

2021 FALL OS Project 3 Help Document



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NOTE

•과제 #0 Set up development environment

기한: 09/18 midnight

방법: etl 제출

•과제 #1

기한: 10/08 midnight

방법: 팀별 repository에 proj1 branch 생성 / 발표자료는 대표 한 명이 etl 제출

•과제 #2

기한: 11/06 midnight

방법: 팀별 repository에 proj2 branch 생성 / 발표자료는 대표 한 명이 etl 제출

•과제 #3

기한: 11/27 midnight

방법: 팀별 repository에 proj3 branch 생성 / 발표자료는 대표 한 명이 etl 제출

•과제 #4

기한: 12/15 midnight

방법: 팀별 repository에 proj4 branch 생성 / 발표자료는 대표 한 명이 etl 제출



Project 3 Overview

- Implement rotation-based read/write lock
- Each lock has a “rotation range”
 - Every lock can be acquired when the current rotation is in the rotation range
 - Or, it is blocked until the current rotation is located in the rotation range
- Read lock could be acquired when no acquired write lock range is overlapping with its range
- Write lock could be acquired when no acquired read/write lock range is overlapping with its range
 - Exclusive access

Rotation Range

- 1 axis: rotation(use daemon)
 - Actually, Tizen orientation has three axes! (Azimuth, Pitch, Roll)
- $(\text{degree} - \text{range}) \leq \text{range} \leq (\text{degree} + \text{range})$
- Rotation ranges are inclusive
 - Ex) [30, 60], [60, 90] are overlapped
- Rotation ranges are circular
 - Ex) [330, 30] and [30, 330]
 - [330 ... 0 ... 30]
 - [30 ... 180 ... 330]

Range Example (1)

- Rotation 1
 - degree = 30
 - range = 30
- Rotation 2
 - degree = 45
 - range = 30

Are they overlapped?

Range Example (1)

- Rotation 1
 - degree = 30
 - range = 30

- Rotation 2
 - degree = 45
 - range = 30

- Rotation 1
 - [0, 60]

- Rotation 2
 - [15, 75]

Are they overlapped? YES!

Range Example (2)

- Rotation 1
 - degree = 30
 - range = 60
- Rotation 2
 - degree = 315
 - range = 30

Are they overlapped?

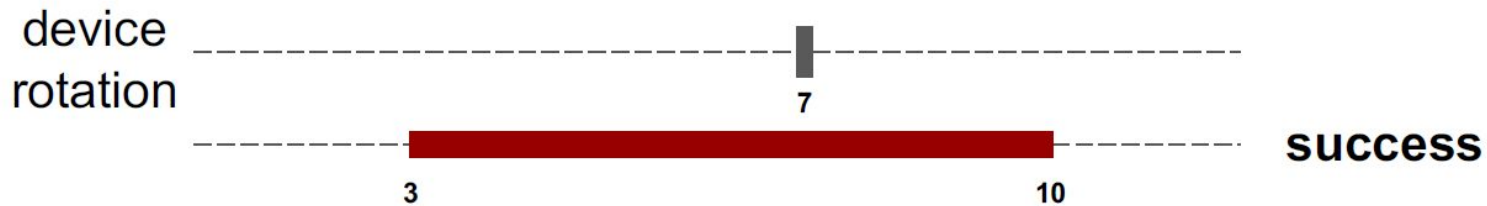
Range Example (2)

- Rotation 1
 - degree = 30
 - range = 60
- Rotation 2
 - degree = 315
 - range = 30
- Rotation 1
 - $[0, 90] + [330, 360)$
- Rotation 2
 - $[285, 345]$

Are they overlapped? YES!

Rotation Lock Example

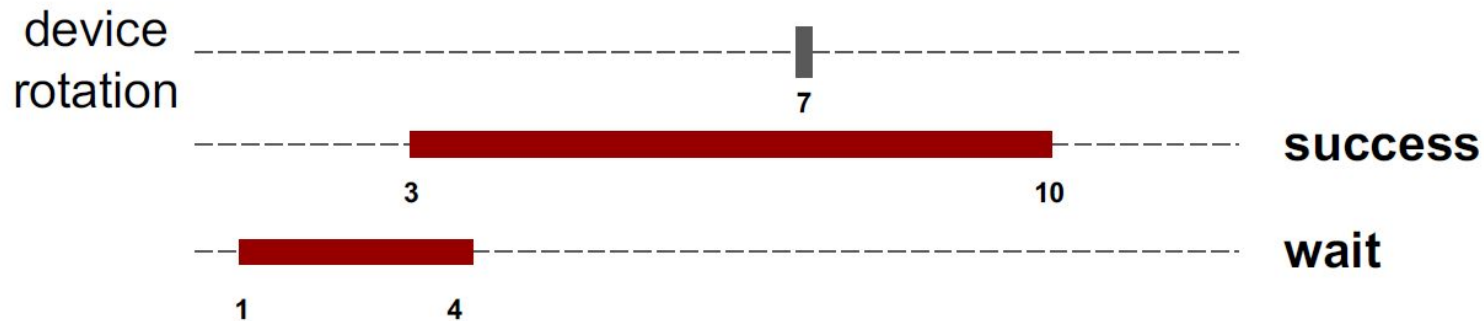
rotlock_write(3-10)



