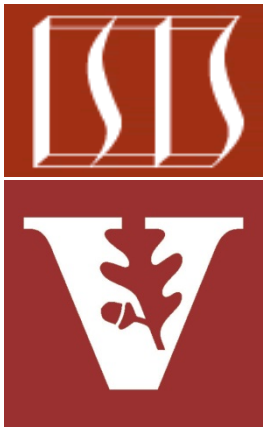
Android Concurrency: Overview of Java Synchronization & Scheduling Classes



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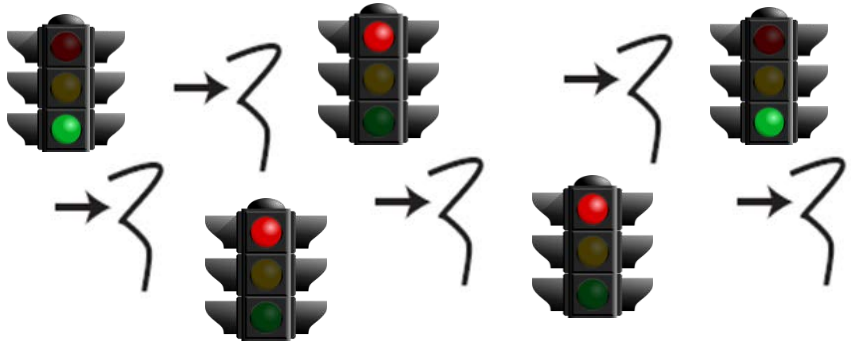
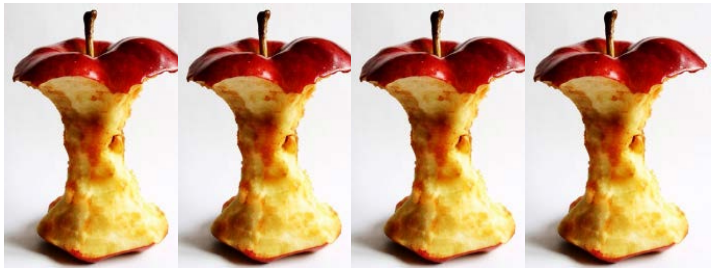
Learning Objectives in this Part of the Module

- Recognize the key Java classes in Android that synchronize & schedule access to critical sections & interactions among threads in concurrent programs





We don’t show any Java code yet – that’s covered in subsequent parts

Java Synchronization & Scheduling Classes

- Java provides many synchronization & scheduling classes
  - e.g., java.util.concurrent & java.util.concurrent.lock

package **Added in API level 1**

java.util.concurrent.locks

Interfaces and classes providing a framework for locking and waiting for conditions that is distinct from built-in synchronization and monitors. The framework permits much greater flexibility in the use of locks and conditions, at the expense of more awkward syntax.
The `Lock` interface supports locking disciplines that differ in semantics (reentrant, fair, etc), and that can be used in non-block-structured contexts including hand-over-hand and lock reordering algorithms. The main implementation is `ReentrantLock`.

package **Added in API level 1**

java.util.concurrent

Utility classes commonly useful in concurrent programming. This package includes a few small standardized extensible frameworks, as well as some classes that provide useful functionality and are otherwise tedious or difficult to implement. Here are brief descriptions of the main components. See also the `java.util.concurrent.locks` and `java.util.concurrent.atomic` packages.

Java Synchronization & Scheduling Classes

- Java provides many synchronization & scheduling classes
- We cover a subset of these classes

Java Class	Purpose
ReentrantLock	A reentrant mutual exclusion lock that extends the built-in monitor lock capabilities
ReentrantReadWriteLock	Improves performance when resources are read much more often than written
Semaphore	A non-negative integer that controls the access of multiple threads to a limited number of shared resources
ConditionObject	Block thread(s) until some condition(s) becomes true
CountDownLatch	Allows one or more threads to wait until a set of operations being performed in other threads complete

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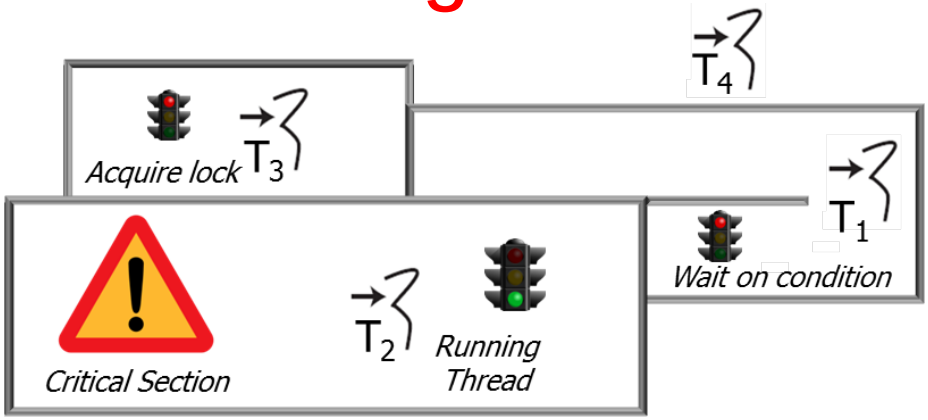

