Usage Considerations of Java ReentrantReadWriteLock

Douglas C. Schmidt
d.schmidt@vanderbilt.edu
www.dre.vanderbilt.edu/~schmidt

Institute for Software Integrated Systems
Vanderbilt University
Nashville, Tennessee, USA
Learning Objectives in this Part of the Lesson

• Understand the structure & functionality of the Java ReentrantReadWriteLock class
• Know the key methods in Java ReentrantReadWriteLock
• Recognize how to apply Java ReentrantReadWriteLock in practice
• Appreciate Java ReentrantReadWriteLock usage considerations
ReentrantReadWriteLock
Usage Considerations
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- It enables more concurrency when accessing shared “read-only” data compared with a ReentrantLock

See [docs.oracle.com/javase/8/docs/api/java/util/concurrent/locks/ReadWriteLock.html](http://docs.oracle.com/javase/8/docs/api/java/util/concurrent/locks/ReadWriteLock.html)
ReentrantReadWriteLock Usage Considerations

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  - It enables more concurrency when accessing shared “read-only” data compared with a ReentrantLock
  - Performance *may* improve if data are read much more often than written on multi-core systems
ReentrantReadWriteLock Usage Considerations

- ReentrantReadWriteLock has a couple of benefits
  - It enables more concurrency when accessing shared “read-only” data compared with a ReentrantLock
  - It is also portable to versions of Java back to Java 5
However, ReentrantReadWriteLock has several limitations

See javaspecialists.eu/talks/jfokus13/PhaserAndStampedLock.pdf
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  • Both read & write locks are “pessimistic” & thus assume contention will always occur
  • In contrast, StampedLock has an “optimistic” read mode & generally performs better
ReentrantReadWriteLock Usage Considerations

• However, ReentrantReadWriteLock has several limitations
  • Both read & write locks are “pessimistic”
  • Can starve readers or writers, depending on their priority

See en.wikipedia.org/wiki/Readers-writer_lock
ReentrantReadWriteLock Usage Considerations

- However, ReentrantReadWriteLock has several limitations
  - Both read & write locks are “pessimistic”
  - Can starve readers or writers, depending on their priority
  - Java 5 (readers priority) & 6+ (writers priority) semantics differ

See www.javaspecialists.eu/archive/Issue165.html
• However, ReentrantReadWriteLock has several limitations
  • Both read & write locks are “pessimistic”
  • Can starve readers or writers, depending on their priority
  • Can be tedious & error-prone to program
ReentrantReadWriteLock Usage Considerations

• However, ReentrantReadWriteLock has several limitations
  • Both read & write locks are “pessimistic”
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See earlier lessons on “Java ReentrantLock” & “Java Semaphore”
• Profiling is essential to see if a ReentrantReadWriteLock is suited for a particular use-case

Selecting Locking Primitives for Parallel Programs
Paul E. McKenney (pmckenney@us.ibm.com)
Sequent Computer Systems, Inc.

Abstract
The only reason to parallelize a program is to gain performance. However, the synchronization primitives used by parallel programs can consume excessive memory bandwidth, can be subject to memory latency, consume excessive memory, and result in unfair access or even starvation. These problems can overwhelm the performance benefits of parallel execution. Therefore, it is necessary to understand these performance implications of synchronization primitives in addition to their correctness, liveliness, and safety properties.

This paper presents a pattern language to assist you in selecting synchronization primitives for parallel programs. This pattern language assumes you have already chosen a locking design, perhaps by using a locking design pattern language [McK96].

1 Overview
A lock-based parallel program uses synchronization primitives to define critical sections of code in which only one CPU or thread may execute concurrently.

For example, Figure 1 presents a fragment of parallel code to search and update a linear list. In this C-code example, the 2->next field links the individual elements together, the 2->key field contains the search key, and the 2->data field contains the data corresponding to that key.

The section of code between the SLock() and the SUnlock() primitives is a critical section. Only one CPU at a time may be executing in this critical section.

A poor choice of locking primitive can result in excessive overhead and poor performance under heavy load. The pattern language in this paper will help you determine what kind of locking primitive to use.

This paper considers a few straightforward test-and-set, queued, and reader/writer locks, which will handle most situations.

This paper presents the implementation level counterpart to a locking design pattern language [McK96].

Section 2 therefore gives an overview of locking design patterns. Section 3 describes the forces common to all of the patterns. Section 4 overviews contexts in which these patterns are useful. Section 5 presents several indexes to the patterns. Section 6 presents the patterns themselves.

2 Overview of Locking Design Patterns and Forces
Although design and implementation are often treated as separate activities, they are almost always deeply intertwined. Therefore, this section presents a brief overview of design-level patterns and the forces that act on them.

2.1 Overview of Locking Design Patterns
This paper refers to the following locking design patterns:

Sequential Program: A design with no parallelism, offering none of the benefits or problems associated with parallel programs.

Code Locking: A design where locks are associated with specific sections of code. In object-oriented designs, code-locking locks classes rather than instances of classes.

Data Locking: A design where locks are associated with specific data structures. In object-oriented designs, data-locking locks instances rather than classes.

Data Ownership: A design where each CPU or thread “owns” its share of the data. This means that a CPU does not need to use any locking primitives to access its own data, but must use some special communications mechanism to access other CPUs’ or threads’ data.

The Active Object pattern [MCK96] defines an object-
ReentrantReadWriteLock Usage Considerations

• Profiling is essential to see if a ReentrantReadWriteLock is suited for a particular use-case
• ReentrantReadWriteLock’s overhead is nearly always greater than any benefits it provides..

See www.takipiblog.com/java-8-stampedlocks-vs-readwritelocks-and-synchronized
End of Usage Considerations of Java ReentrantReadWriteLock