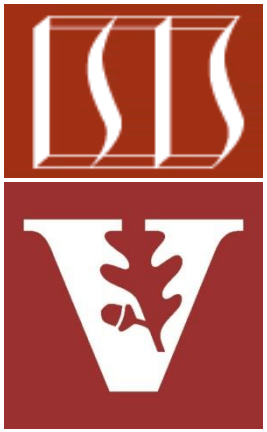
Android Concurrency: Overview of Java Threads (Part 2)



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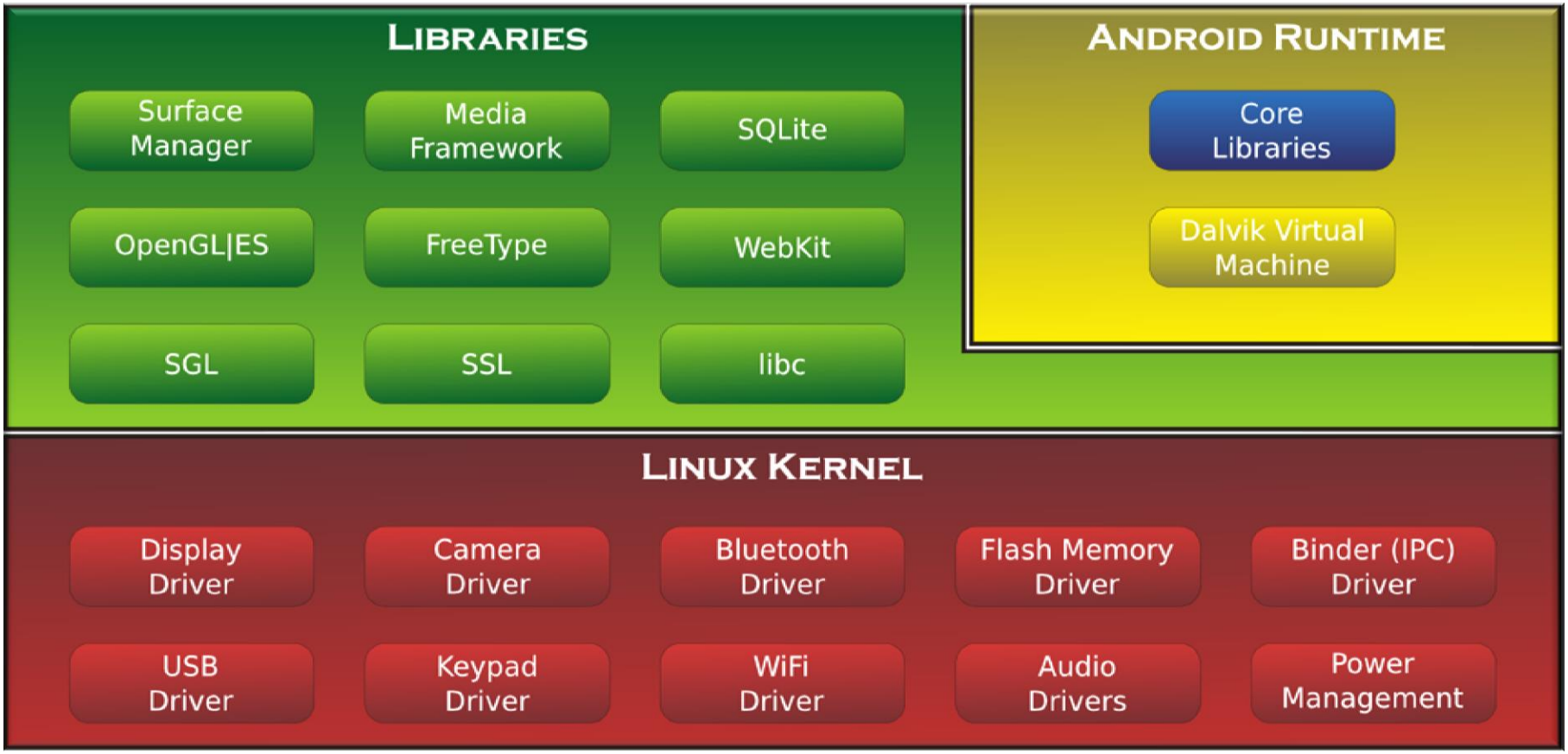
Vanderbilt University
Nashville, Tennessee, USA

Learning Objectives in this Part of the Module

- Understand more about how Java concurrency mechanisms available in Android are implemented



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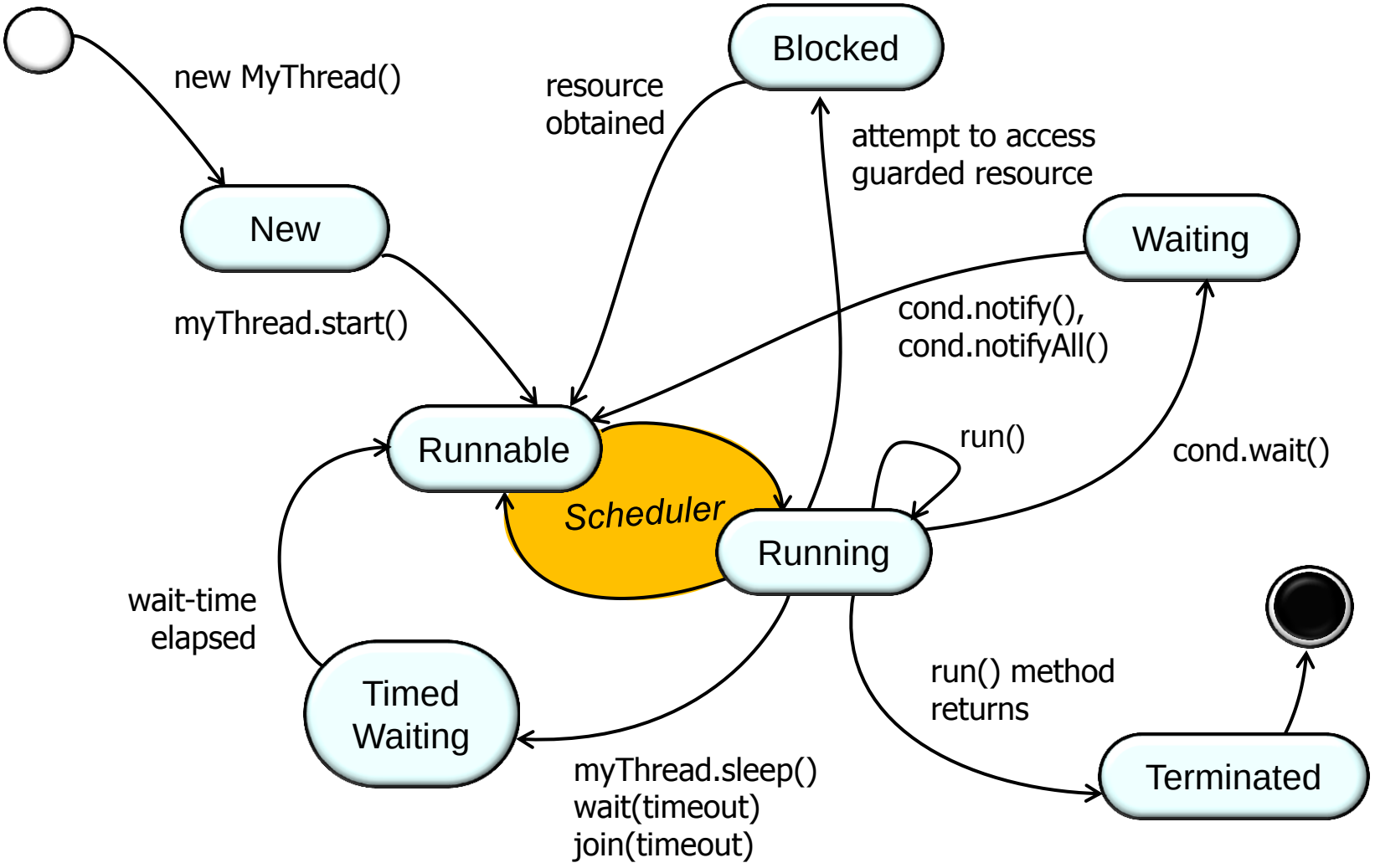
State Machine for Java Threads in Android



docs.oracle.com/javase/7/docs/api/java/lang/Thread.State.html has more

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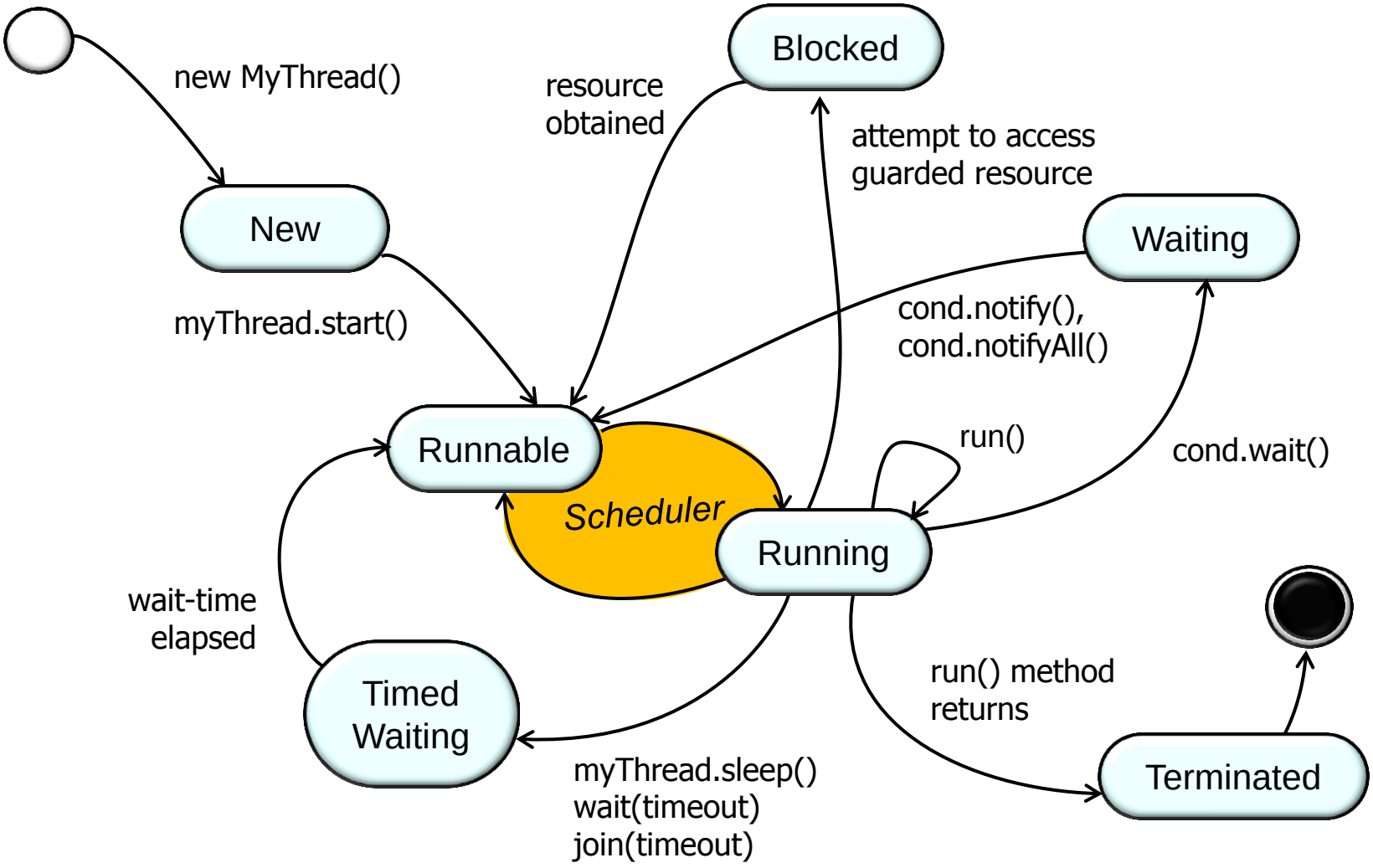

You don't need to understand all these details to program Java threads!!