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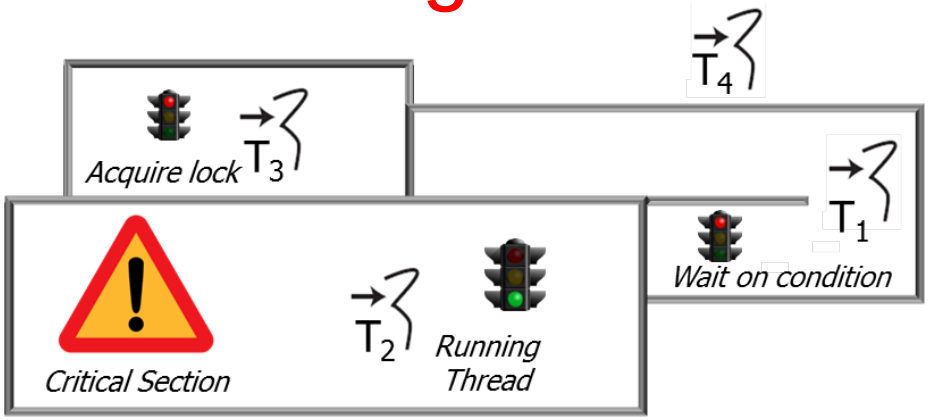
- These classes are distinct from Java's built-in monitor object mechanisms
  - e.g., the synchronized keyword & the wait(), notify(), & notifyAll() methods



See docs.oracle.com/javase/tutorial/essential/concurrency/guardmeth.html

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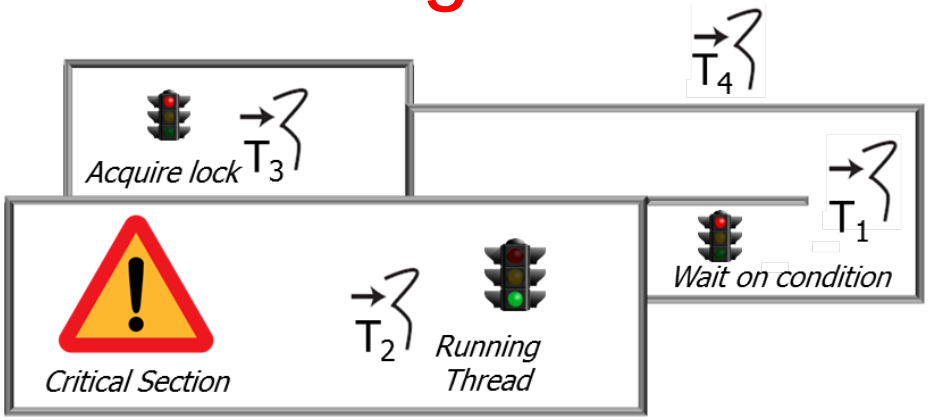
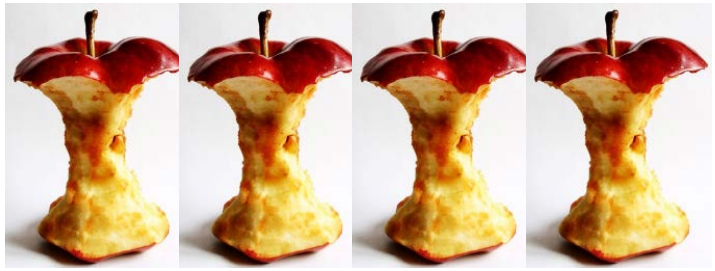
- These classes are distinct from Java's built-in monitor object mechanisms
- They are more fundamental & flexible, so we present them first





Performance & Usability Considerations

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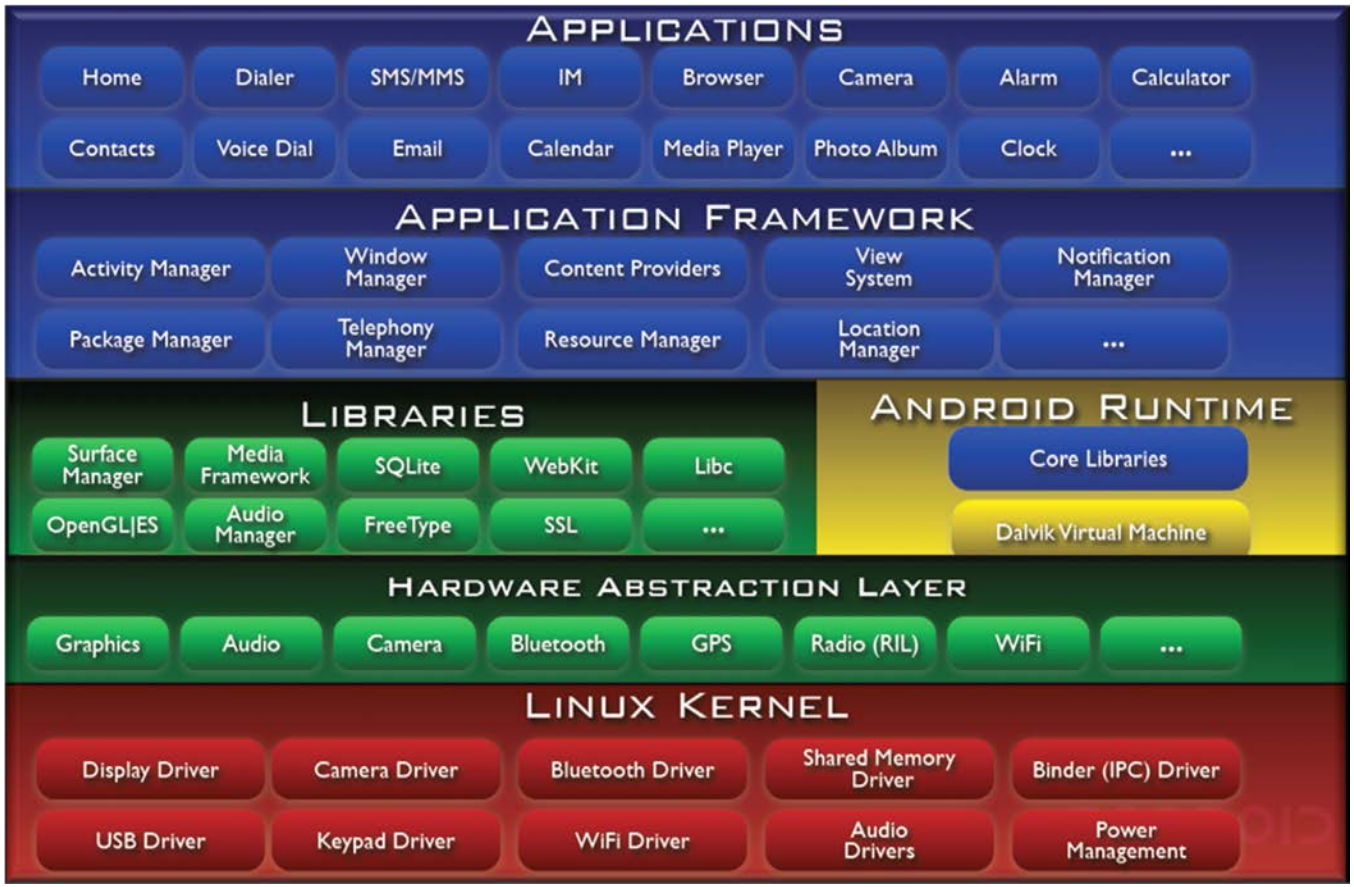
- The performance of these classes depends on details of the Java virtual machine, operating system, hardware, & program use cases



