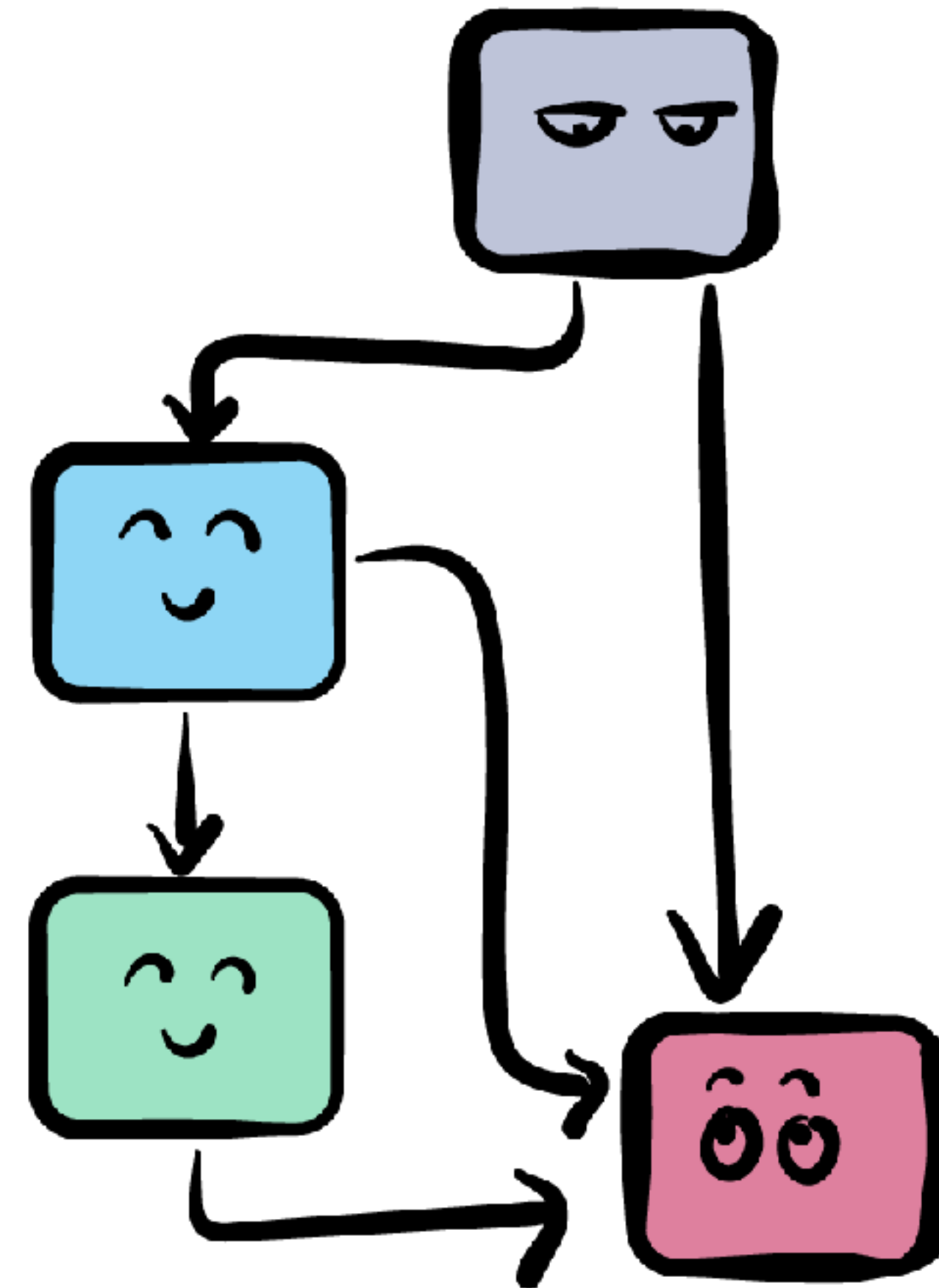


»» iOS «« CONCURRENCY WITH GCD & OPERATIONS



PART 11: CONCURRENCY SOLUTIONS

CONCURRENCY PROBLEMS

- ⚙ Race condition
- ⚙ Priority inversion
- ⚙ Deadlock



GENERAL ADVICE

- ⚙ One QoS for tasks accessing shared resource
- ⚙ Serial queue to access shared resource
- ⚙ Avoid Operation dependency cycles
- ⚙ Be careful when calling sync()
- ⚙ **Never** call sync() on the current queue
- ⚙ **Never ever** call sync() from the main queue