 writer
 reader

Rotation Lock Example

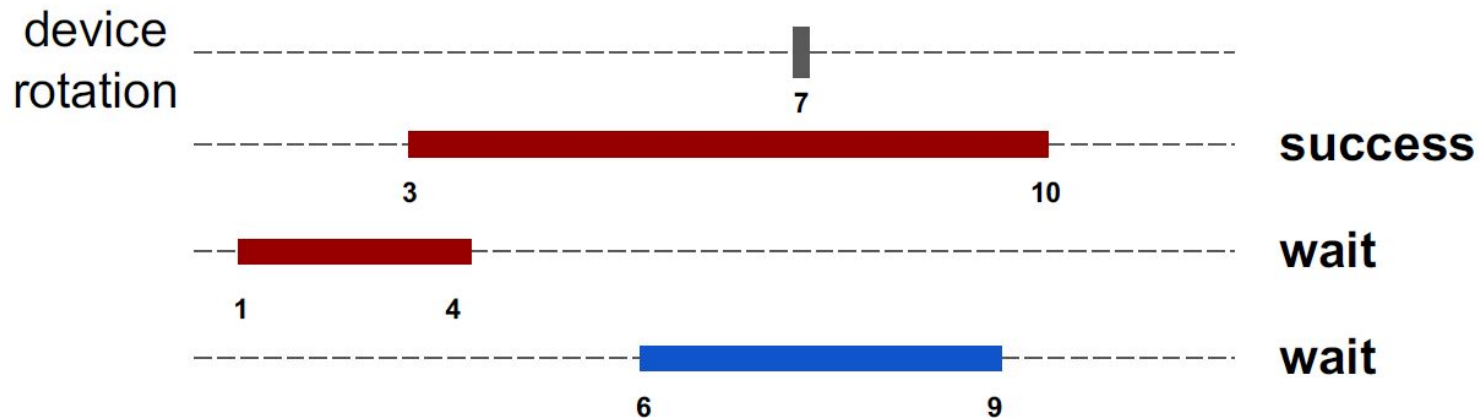
rotlock_write(1-4)



writer
reader

Rotation Lock Example

rotlock_read(6-9)

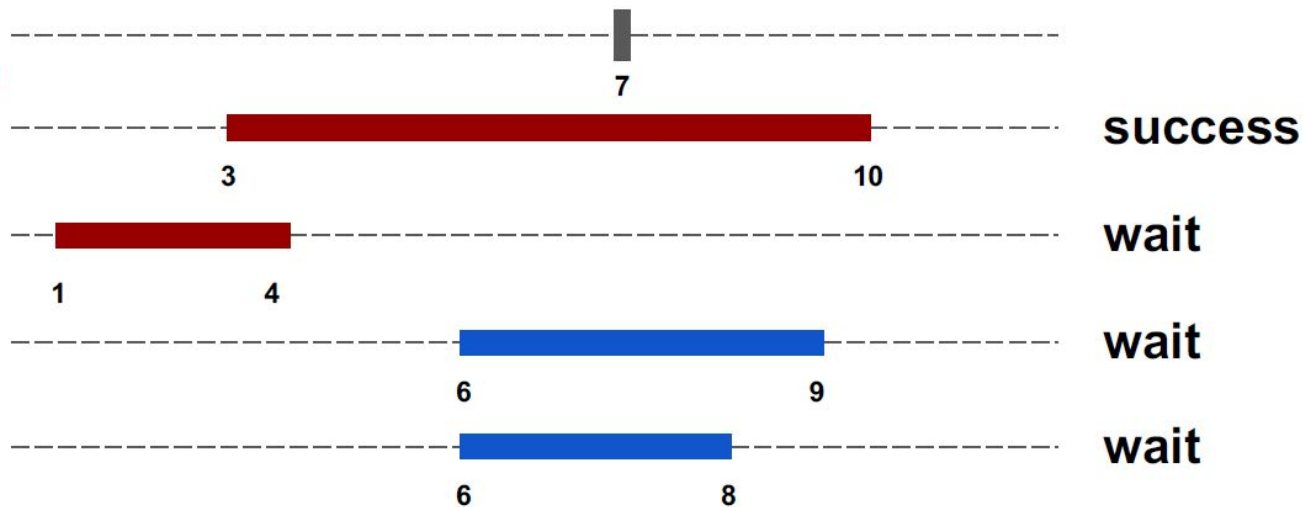


 writer
 reader

Rotation Lock Example

rotlock_read(6-8)