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en.wikipedia.org/wiki/Spinlock has more on spin locks

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en.wikipedia.org/wiki/Busy_waiting has more on busy waiting

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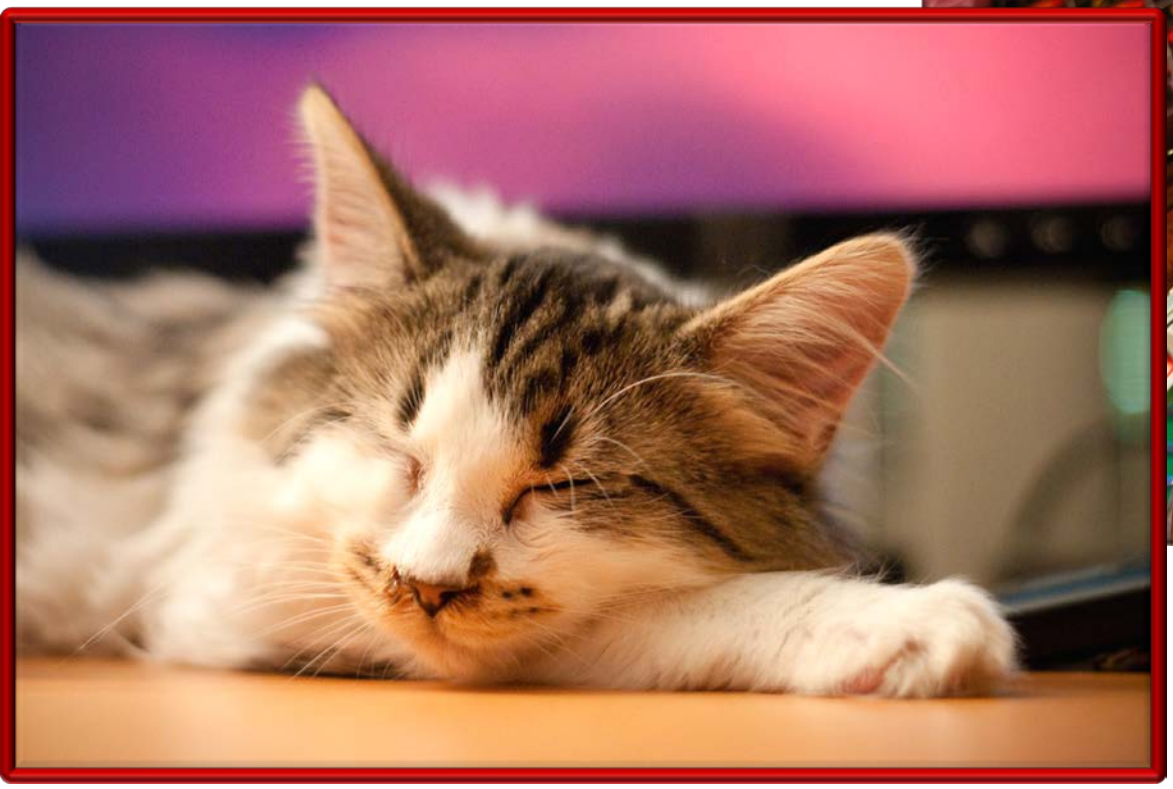