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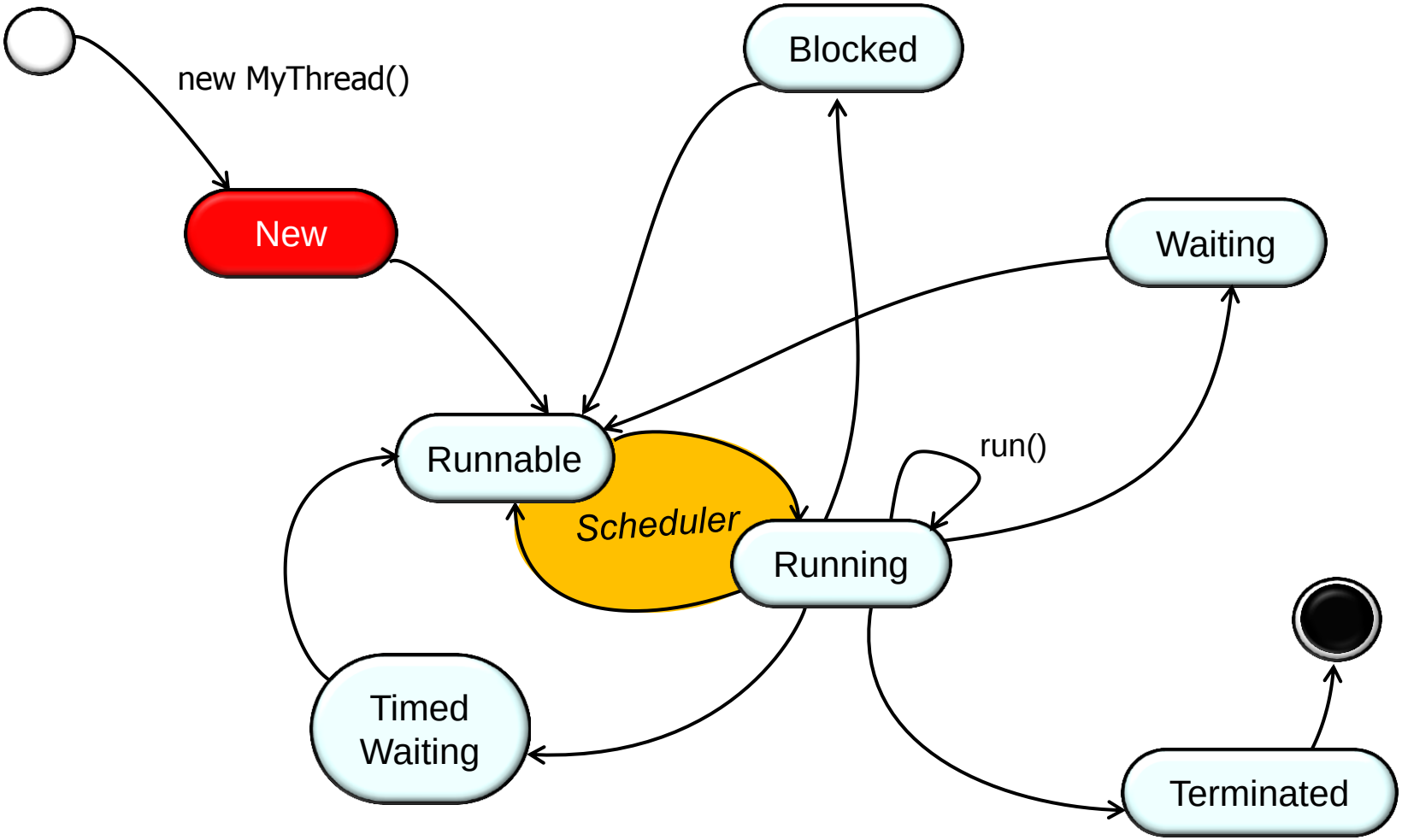

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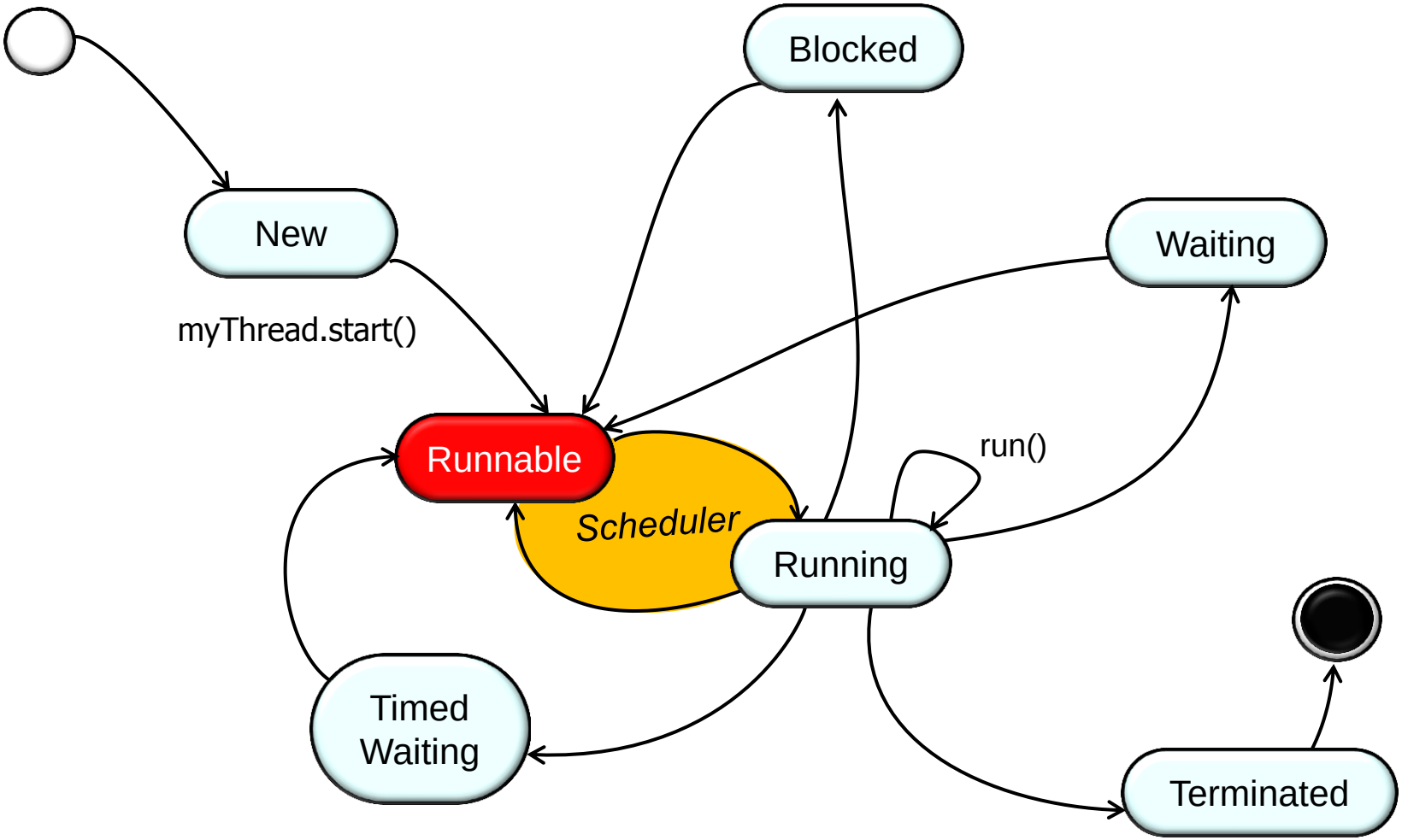

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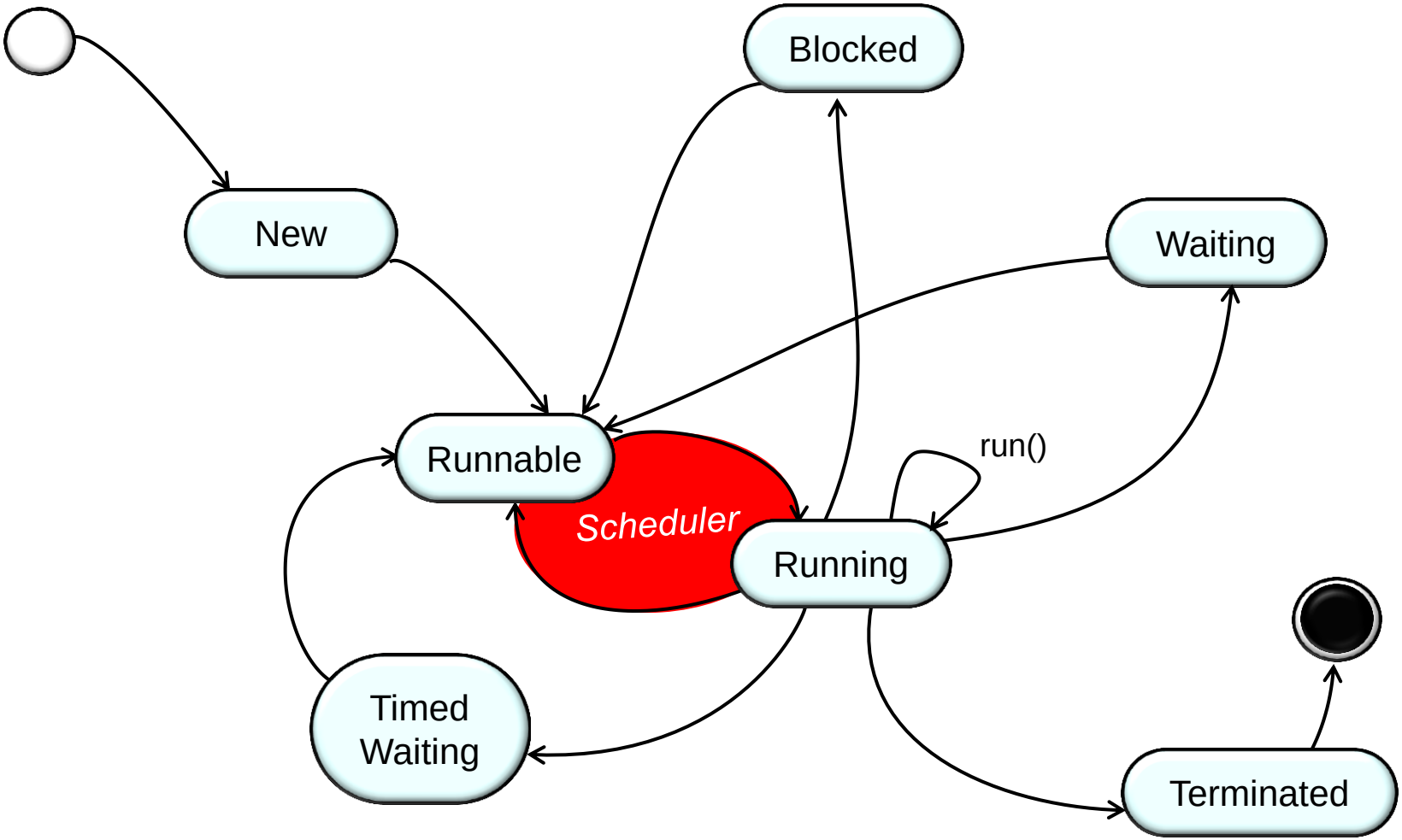