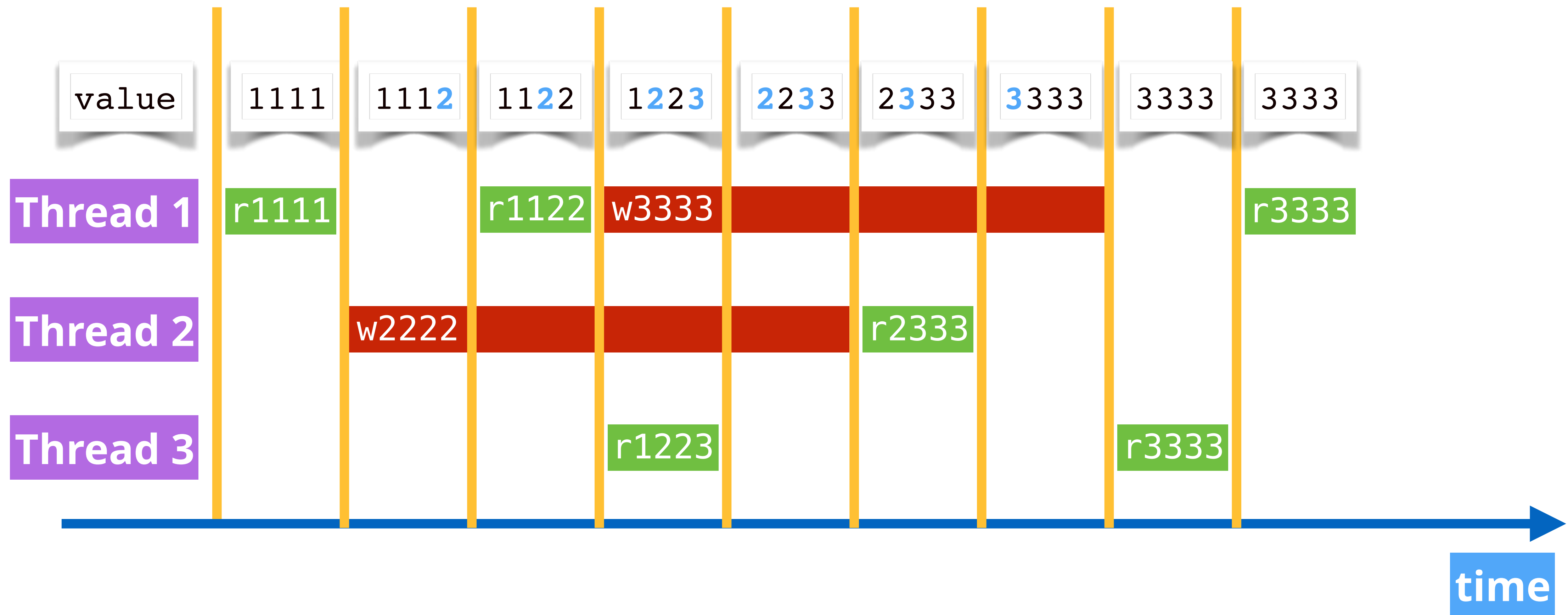


PRIORITY INVERSION SOLUTION

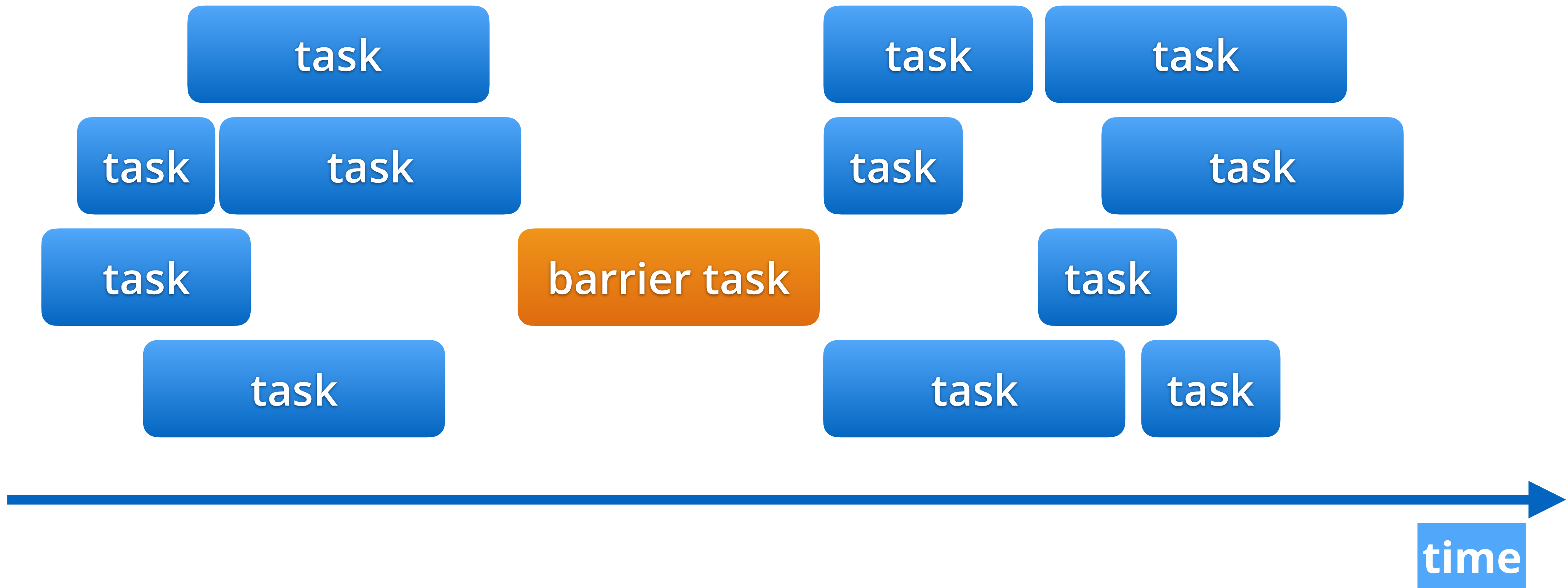
- ⚙️ A priority inversion can happen when:
 - ⚙️ High-QoS task needs a resource locked by lower-QoS task
 - ⚙️ High-QoS operation depends on lower-QoS task
 - ⚙️ High-QoS task enters serial queue after lower-QoS task
 - ⚙️ DispatchWorkUnit's wait() method is called
- ⚙️ Solution: GCD and OperationQueue promote the lower-QoS to the higher level