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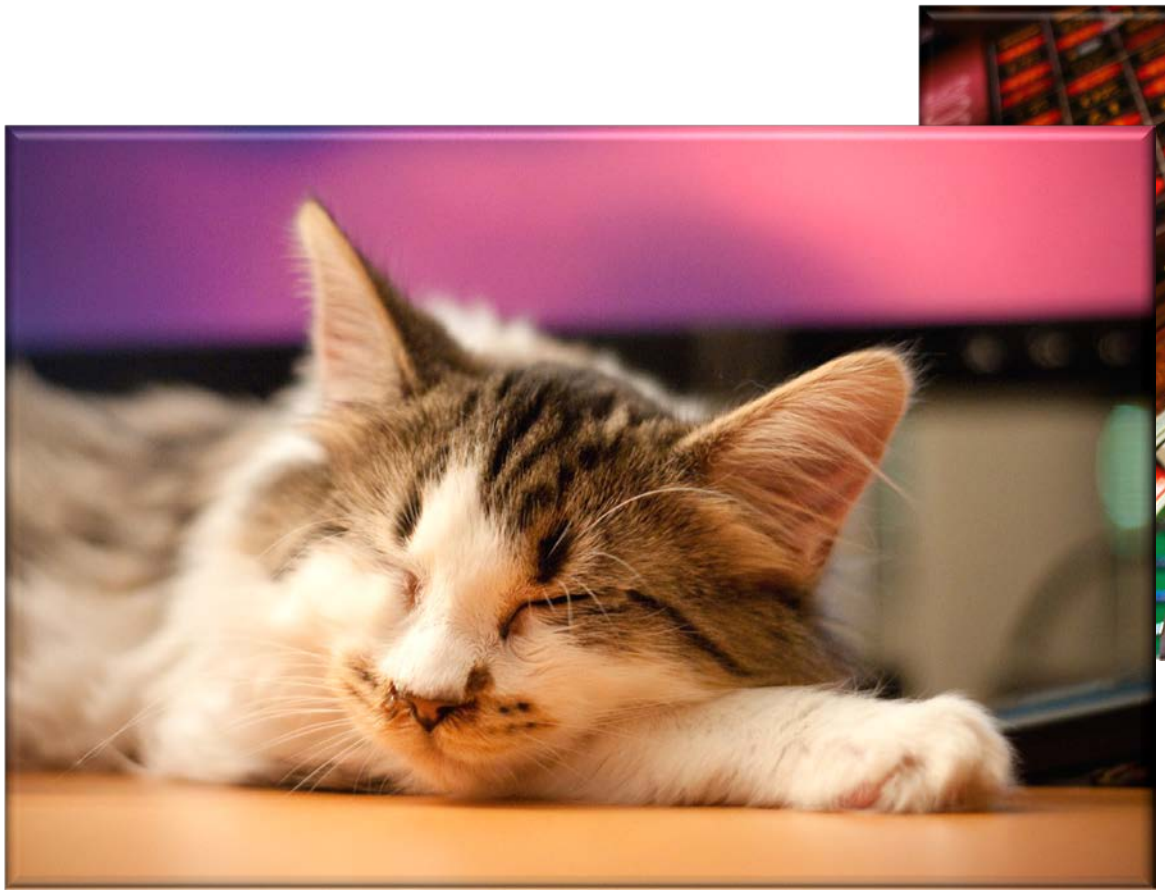

www.dre.vanderbilt.edu/~schmidt/PDF/beyond_mp.pdf covers adaptive locks

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www.youtube.com/watch?v=sq0MX3fHkro has more on java.util.concurrent

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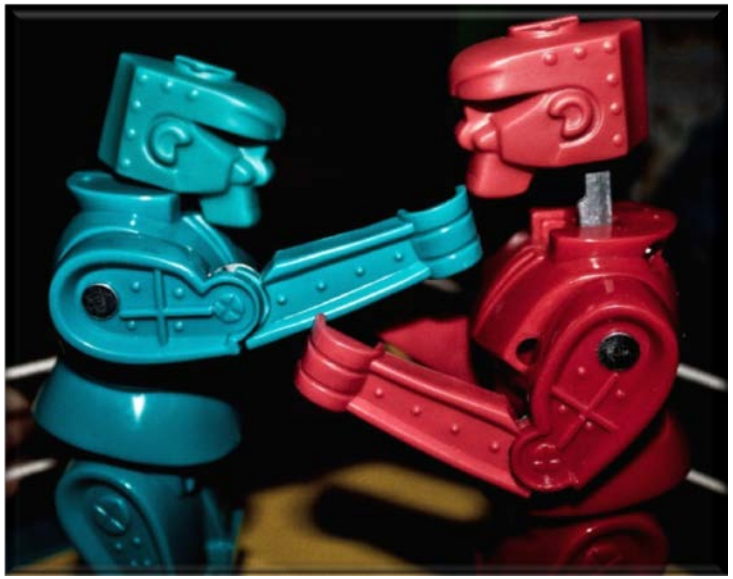

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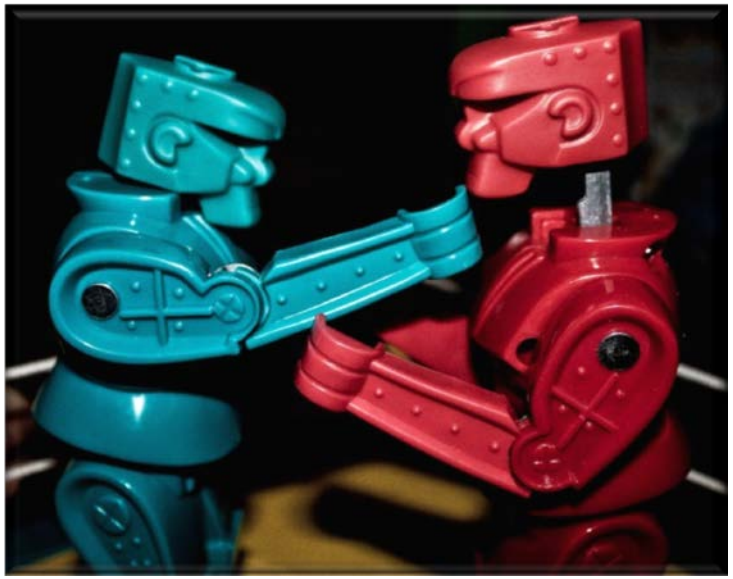