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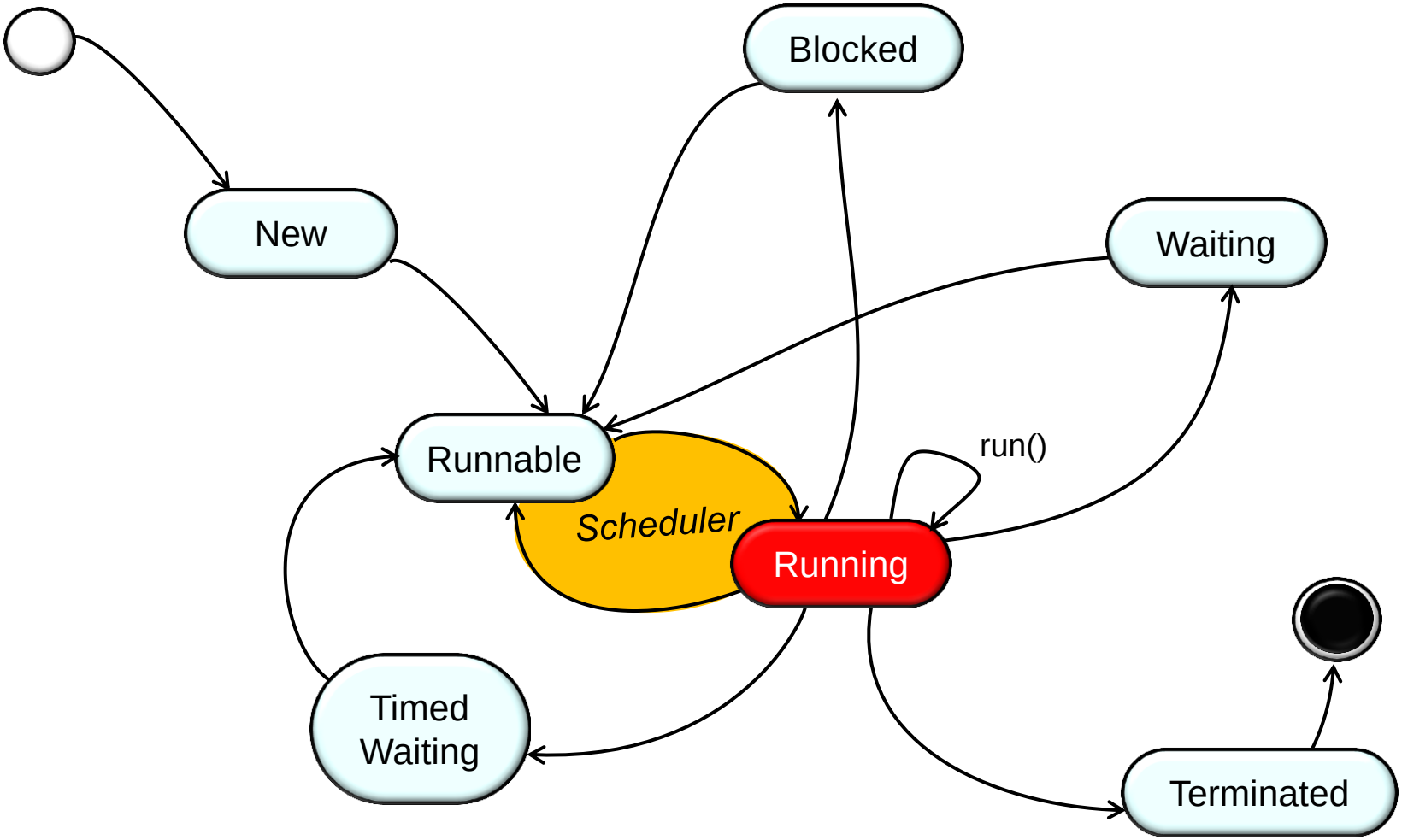

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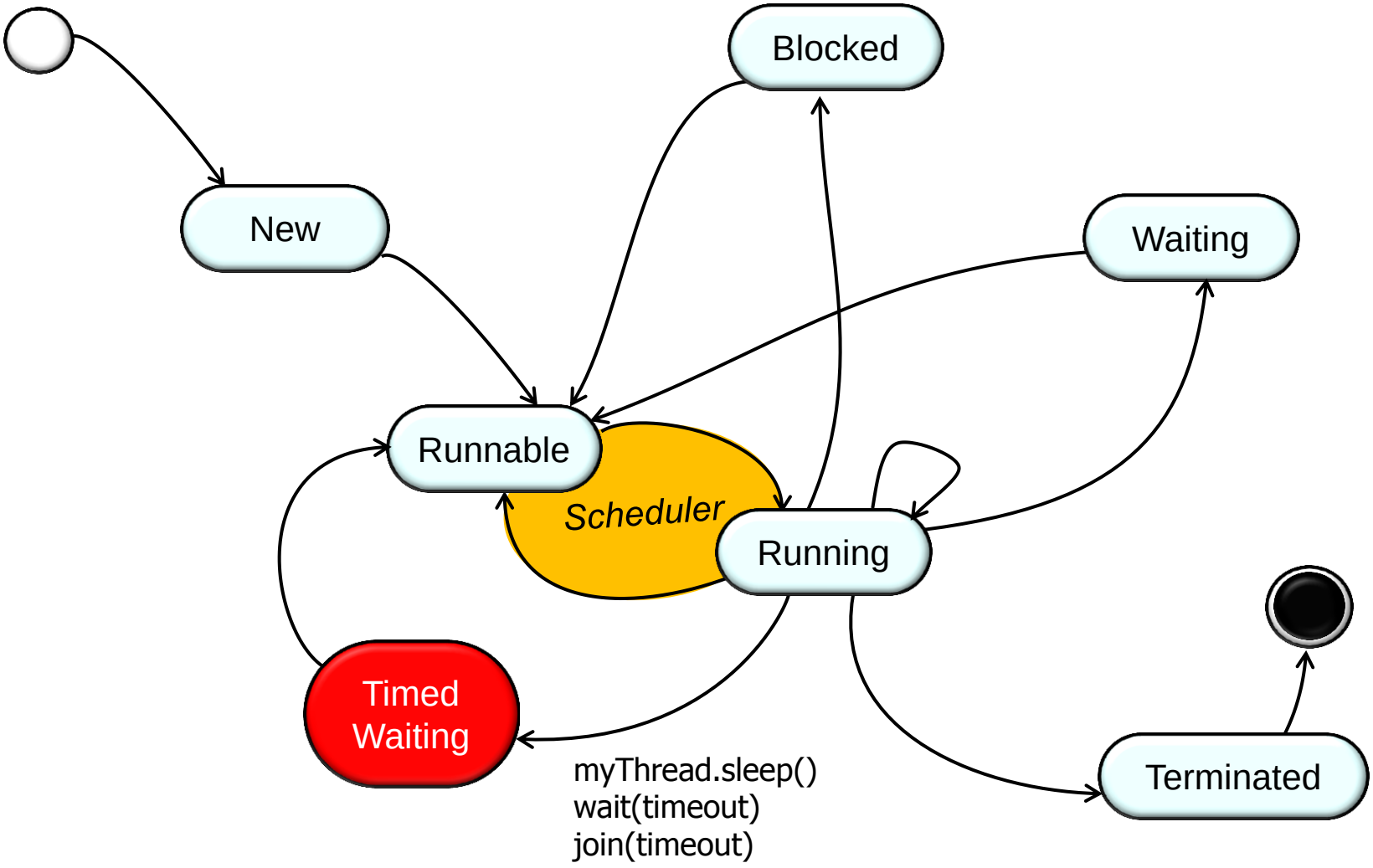

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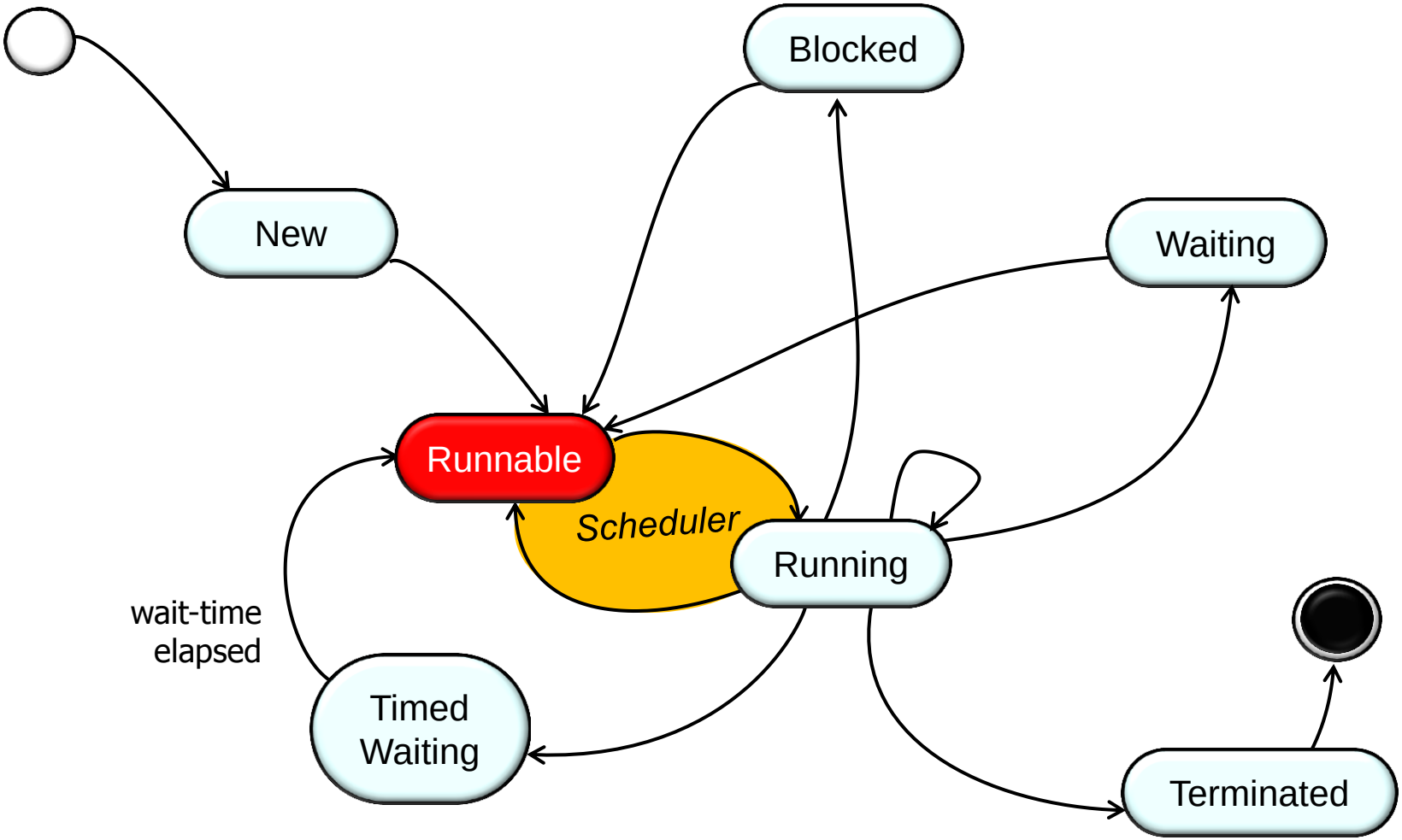