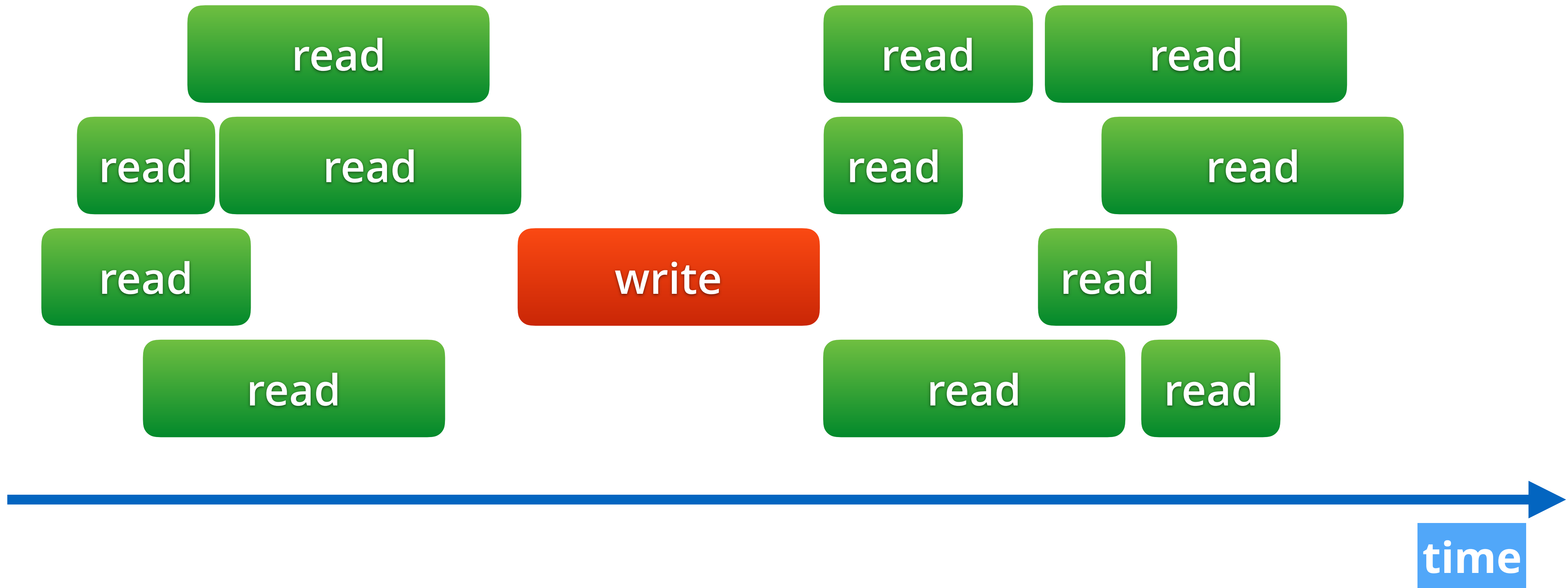
THREAD SAFETY



DISPATCH BARRIER



DISPATCH BARRIER



DISPATCHBARRIER

```
public func async(group: DispatchGroup? = default,  
    qos: DispatchQoS = default,  
    flags: DispatchWorkItemFlags = default,  
    execute work: @escaping @convention(block) () -> Swift.Void)
```

```
public static let barrier: DispatchWorkItemFlags
```