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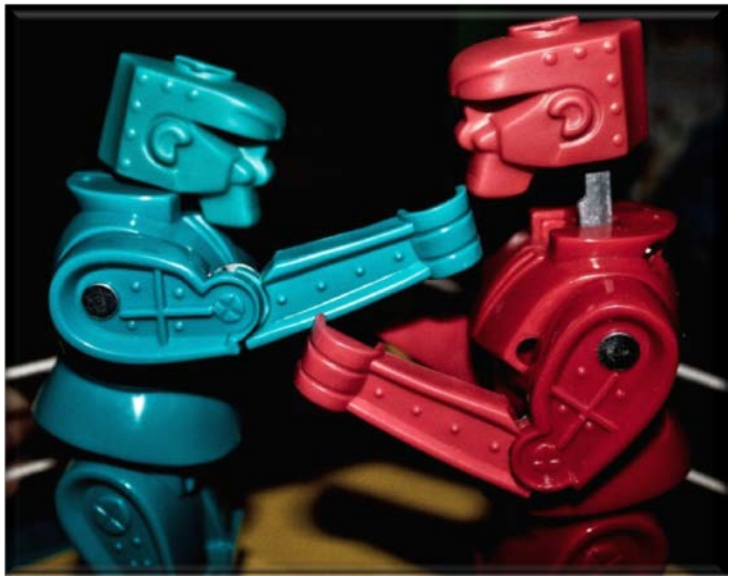
    - But ReentrantReadWriteLocks may enable more concurrency on multi-core or multi-processor hardware



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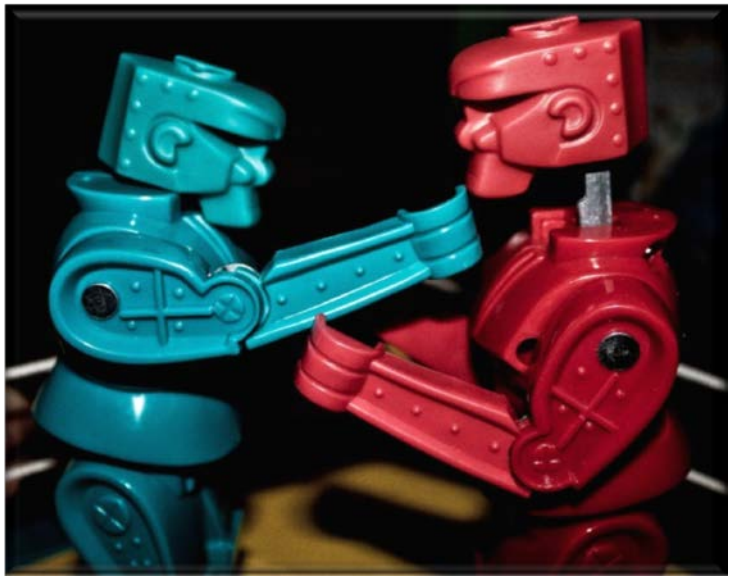

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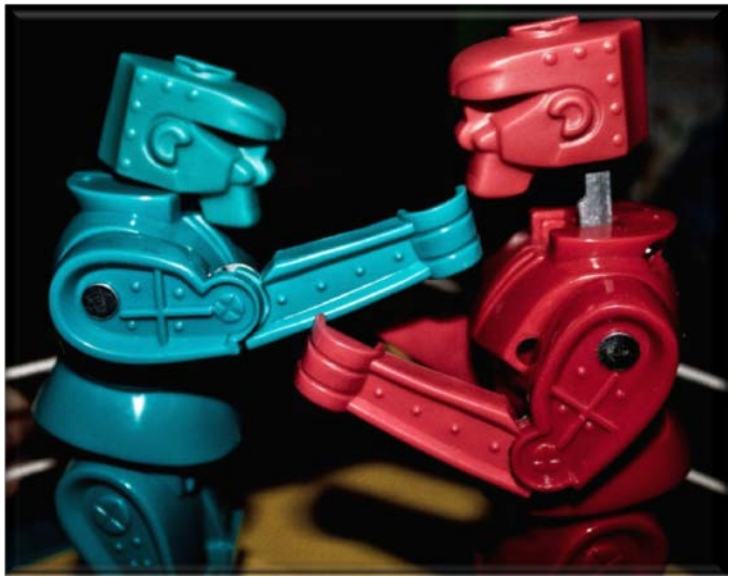

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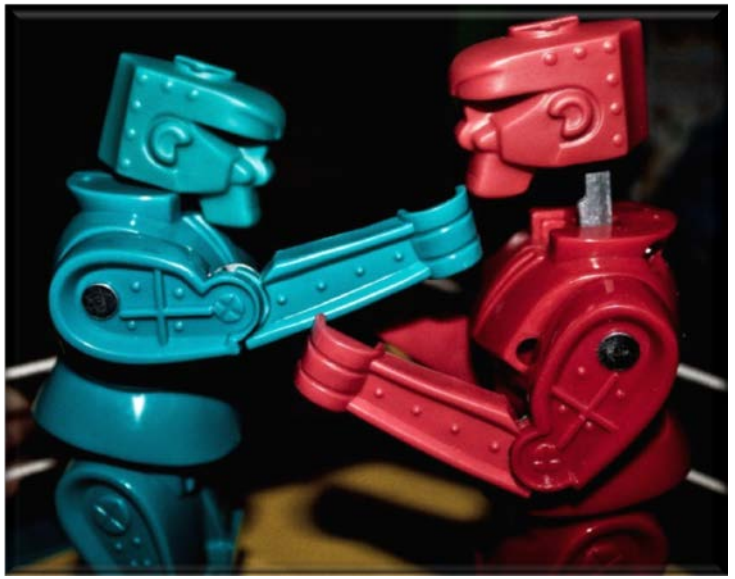
    - e.g., they allow threads to coordinate their interactions