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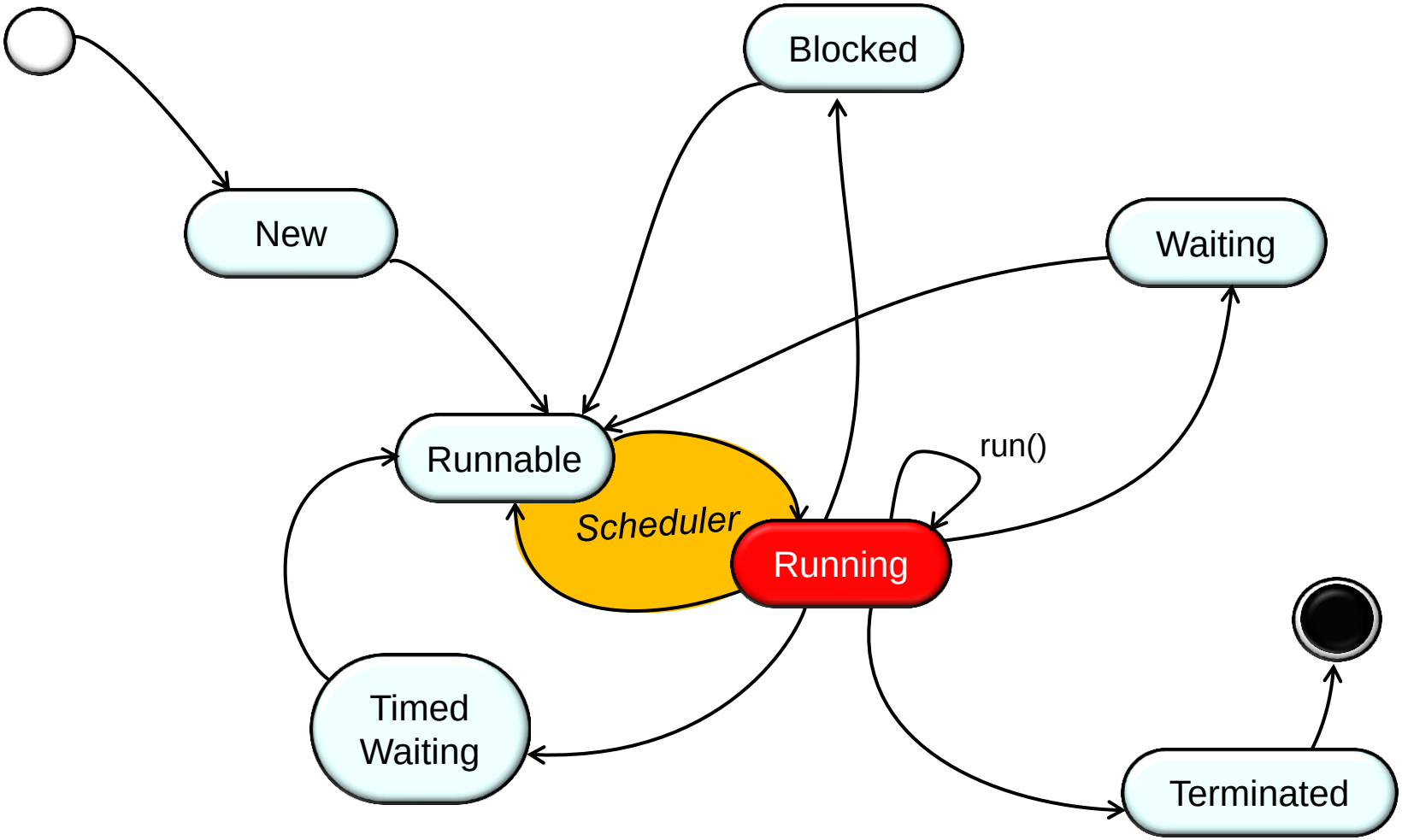

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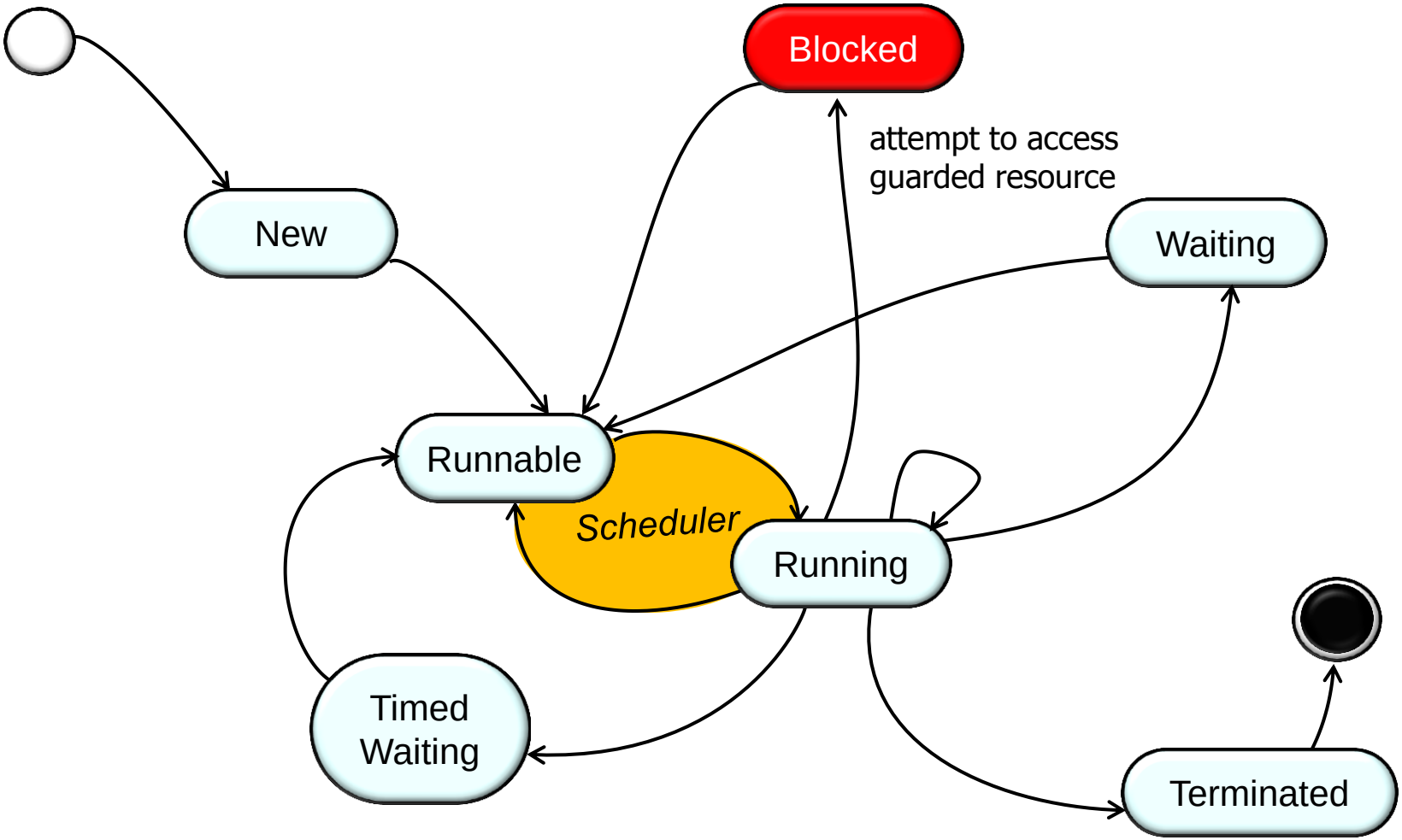