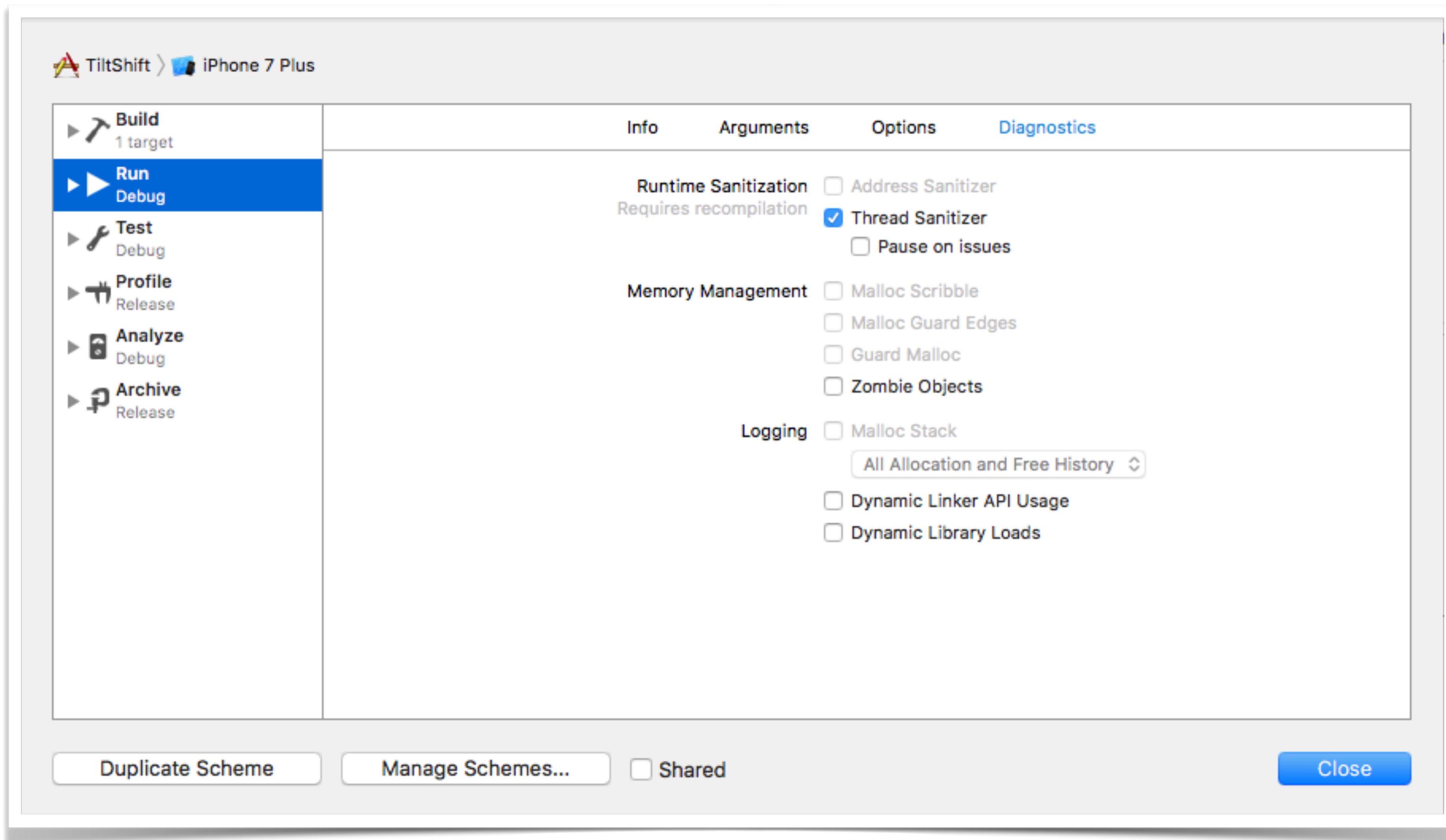
```
isolationQueue.async(flags: .barrier) {  
    // barrier task  
}
```