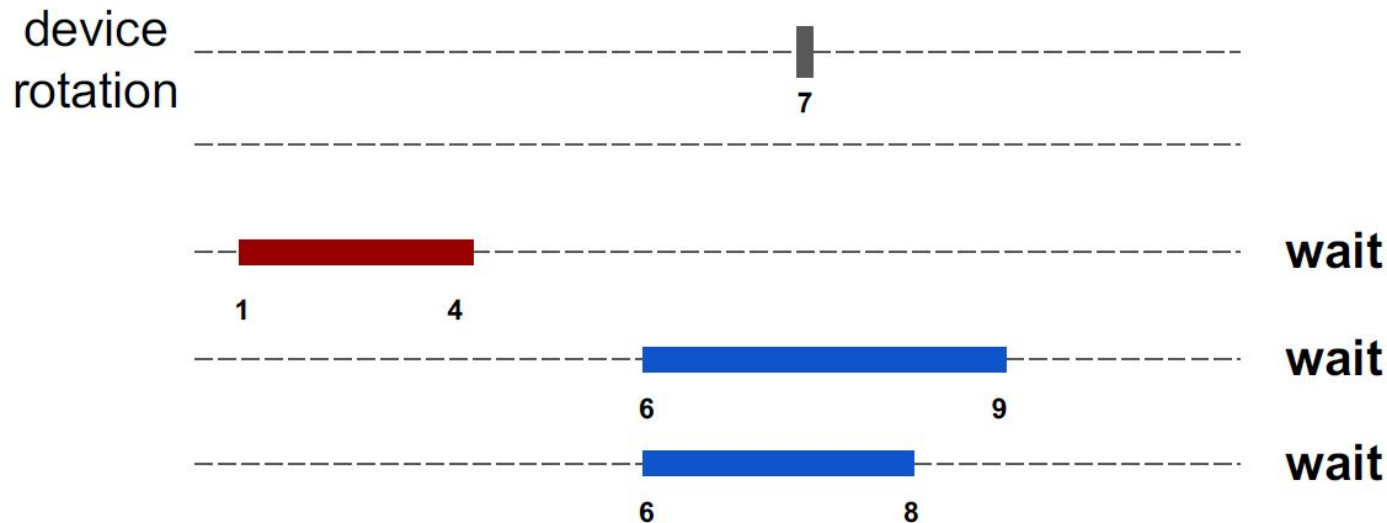
device
rotation



writer
reader

Rotation Lock Example

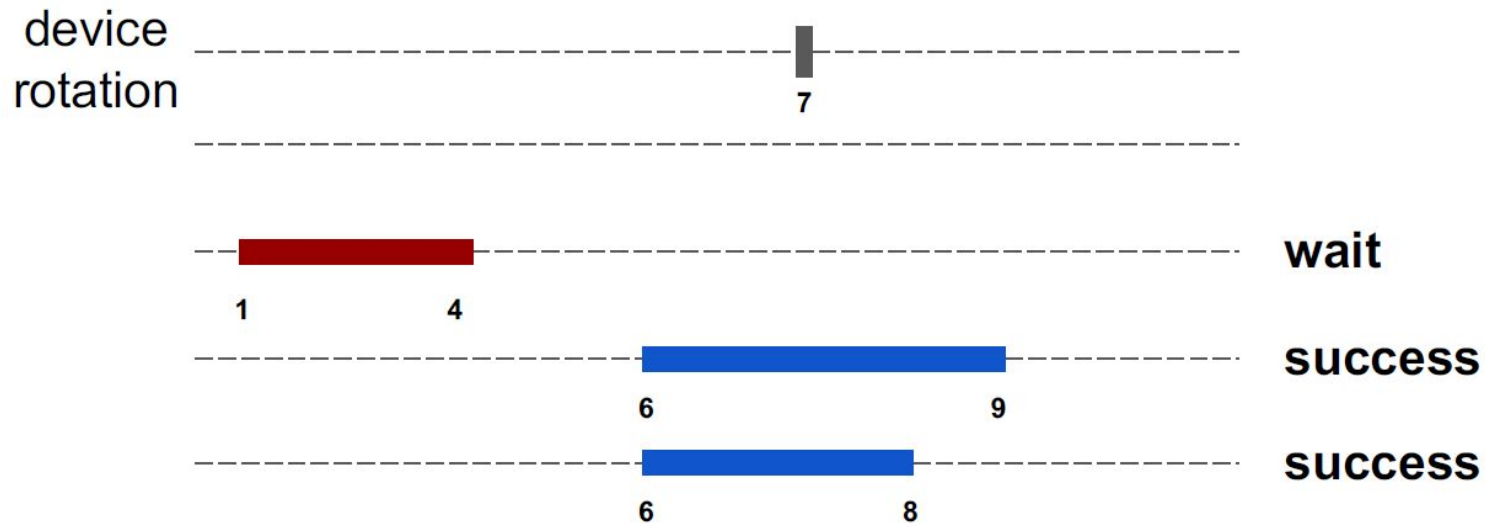
rotunlock_write(3-10)



 writer
 reader

Rotation Lock Example

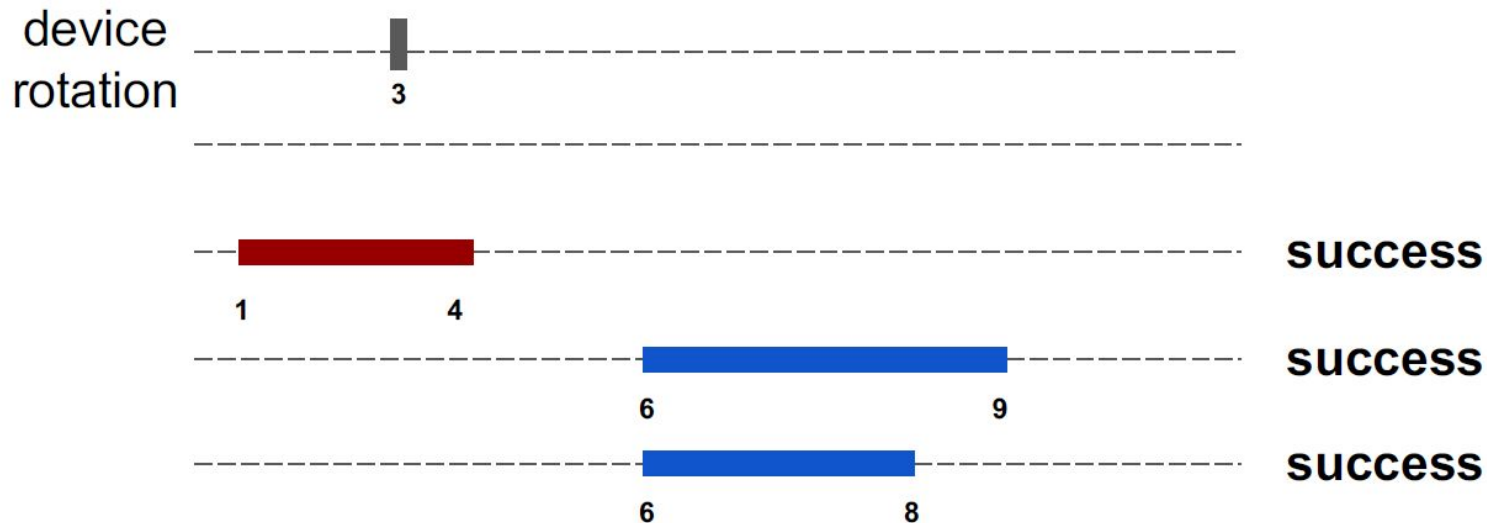
rotunlock_write(3-10)