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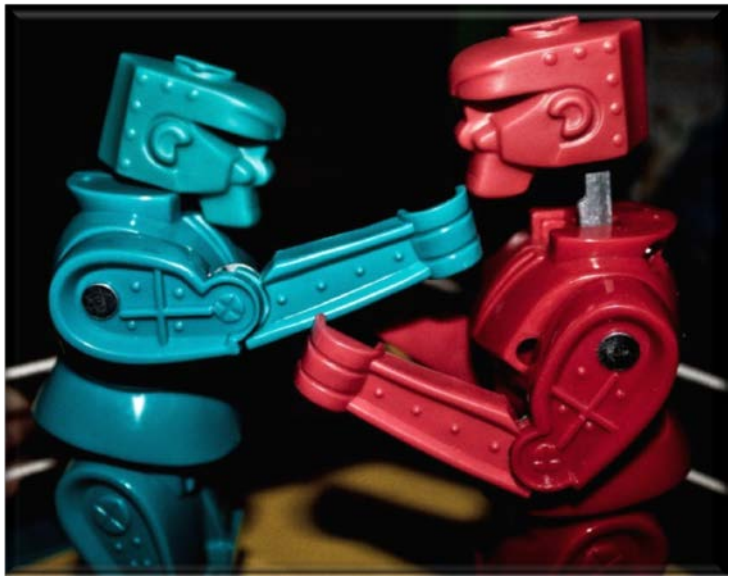

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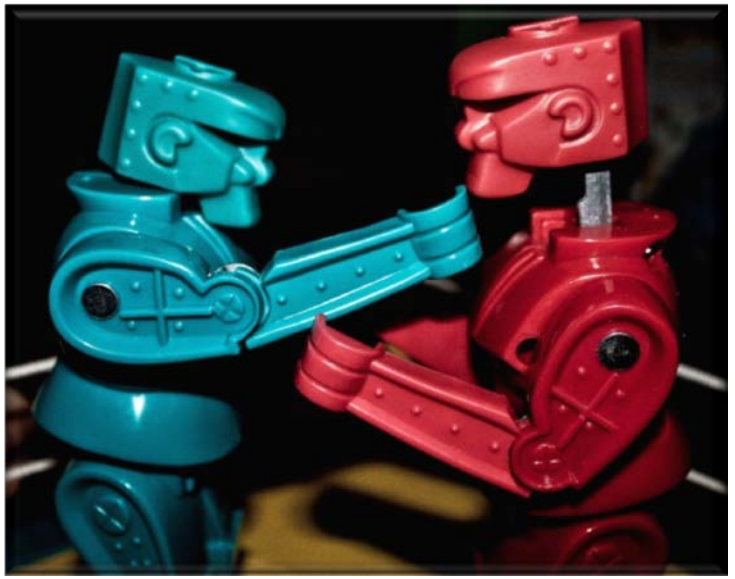

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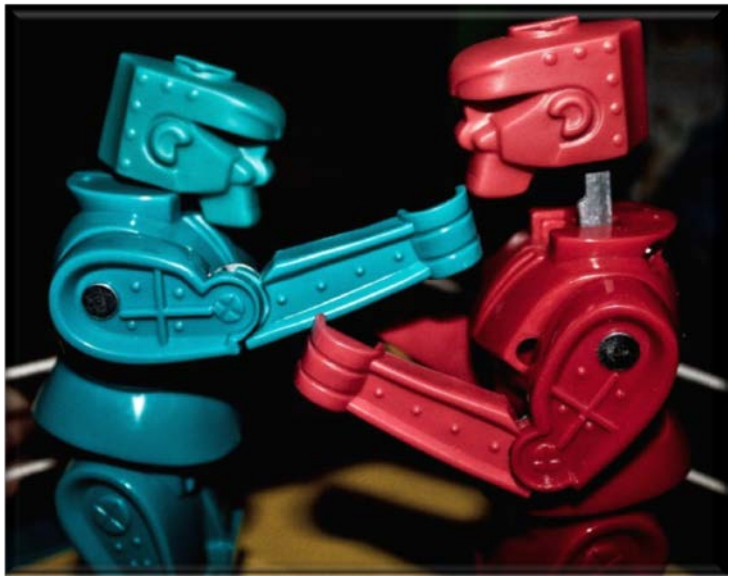
    - A thread uses a ConditionObject to keep itself out of a critical section until it can make forward progress



