section Problem? (1981!)

```
raise my flag

turn = your_id

wait while your flag is raised and turn is your_id

// Do Critical Section stuff

lower my flag
```

Code Examples-

Example code for ____?

```
void lock_init(){
    flag[0] = flag[1] = 0;
    turn = 0;
}

//Call before critical section
void lock(int self){
    flag[self] = 1;
    turn = 1 - self;
    while(flag[1-self]==1 && turn==1-self);
}

// Call after critical section
void unlock(int self){
    flag[self] = 0;
}
```

Also

<https://android.googlesource.com/kernel/tegra.git/+/android-tegra-3.10/arch/arm/mach-tegra/sleep.S#58>

spinlock implementation with no atomic test-and-set and no coherence

```
* using Peterson's algorithm on strongly-ordered registers
* used to synchronize a cpu waking up from wfi with entering
lp2 on idle
    mov    r12, #1
    str    r12, [r2]    @ flag[cpu] = 1
    dsb
    str    r12, [r1]    @ !turn = cpu
1:    dsb
    ldr    r12, [r3]
    cmp    r12, #1      @ flag[!cpu] == 1?
    ldreq  r12, [r1]
    cmpeq  r12, r0      @ !turn == cpu?
    beq    1b          @ while !turn == cpu &&
flag[!cpu] == 1
    mov    pc, lr      @ locked
```

Challenges with code implementations?