writer
reader

Rotation Lock Example

Device rotation changed to 3



writer
reader

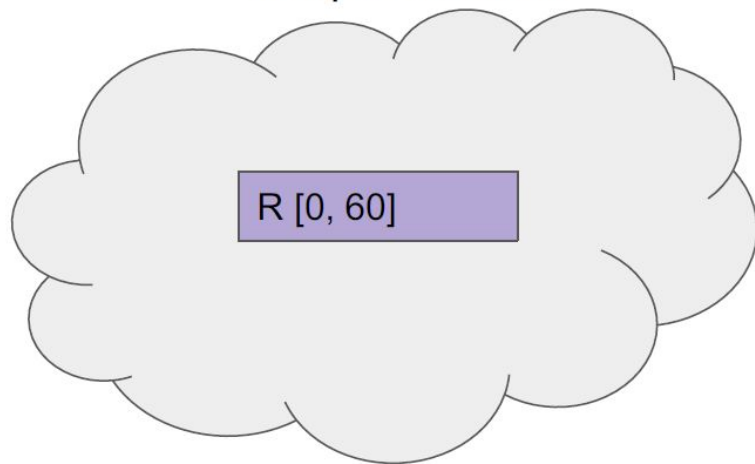
Preventing writer starvation

- You should implement a policy for preventing starvation of writers
 - Why? If reader comes in infinitely, a writer could wait forever!
- If a reader holds a lock and a writer wants to take the lock, no more readers can take the lock
- If you design your own additional policy, explain that in your README.md file, report, and slides!

How to prevent Starvation?

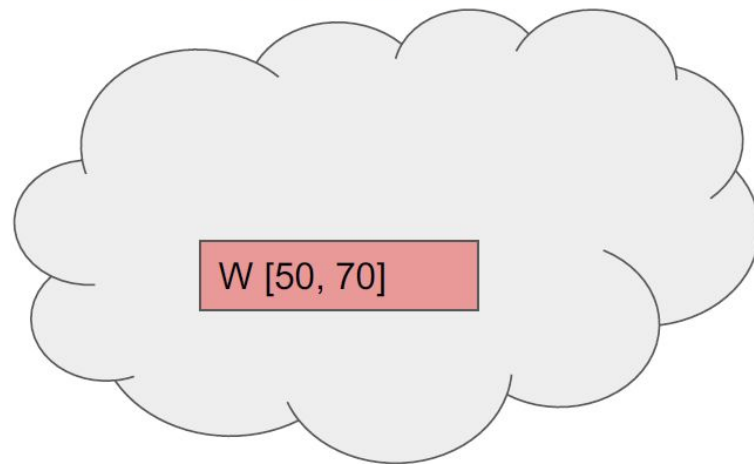
- A write lock is waiting for the rotation changes & the reader to release its lock

Acquired locks



Current Rotation = 40

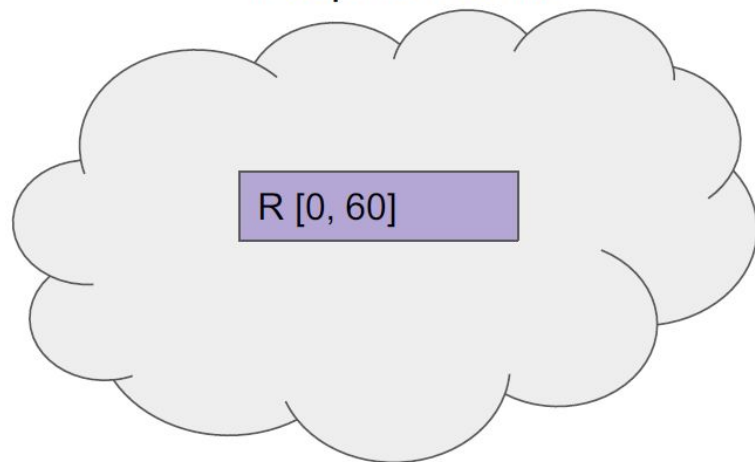
Waiting locks



How to prevent Starvation?

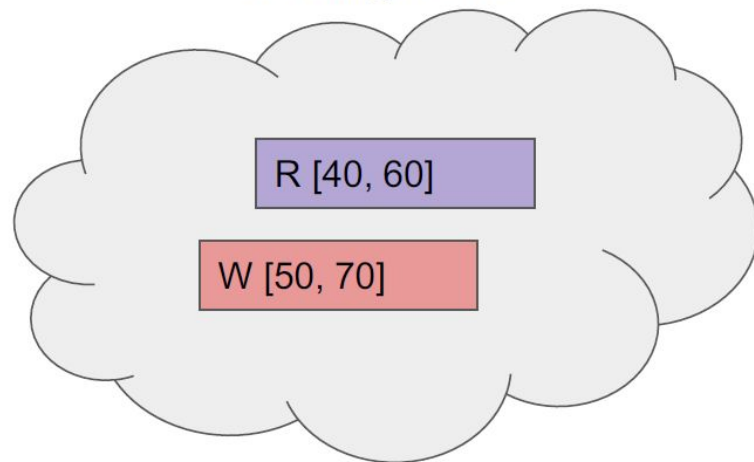
- A read lock [40, 60] came

Acquired locks



Current Rotation = 40

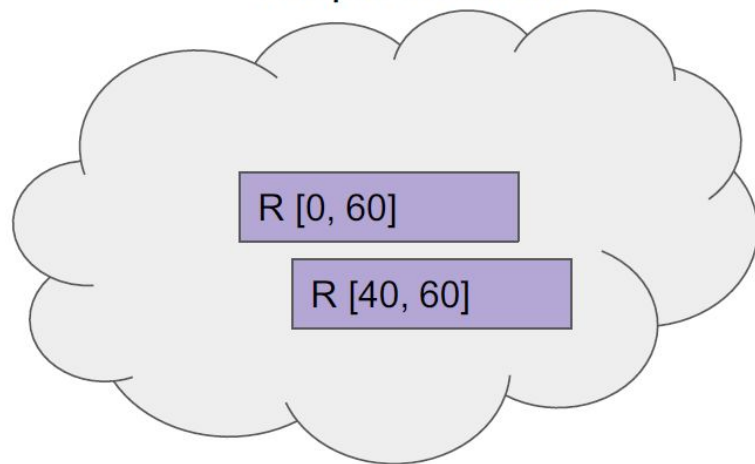
Waiting locks



How to prevent Starvation?