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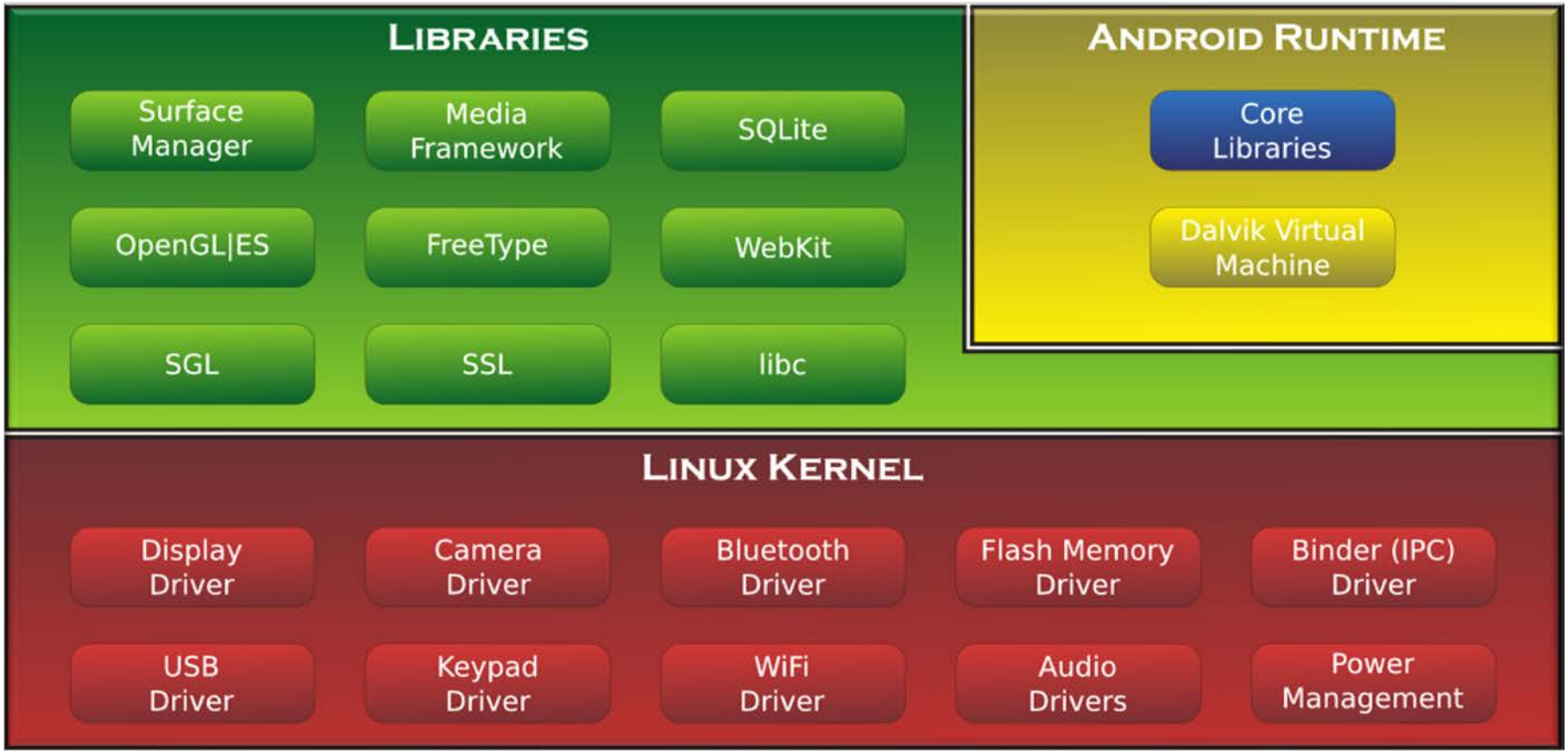

Download the Android source code from source.android.com

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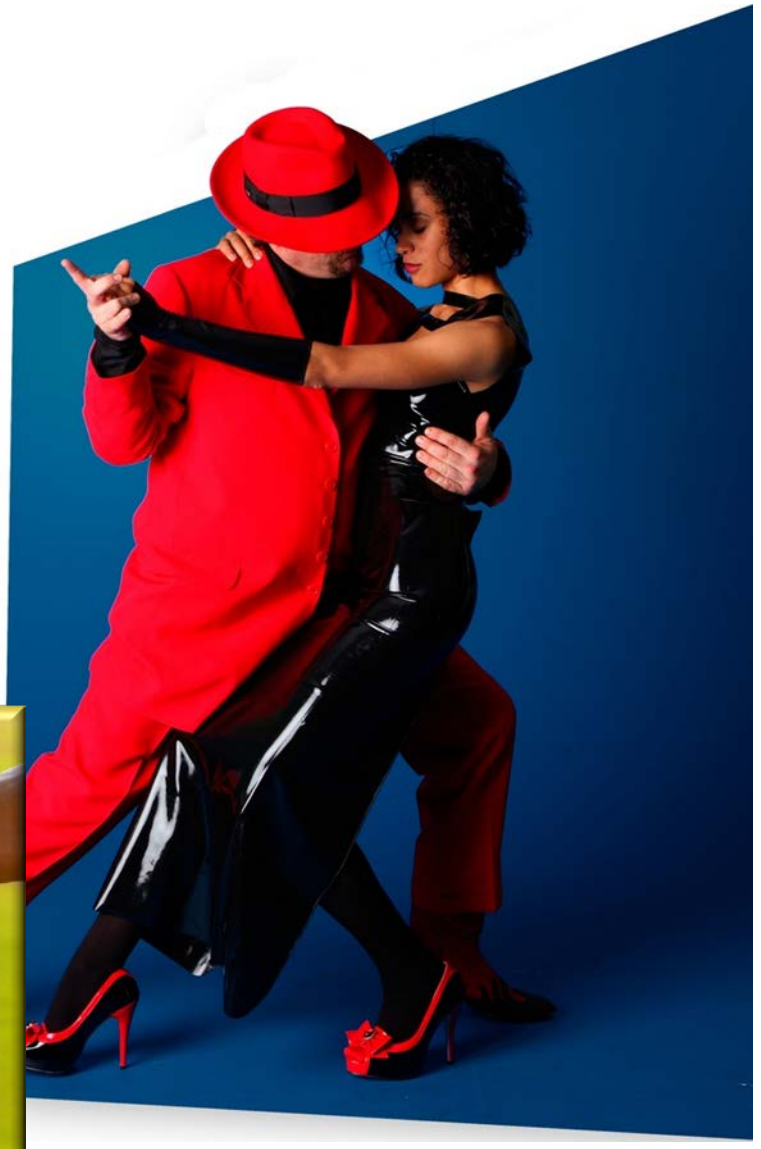
- Concurrent programs use these classes for several reasons



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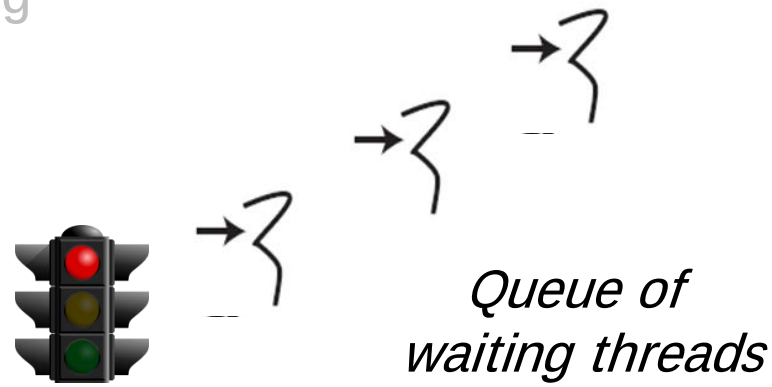