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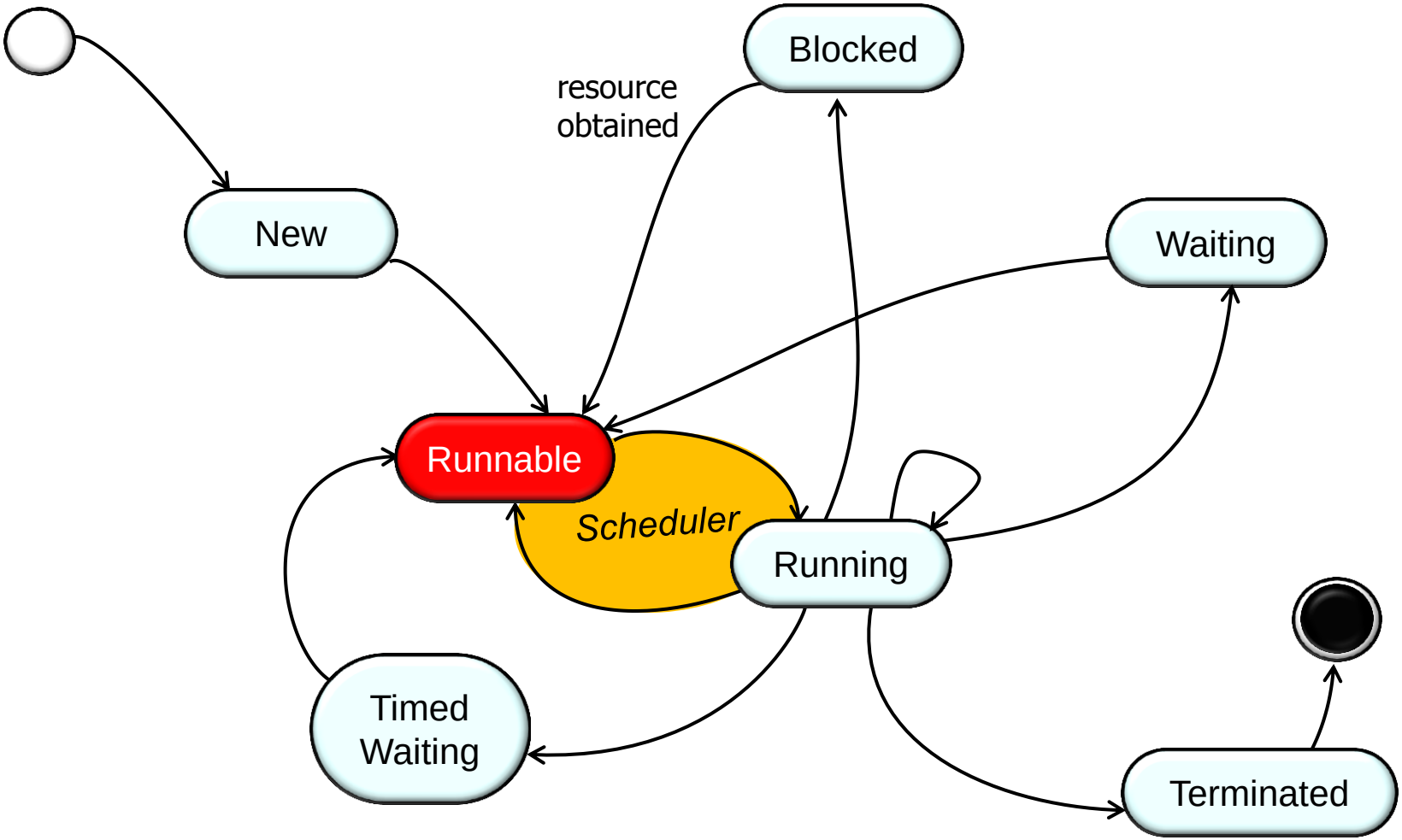

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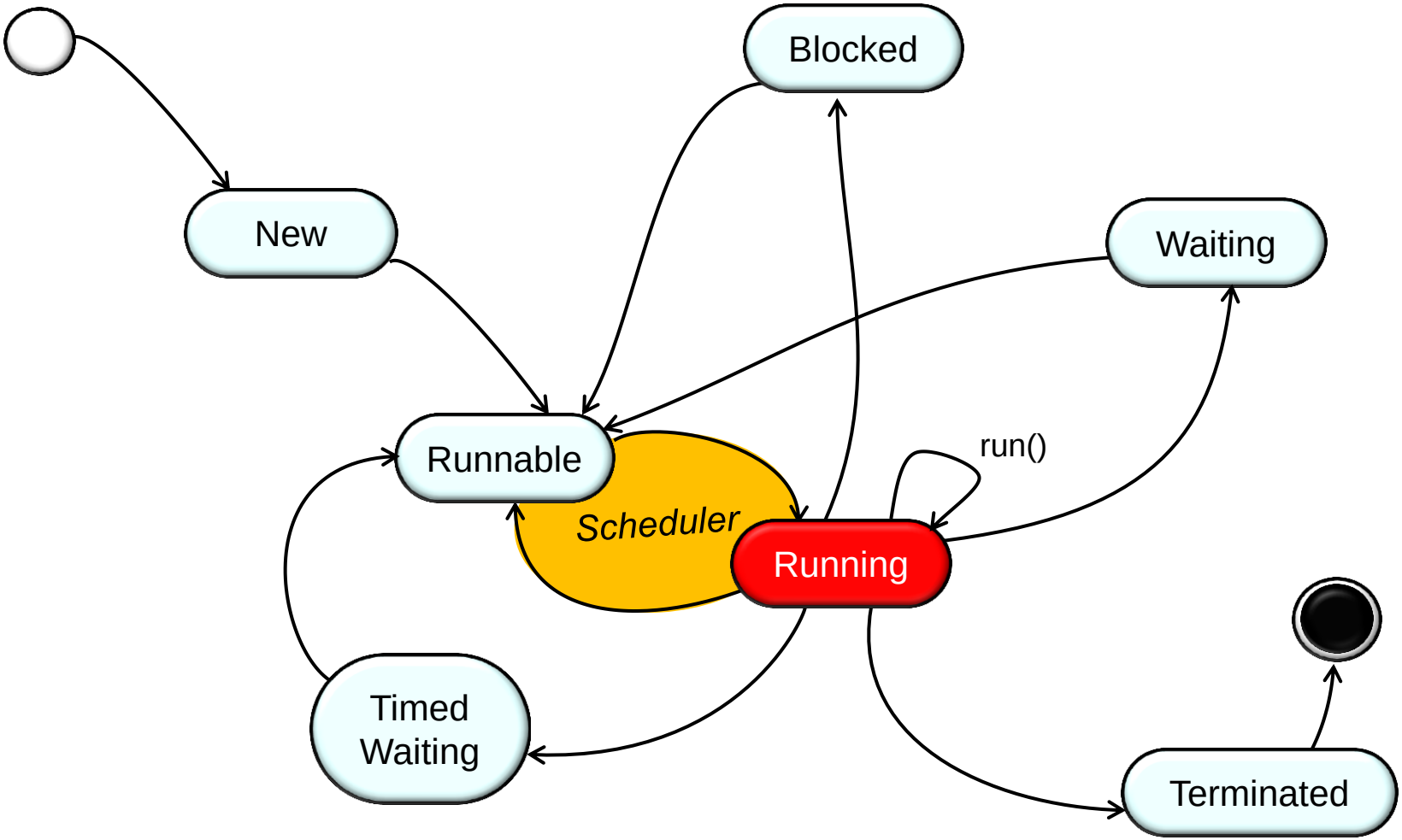

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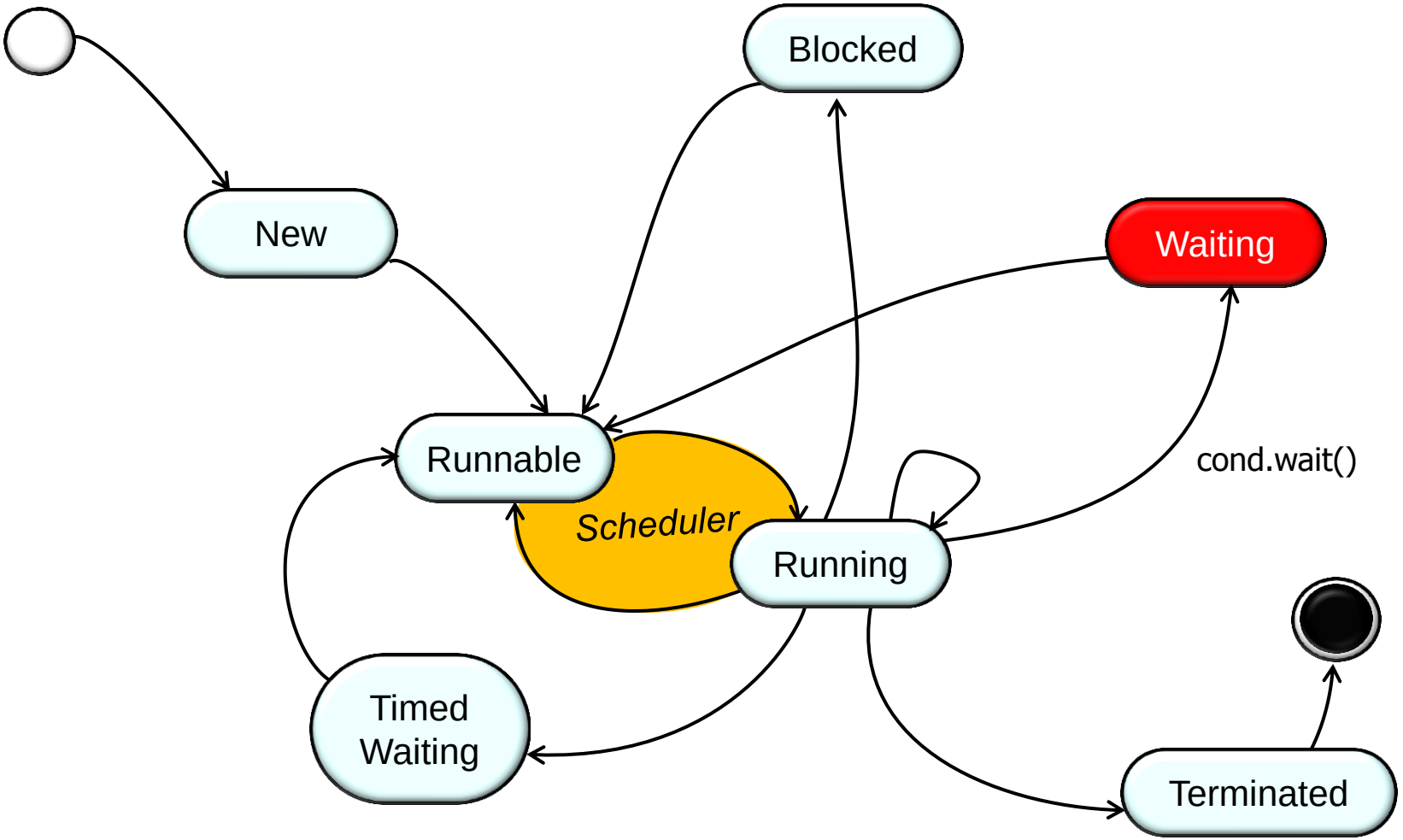