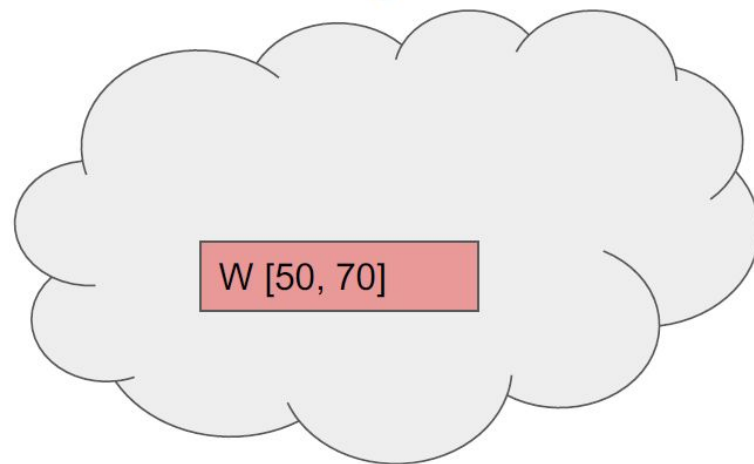
- $40 \in [40, 60] \rightarrow$ Acquires its lock immediately

Acquired locks



Current Rotation = 40

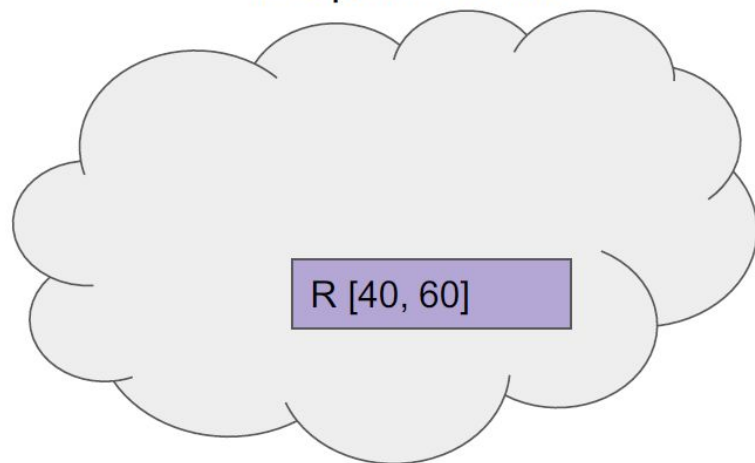
Waiting locks



How to prevent Starvation?

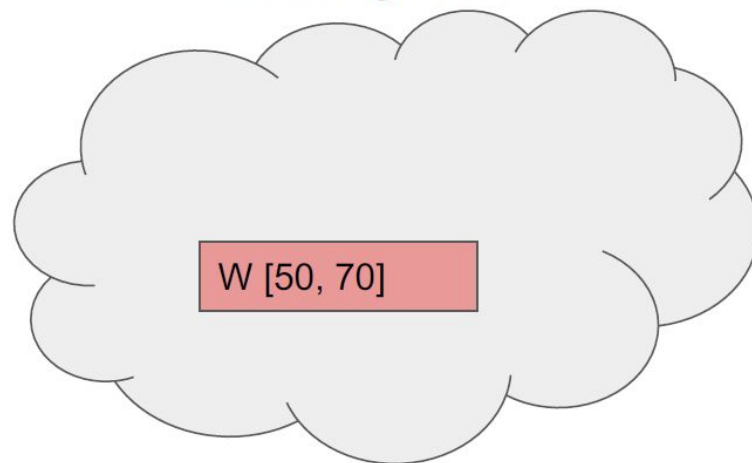
- R [0, 60] releases its lock

Acquired locks



Current Rotation = 40

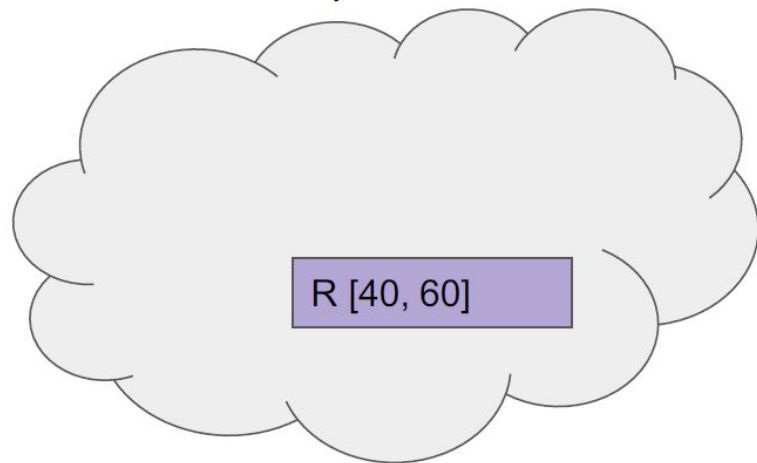
Waiting locks



How to prevent Starvation?

