

## Deadlock

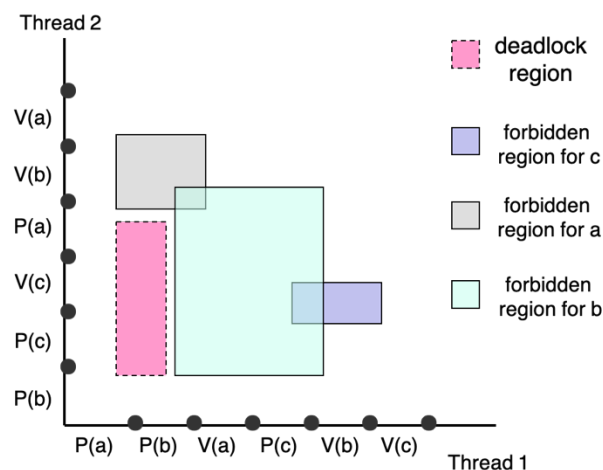
1. Does it cause deadlock? Please show at least two execution flow that will cause deadlock (You just need to answer the states of involved threads. e.g. After T1 finishes step1 and T2 finishes step2) .

Case1: After T1 finish step1 and T2 finish step3

Case2: After T1 finish step1, T2 finish step1, and T3 finish step3, they will enter deadlock.

2. If we remove **Thread3**, will it cause deadlock? Please draw the **progress graph** and explain your reason.

It may cause deadlock. A possible execution flow is P1(a) -> P2(b) -> P2(c) -> V2(c) -> deadlock



## Spin lock

1) In the modified ticket lock, a lock waiter will idle (instead of always spinning in the original ticket lock) some amount of time proportional to his distance between the lock holder based on the fact that late-comers will wait more time before the lock is passed to them. This can greatly reduce the number of memory access from the lock waiters.

2) However, it is hard to estimate an appropriate idle time since the time of critical section is unknown and variant. It may slow the whole queue if one of the waiter's idle time is too long.

3) In ticket lock, the time a thread will wait on the lock is proportional to his distance between the lock holder. So `IDLE(myturn - lock->turn)` saves memory access with respect to his waiting time.

## Schedule

|          |           |          |              |           |       |           |           |       |
|----------|-----------|----------|--------------|-----------|-------|-----------|-----------|-------|
| Timeline | 0         | 2        | 3            | 6         | 8     | 10        | 12        | 13    |
| CPU      | A->2      | A->6     | A->6         | B->8      | C->10 | B->13     | B->13     | D->15 |
| Q2       | A(7)      |          | B(5)         | B(5)C(13) | C(13) |           | D(8)      | D(8)  |
| Q1       |           | A(5)     | A(4)         |           | B(3)  | B(3)C(11) | B(1)C(11) | C(11) |
| Q0       |           |          |              | A(1)      | A(1)  | A(1)      | A(1)      | A(1)  |
| Timeline | 15        | 19       | 23           | 24        | 31    | 33        |           |       |
| CPU      | C->19     | D->23    | A->24        | C->31     | D->33 |           |           |       |
| Q2       |           |          |              |           |       |           |           |       |
| Q1       | C(11)D(6) | D(6)     |              |           |       |           |           |       |
| Q0       | A(1)      | A(1)C(7) | A(1)C(7)D(2) | C(7)D(2)  | D(2)  |           |           |       |

$$2. Tr = (0+3+2+1)/4=1.5ms$$

$$Tt=(24+10+25+21)/4=20ms$$

No. Long jobs which came early are starved for a long time.