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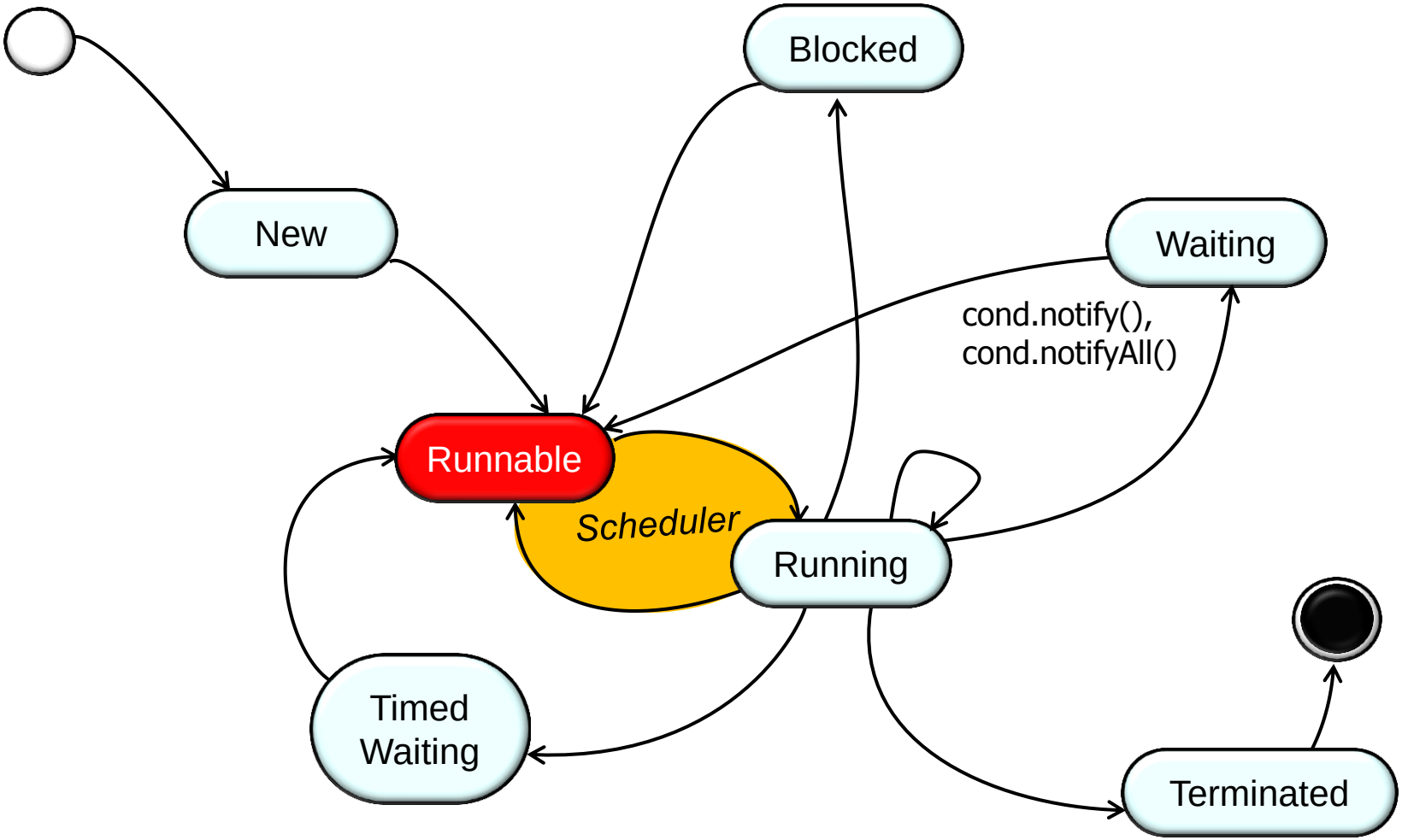

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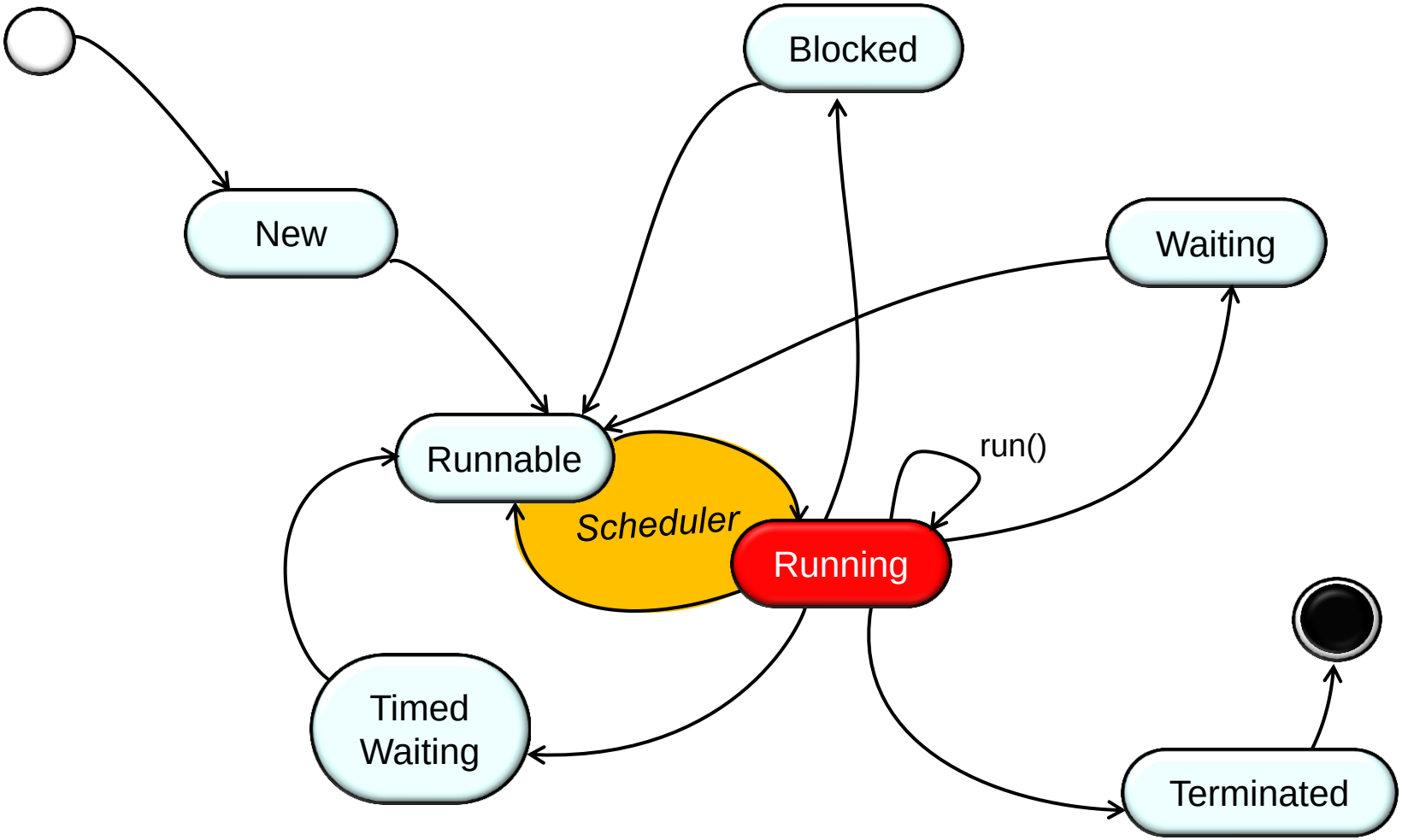

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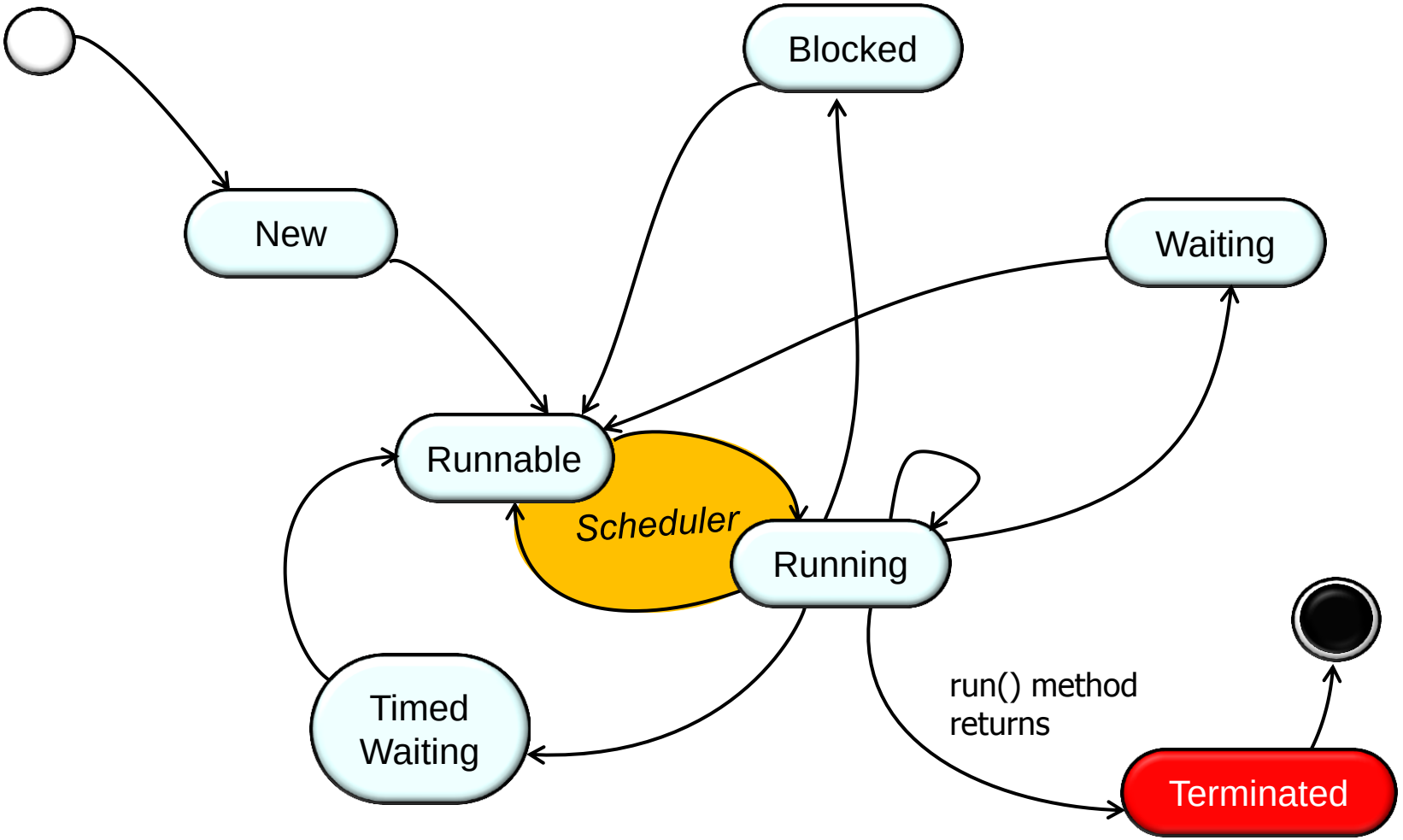