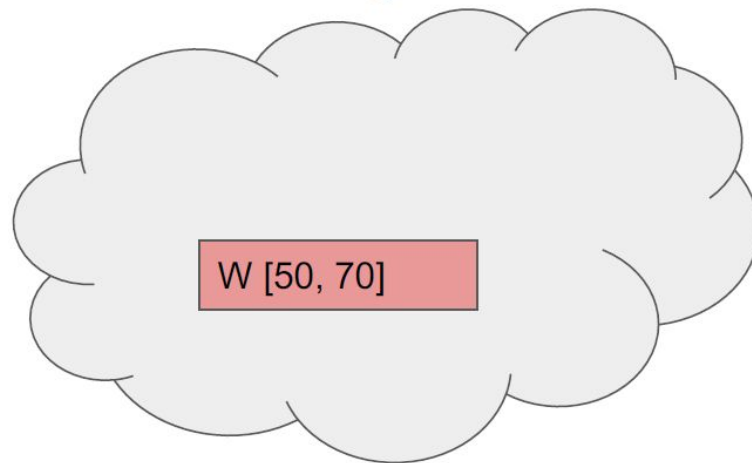
- Rotation changes 40 \rightarrow 50

Acquired locks



Current Rotation = 50

Waiting locks

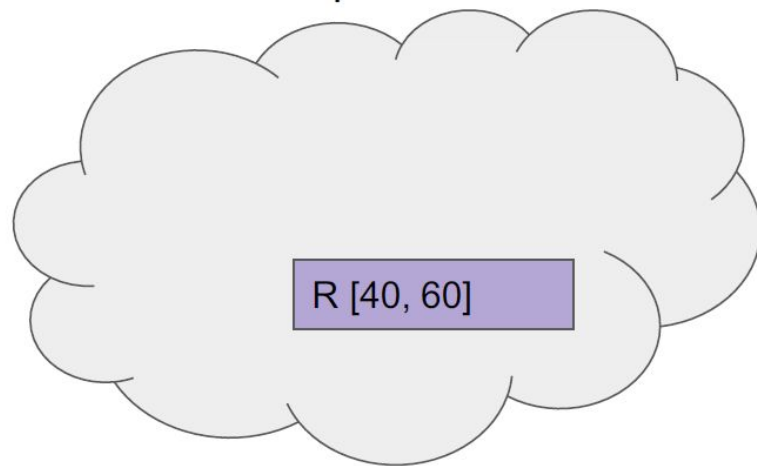


How to prevent Starvation?

How to prevent writer starvation?

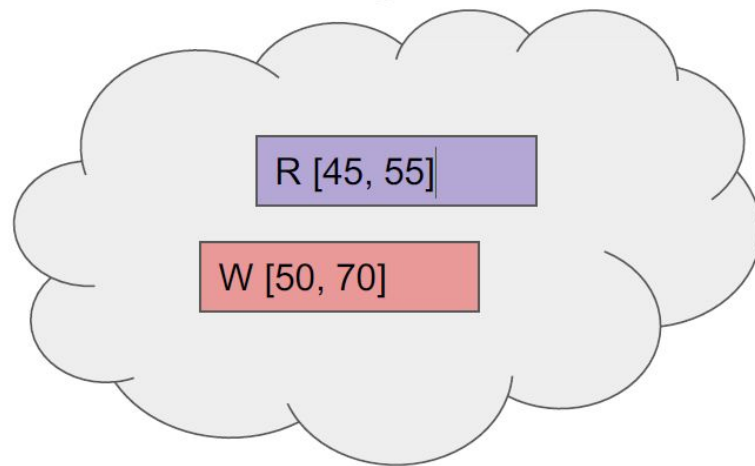
Acquired locks Waiting locks

Acquired locks



Current Rotation = 50

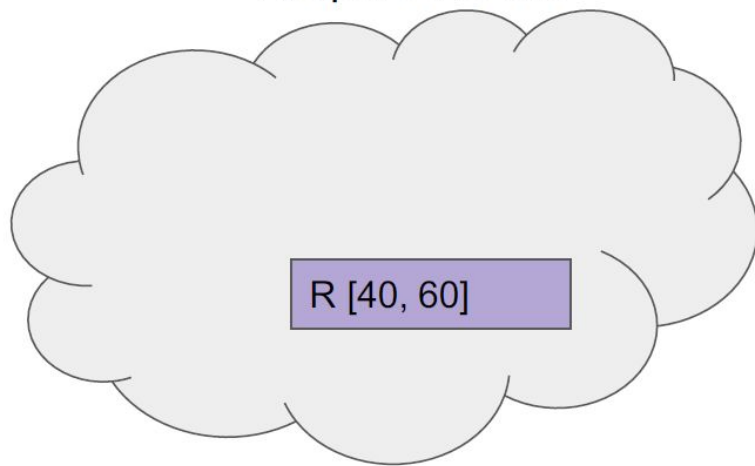
Waiting locks



How to prevent Starvation?

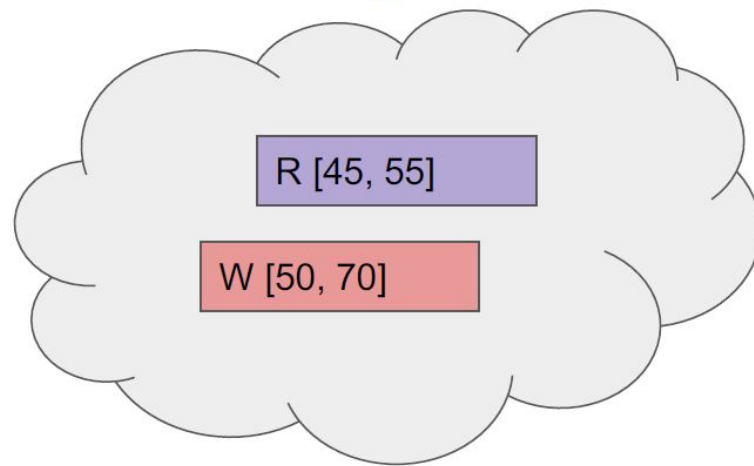
- W [50, 70] is waiting and $50 \in [50, 70]$
- W [50, 70] is waiting for R [40, 60] to release its lock
- [45, 55] overlaps with [50, 70]

Acquired locks



Current Rotation = 50

Waiting locks



How to prevent Starvation?