SYNC READING/WRITING VALUES

```
private let internalQueue = DispatchQueue(label:
    "com.raywenderlich.person.internal")
var name: String {
    get {
        return internalQueue.sync { internalName }
    }
    set (newName) {
        internalQueue.sync { internalName = newName }
    }
}
```

TSAN



TSAN

Running TSanExample on iPhone 7 Plus

Buildtime Runtime (7)

TSanExample - 4639 7 issues

- Threading Issues
 - Data race in TSanExample.Person.changeName (firstName : Swift.String, lastName : Swift.String) -> () at 0x7d1000055740
 - Location is a 64-byte heap object at 0x7d1000055740
 - Read of size 8 by thread 9
 - Write of size 8 by thread 11
 - Heap block allocated by thread 13
 - Data race in TSanExample.Person.changeName (firstName : Swift.String, lastName : Swift.String) -> () at 0x7d1000055740
 - Location is a 64-byte heap object at 0x7d1000055740
 - Read of size 8 by thread 9
 - Write of size 8 by thread 11
 - Heap block allocated by thread 13
 - Data race in TSanExample.Person.changeName (firstName : Swift.String, lastName : Swift.String) -> () at 0x7d1000055740
 - Location is a 64-byte heap object at 0x7d1000055740
 - Read of size 8 by thread 9
 - Write of size 8 by thread 11
 - Heap block allocated by thread 13

ThreadSanitizer debugger support is active.
(void *) \$0 = 0x00007d4000007f00
=====

WARNING: ThreadSanitizer: data race (pid=4639)
Read of size 8 at 0x7d1000055750 by thread T6:
#0 _TFC11TSanExample6Person10changeNameFT9firstNameSS8lastNameSS_T_ Person.swift:37 (TSanExample+0x0001000021f4)
#1 _TFFC11TSanExample14ViewController14changeNameRaceFT_T_U_FT_T_ ViewController.swift:52 (TSanExample+0x0001000057b5)
#2 _TPA__TFFC11TSanExample14ViewController14changeNameRaceFT_T_U_FT_T_ ViewController.swift (TSanExample+0x00010000622e)
#3 _TTRXFo___XFdCb___ ViewController.swift (TSanExample+0x0001000044f5)
#4 __wrap_dispatch_group_async_block_invoke <null>:225 (libclang_rt.tsan_iossim_dynamic.dylib+0x00000005d4c7)
#5 _dispatch_client_callout <null>:159 (libdispatch.dylib+0x00000002c0cc)

Previous write of size 8 at 0x7d1000055750 by thread T8:
#0 _TFC11TSanExample6Person10changeNameFT9firstNameSS8lastNameSS_T_ Person.swift:37 (TSanExample+0x00010000222c)
#1 _TFFC11TSanExample14ViewController14changeNameRaceFT_T_U_FT_T_ ViewController.swift:52 (TSanExample+0x0001000057b5)
#2 _TPA__TFFC11TSanExample14ViewController14changeNameRaceFT_T_U_FT_T_ ViewController.swift (TSanExample+0x00010000622e)
#3 _TTRXFo___XFdCb___ ViewController.swift (TSanExample+0x0001000044f5)
#4 __wrap_dispatch_group_async_block_invoke <null>:225 (libclang_rt.tsan_iossim_dynamic.dylib+0x00000005d4c7)
#5 _dispatch_client_callout <null>:159 (libdispatch.dylib+0x00000002c0cc)

As if synchronized via sleep:
#0 usleep <null>:225 (libclang_rt.tsan_iossim_dynamic.dylib+0x00000002204e)
#1 _TF11TSanExample11randomDelayFT11maxDurationSd_T_ Delay.swift:27 (TSanExample+0x000100002ebb)
#2 _TFC11TSanExample6Person10changeNameFT9firstNameSS8lastNameSS_T_ Person.swift:36 (TSanExample+0x0001000021cb)
#3 _TFFC11TSanExample14ViewController14changeNameRaceFT_T_U_FT_T_ ViewController.swift:52 (TSanExample+0x0001000057b5)
#4 _TPA__TFFC11TSanExample14ViewController14changeNameRaceFT_T_U_FT_T_ ViewController.swift (TSanExample+0x00010000622e)

Filter All Output Filter

CHALLENGE TIME!

```
class Number {  
  var value: Int  
  var name: String  
  
  init(value: Int, name: String) {  
    self.value = value  
    self.name = name  
  }  
  
  func changeNumber(value: Int, name: String) {  
    randomDelay(0.1)  
    self.value = value  
    randomDelay(0.5)  
    self.name = name  
  }  
  
  var number: String {  
    return "\(value) :: \(name)"  
  }  
}
```