

# **CSE 451: Operating Systems**

## **Hard Lessons Learned**

**Windows**  
**Reader/Writer Locks**

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# But first some Truth in advertising

## Wait()

- Wait() in Windows comes in many flavors and is not as simple as we've made it out to seem.
- You can wait() for a **single**, **any**, or **multiple** events/objects and not just locks
- You can optionally specify a **timeout** period
- When returning from a wait you therefore need to check why wait() returned.

# Without going into great details

## A brief look at deadlocks and starvation

- In lay terms a **Deadlock** is when a thread holds a lock (lock1) and is waiting for another lock (lock2) that it will never get because a second thread holds lock2 and is waiting to get lock1.
  - Circular wait. Aka deadly embrace.
  - Deadlocked threads are typically in the **blocked** state.
  - Root cause is often how one uses (misuses) locks

# Without going into great details

## A brief look at deadlocks and starvation

- In lay terms **Starvation** is when a thread is ready to run but because of scheduling peculiarities it never gets a chance to run, most likely because there is a higher priority thread always running.
  - Starved threads are typically stuck in the **ready** queue.
  - A problem mostly blamed on the scheduler.

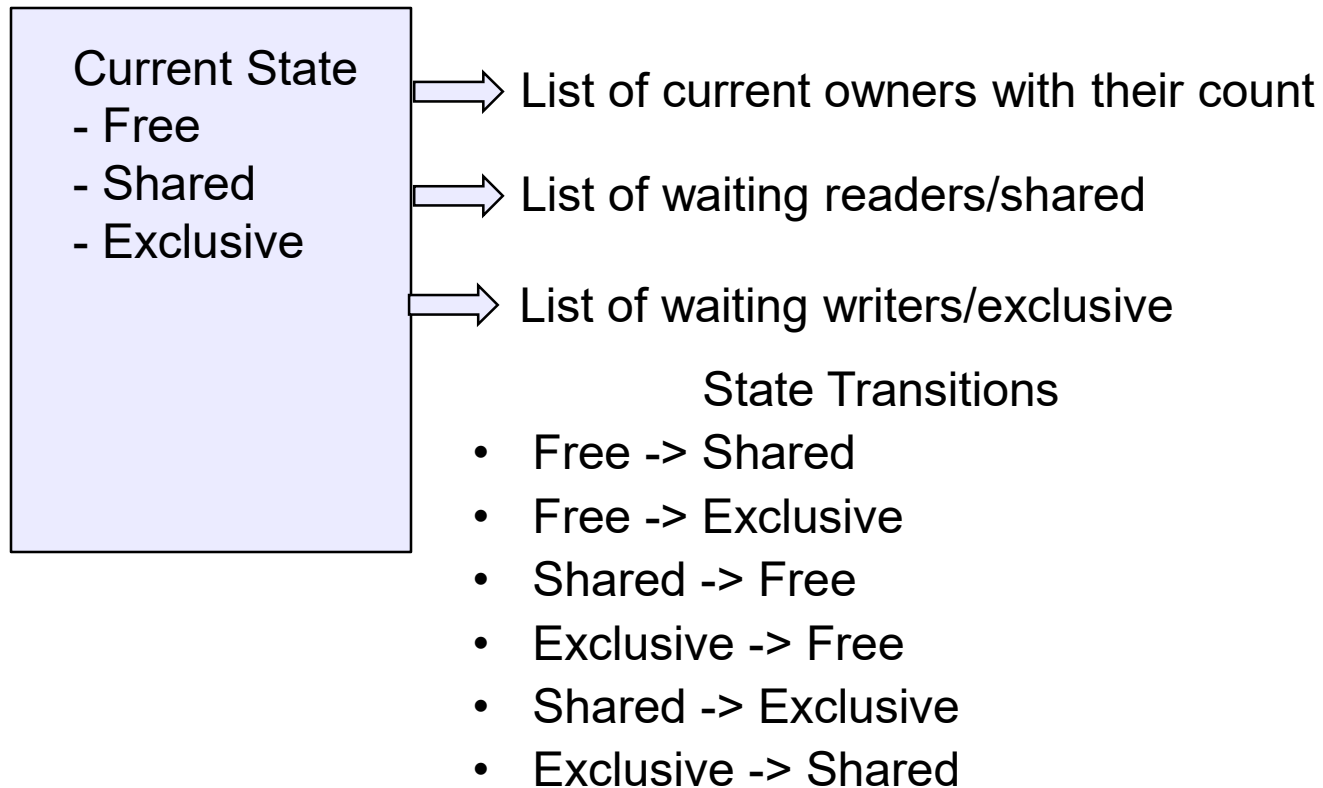
# Priority Inversion and starvation

- In lay terms **Priority Inversion** is when a high priority thread is waiting for a lock owned by a lower priority thread that cannot make progress because it is being starved.
- Example using Undergraduate, Graduate, and Professor waiting to get coffee.
- One solution is to do a priority boost.
- Note: This is not practical using monitors.

# Windows Readers/Writers nuances

- Call EResource in Windows.
- Used the terms **exclusive** and **shared** access.
- Avoided starving exclusive by making shared requests wait
- Allowed recursive acquisition of a lock. Meant keeping ownership information
- Addressed an issue called priority inversion
- Then one hack added after another.
  - Added call to “Try” to acquire access without blocking
  - Added call to starve an exclusive waiter
  - Added call to release lock for a different thread
  - Augh...

# Picture of the resource



# Where we started

- `ExInitializeResource`
- `ExAcquireResourceShared`
  - If currently free, then it's yours
  - If currently exclusive, then you wait
  - If currently shared and you already have it, then up your count
  - If currently shared and there are no exclusive waiters then you it's yours
  - If currently shared and there is an exclusive waiter, then you wait
- `ExAcquireResourceExclusive`
  - Similar logic as above
- `ExReleaseResource`
  - The usual logic but now Ping-Pong back-and-forth between shared and exclusive if necessary



## Added “features?”

- ExAcquireResourceShared( Wait );
- ExAcquireResourceExclusive( Wait );
- ExAcquireSharedStarveExclusive
- ExReleaseResourceForThread
- ExConvertExclusiveToShared
- ExDisableResourceBoost
- ExReinitializeResource
- ExSetResourceOwnerPointer
- ExDeleteResource

## More added “features?”

- ExGetExclusiveWaiterCount
- ExGetSharedWaiterCount
- ExIsResourceAcquiredExclusive
- ExIsResourceAcquiredShared
- Bottom line: Learning to say “NO” to requests for adding new features.