- W [50, 70] is waiting and $50 \in [50, 70]$

- W [50, 70] is waiting

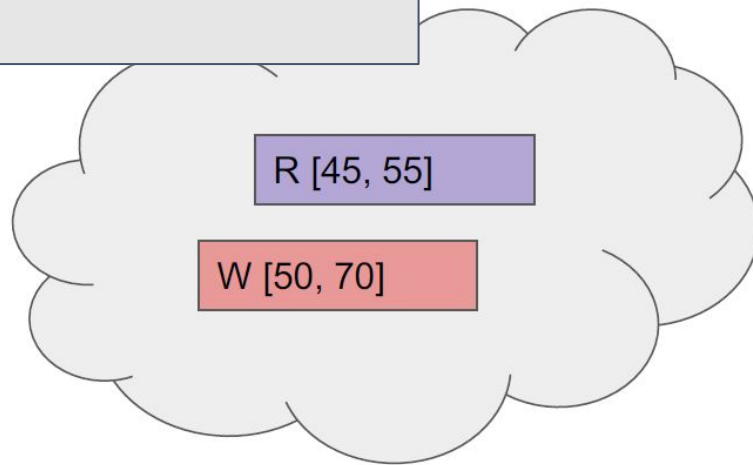
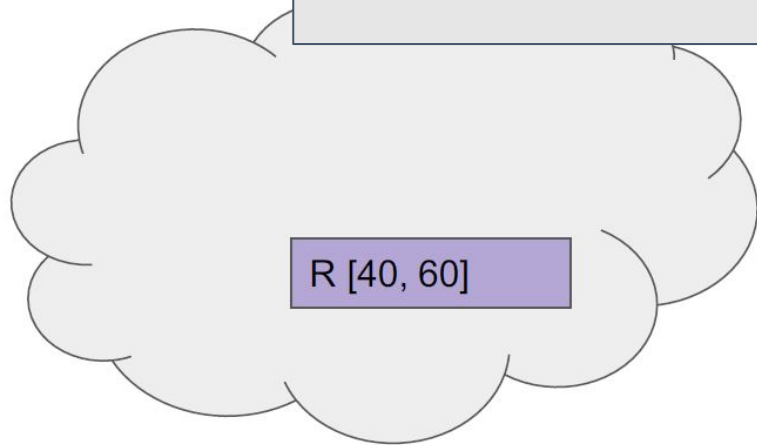
- [45, 55] overlaps w

If a reader holds a lock

and a writer wants to take the lock,

no more readers can take the lock

locks



Current Rotation = 50

How to prevent Starvation?

- W [50, 70] is waiting and $50 \in [50, 70]$

- W [50, 70] is waiting

- [45, 55] overlaps w

If a reader(R[40, 60]) holds a lock

and a writer(W[50, 70]) wants to take($50 \in [50, 70]$)

the lock([40, 60] overlaps with [50, 70], waiting),

no more readers(R[45, 55])

can take the lock([45, 55] overlaps with [50, 70])

locks

R [40, 60]

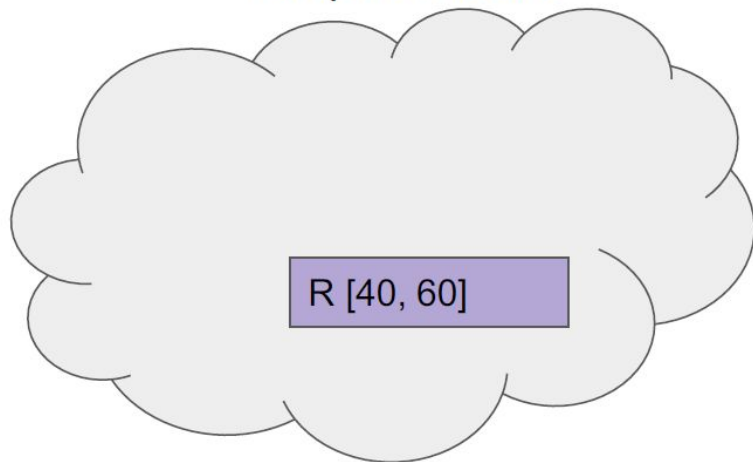
W [50, 70]

Current Rotation = 50

How to prevent Starvation?

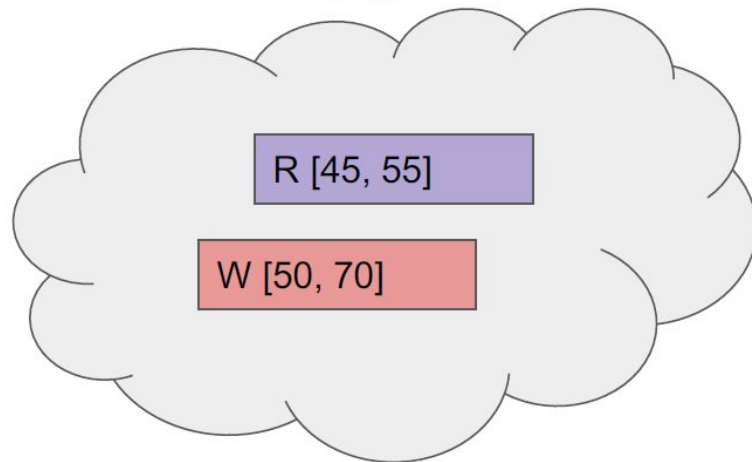
- Rotation changes 50 \rightarrow 45

Acquired locks



Current Rotation = 45

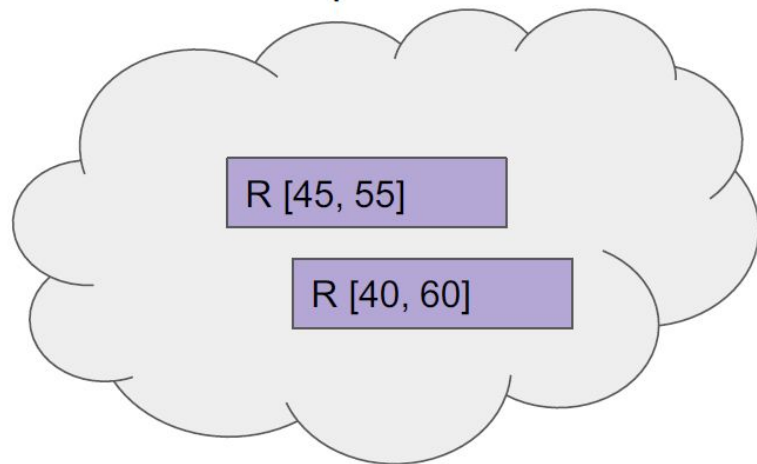
Waiting locks



How to prevent Starvation?