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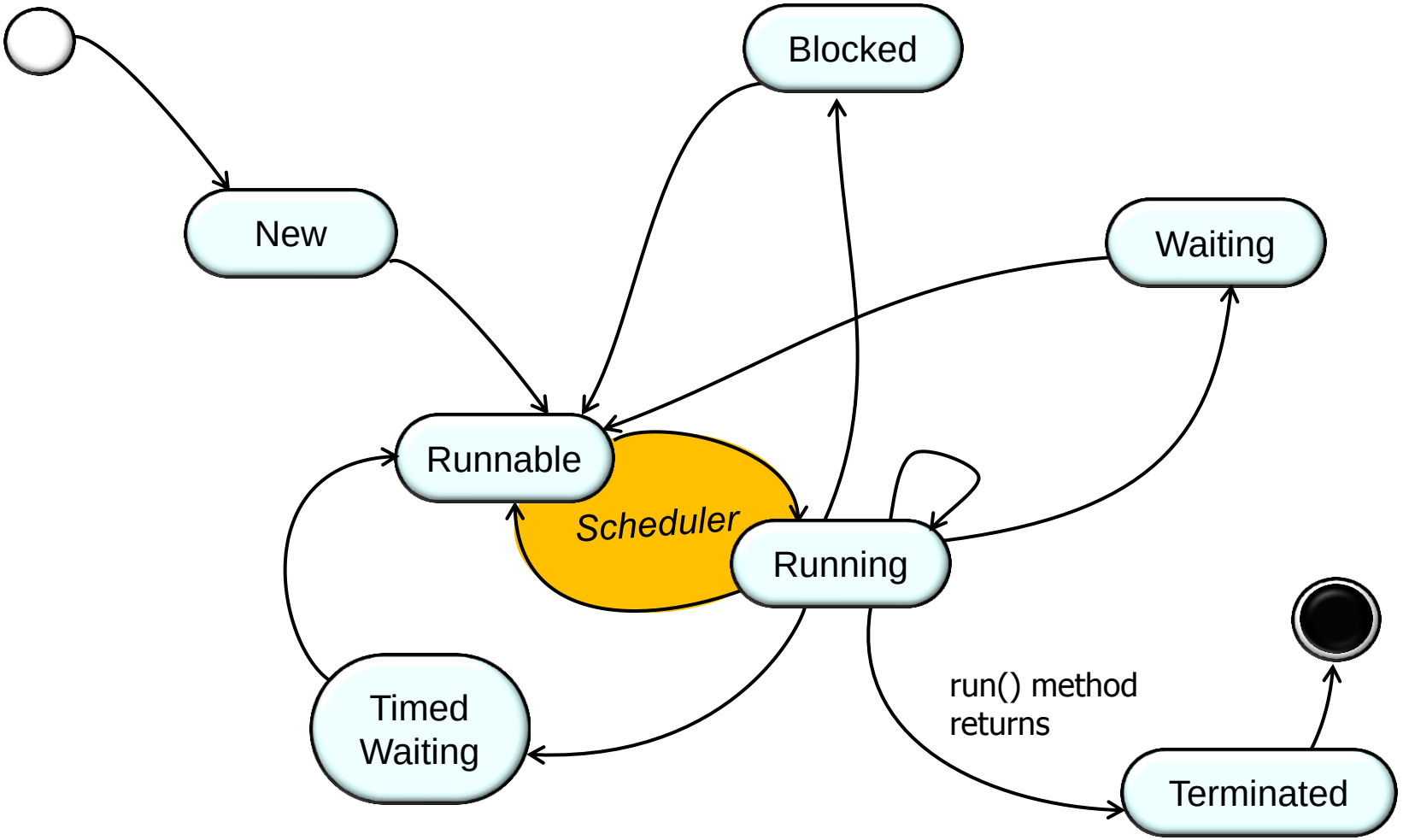
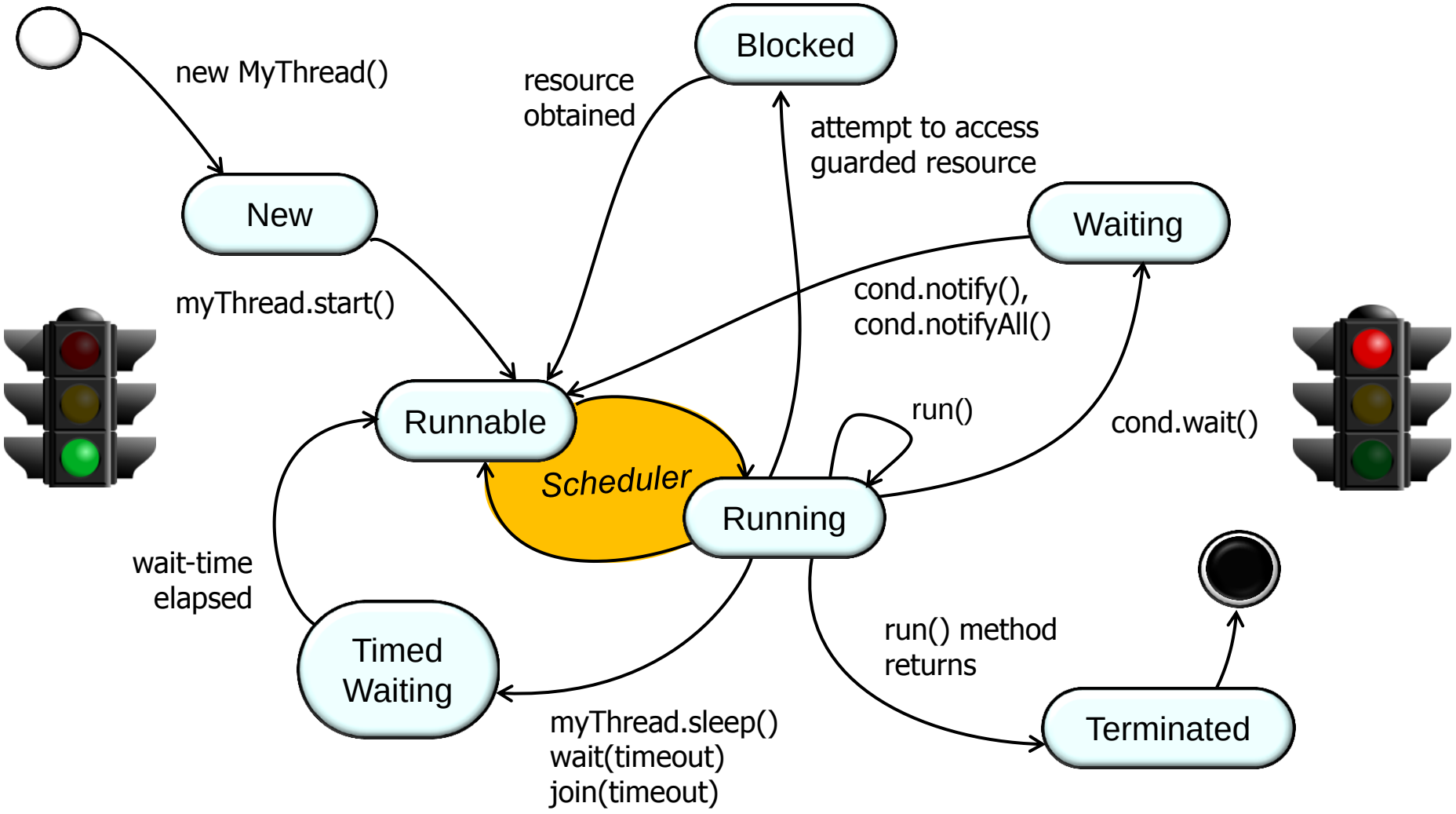


www.uml-diagrams.org/examples/java-6-thread-state-machine-diagram-example.html

Starting Java Threads on Android

Starting & Stopping Java Threads on Android



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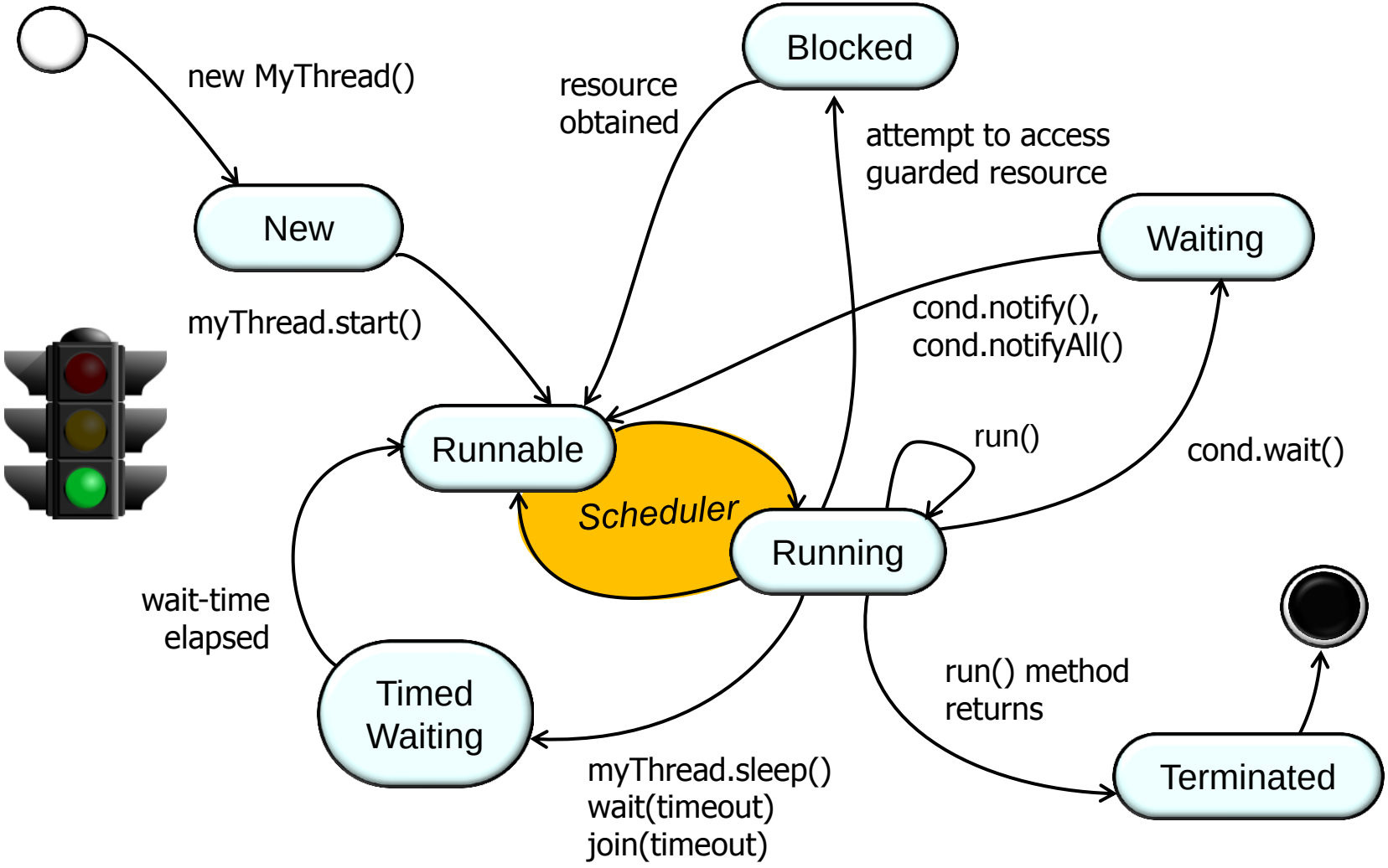