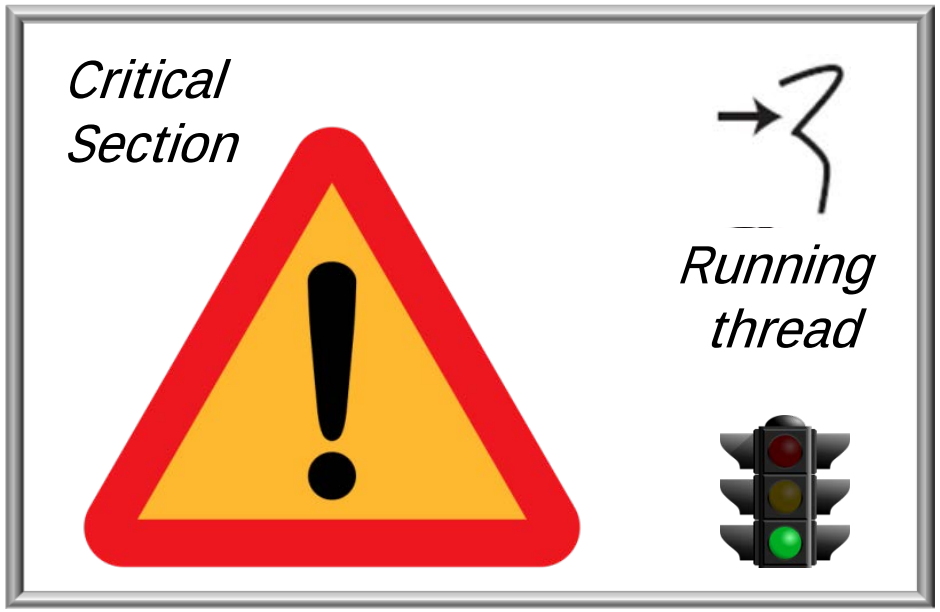

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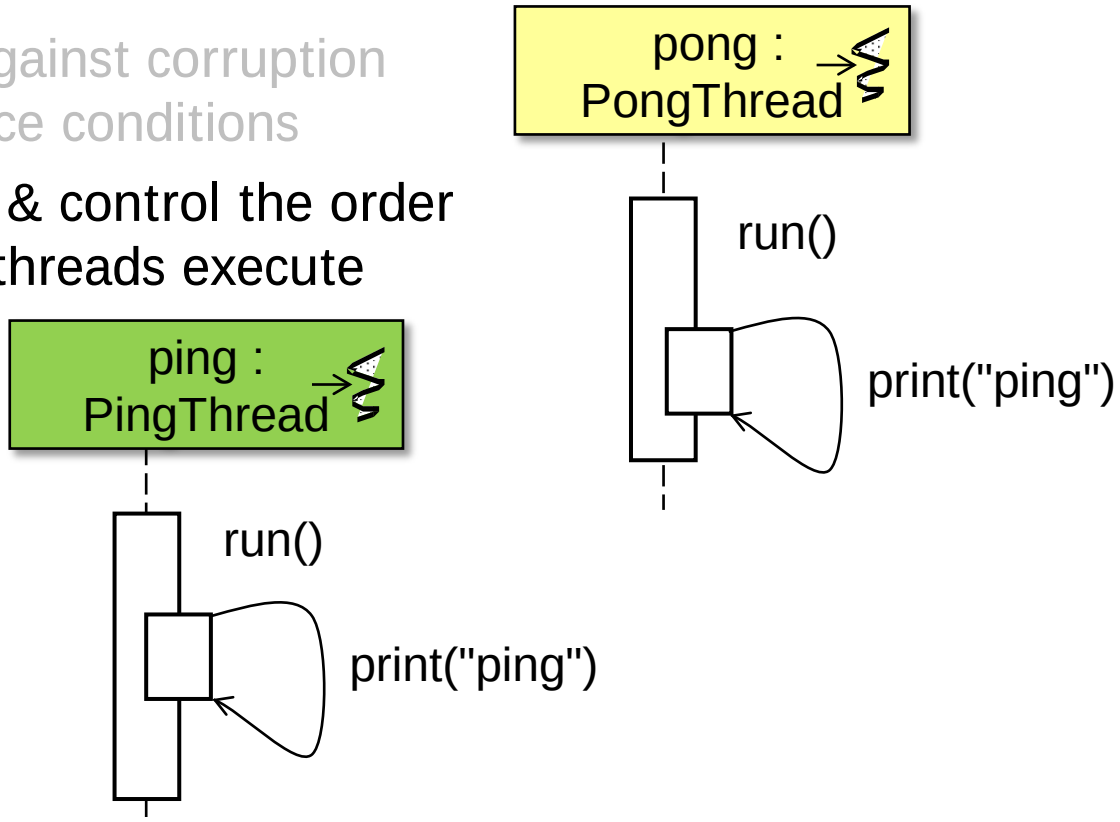
  - Protect against corruption due to race conditions
  - Schedule & control the order in which threads execute




```
% java PingPong
Ready...Set...Go!
Ping!(1)
Pong!(1)
Ping!(2)
Pong!(2)
Ping!(3)
Pong!(3)
Ping!(4)
Pong!(4)
Ping!(5)
Pong!(5)
Ping!(6)
Pong!(6)
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Pong!(8)
Ping!(9)
Pong!(9)
Ping!(10)
Pong!(10)
Done!
```

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Thread coverage

Synchronization & scheduling coverage

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  - Complexity arises largely from coordinating interactions of multiple entities that run concurrently

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We'll show how these classes are implemented & used in Android