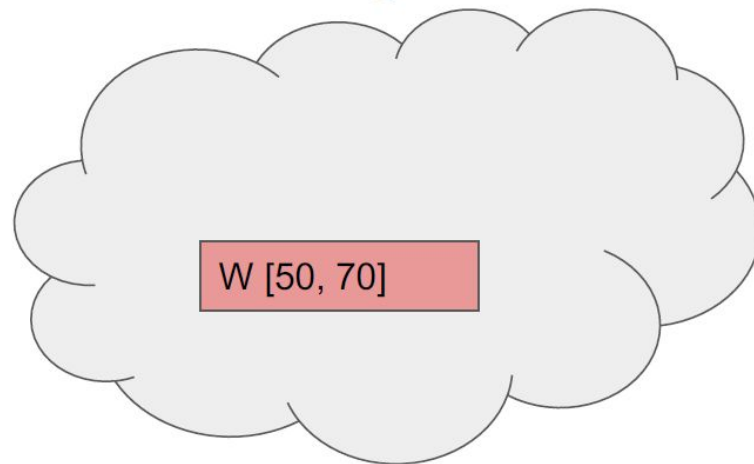
- W [50, 70] cannot grab its lock anymore ($\therefore 45 \notin [50, 70]$)
- Starvation prevention policy is no more applied \rightarrow R [45, 55] acquires its lock

Acquired locks



Current Rotation = 45

Waiting locks

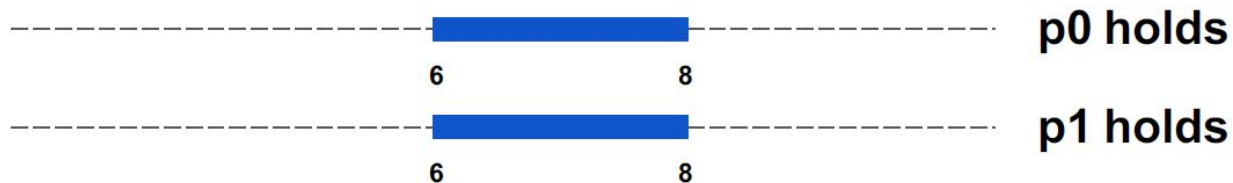


Terminating routine

- When a thread that has some holding or waiting locks is terminating, the remaining locks should be released (holding) or removed (waiting).
- Hints
 - `exit_rotlock()` in `kernel/rotation.c`
 - Release holding locks
 - Remove waiting locks
 - Inject `exit_rotlock()` to `do_exit()` in `kernel/exit.c`

Isolation

- Multiple processes shares same rotation lock system.
 - You have to identify which process (thread) the lock belongs to.
- A process can't release locks that other processes hold.



Isolation

- A process can't release locks that other processes hold.

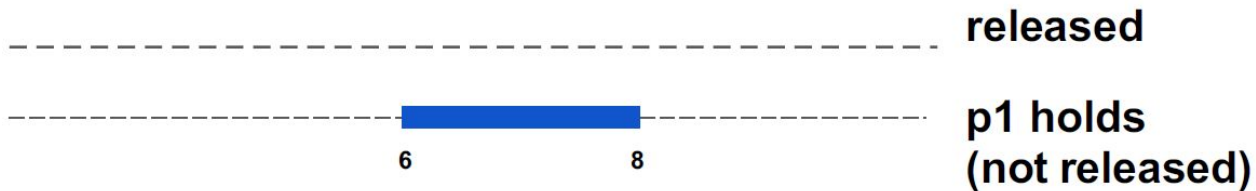
p0 calls unlock(6-8)



Isolation

- A process can't release locks that other processes hold.

p0 calls unlock(6-8) **again**



TA hints

- You will have create things like acquired lock list and waiting lock list
 - Different approaches are also possible :)
 - Ex) Bitmap, linked list, ...
- Accessing those lists could result in race conditions
 - if you are working on multicore machine
 - You should carefully design your code to prevent possible race conditions
 - Ex) One thread is removing a lock from waiting list, but another thread can access to the waiting list at the same time (inconsistency issues)

TA hints

- Possible approaches
 - Global
 - Ex) Manage acquired lock list and waiting lock list using a same lock
 - Fine-grained
 - Ex) Manage acquired lock list and waiting lock list using separated locks
 - Better concurrency, more complicated :)
- Synchronization mechanism
 - Spin Lock
 - Eligible for short sleep (e.g. short list iteration)
 - RCU (Read-Copy-Update)
 - ...

TA hints

- How to block processes || How to wake up blocked processes
 - You may use - not explained in this ppt :)
 - Wait Queue (Starts with DECLARE_WAIT_QUEUE_HEAD)
 - Condition Variable (Define your own CV)
 - Mutex
 - ...

TA hints

- Lists could be changed during iteration
 - `list_for_each_entry_safe` could be useful to you
- Please remember that ...
 - The rotation range is circular!
 - You should implement a logic for determining two circular ranges are overlapping or not
 - Beware of deadlocks!

Selector and trial

- Selector & Trial require a same lock ($0 \leq \text{range} \leq 180$)
 - If current rotation is 240, both selector & trial wait.
- When the device rotation is out of that range, both Selector & Trial stop working
- When the device rotation gets inside that range, Selector & Trial start to work

Selector

Trial

write_lock_____

_____read_lock & wait

10

write_unlock_____acquire_lock

10 = 2 * 5

acquire lock_____read_unlock

About submission

Same rules as previous projects

- Make sure your branch name: proj3
- Save your C program as: test/selector.c, test/trial.c
- Check for format : slides title / demo name / test file names / branch name and directory name
- Please aggregate your demo videos (=submit only one video!)
- Deadline
 - Due:11/27 midnight + 3 days of late submission allowed (10% will be deducted for every day)