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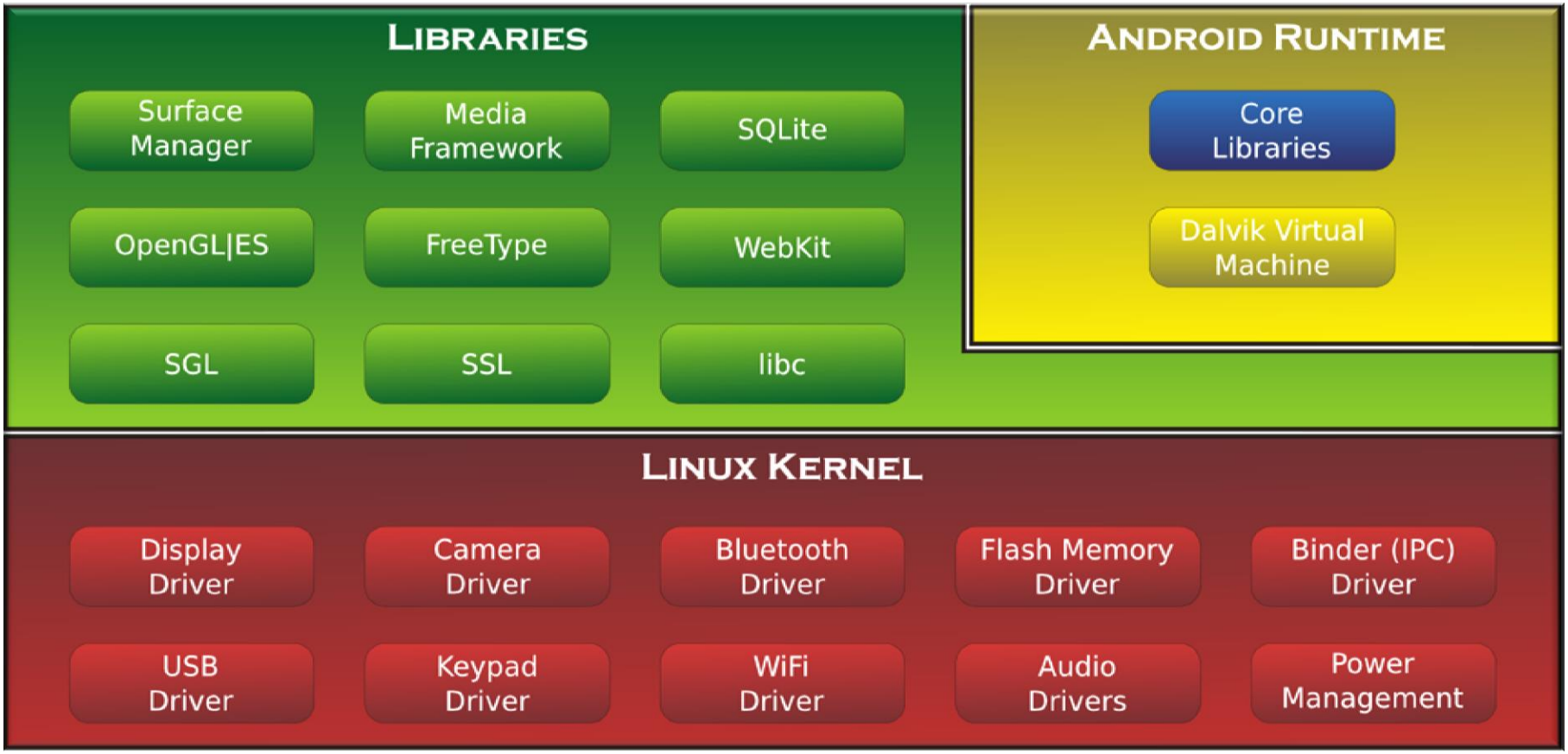
Starting Java Threads on Android

- Calling start() on a Thread causes it to begin executing its run() hook method
  - Many steps occur at the Java middleware, virtual machine, & OS layers



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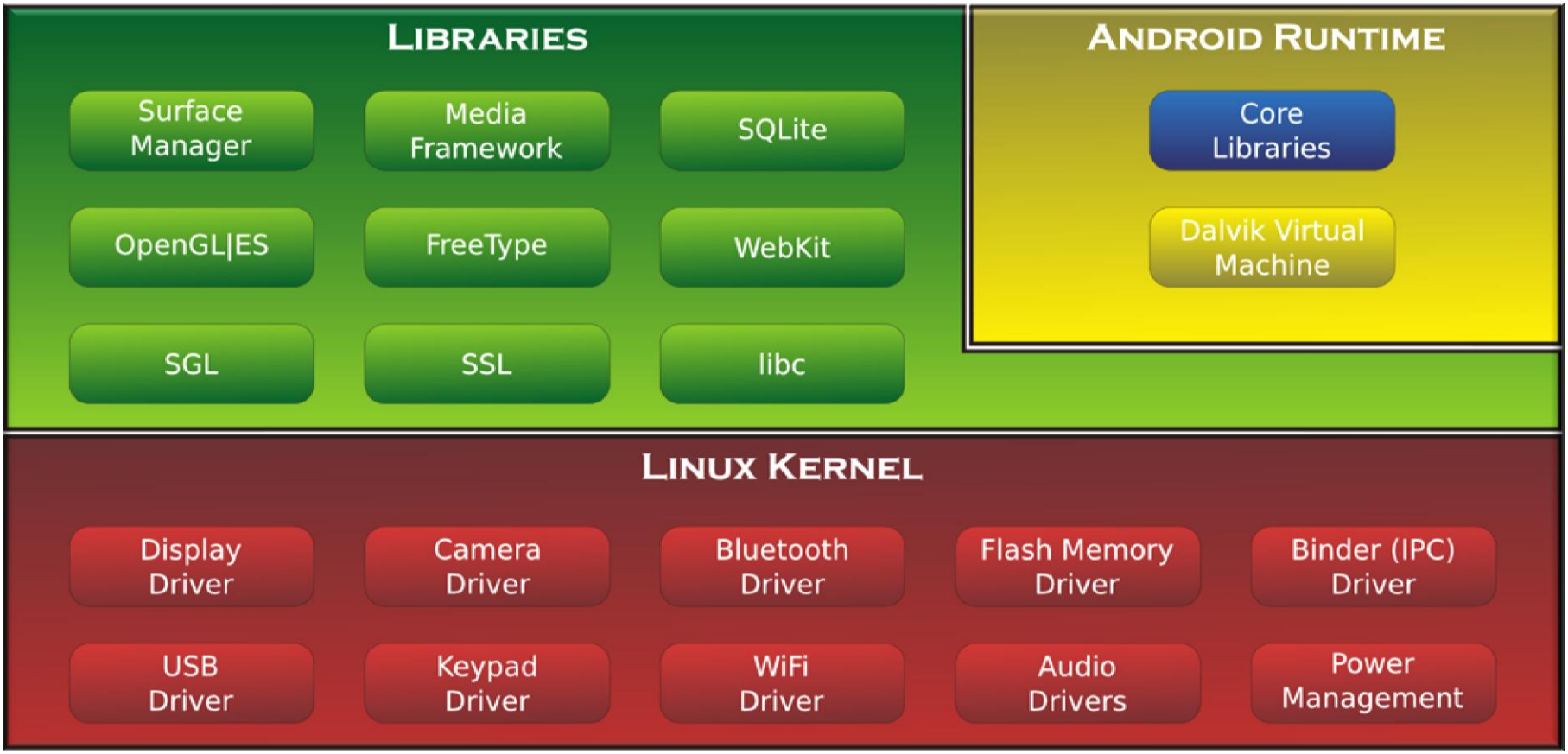

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See libcore/luni/src/main/java/java/lang/Thread.java

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See dalvik/vm/native/java_lang_VMThread.cpp

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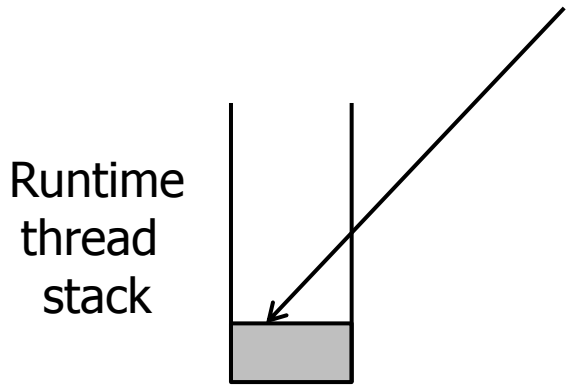

See bionic/libc/bionic/pthread.c

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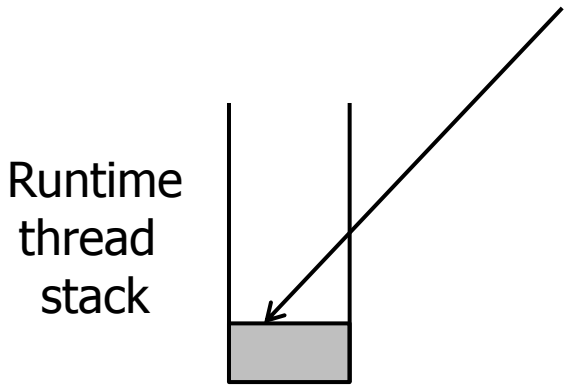

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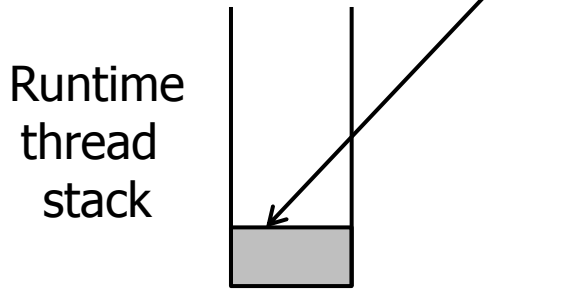

See dalvik/vm/Thread.cpp

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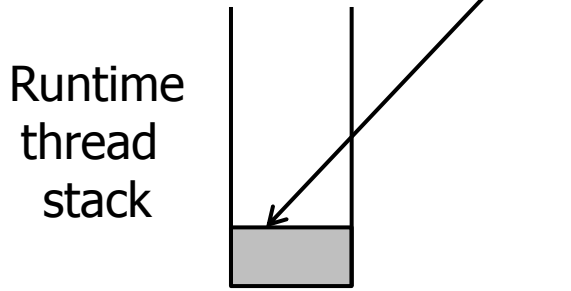

See dalvik/vm/interp/Stack.cpp

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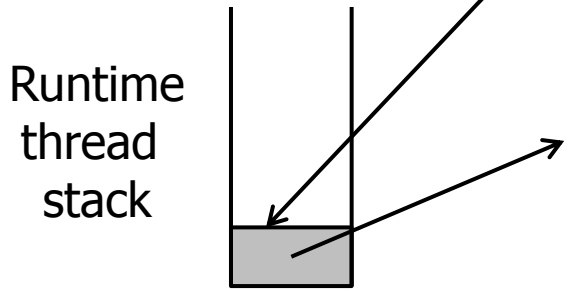

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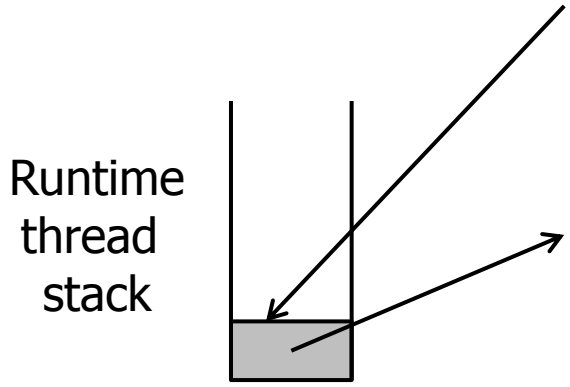
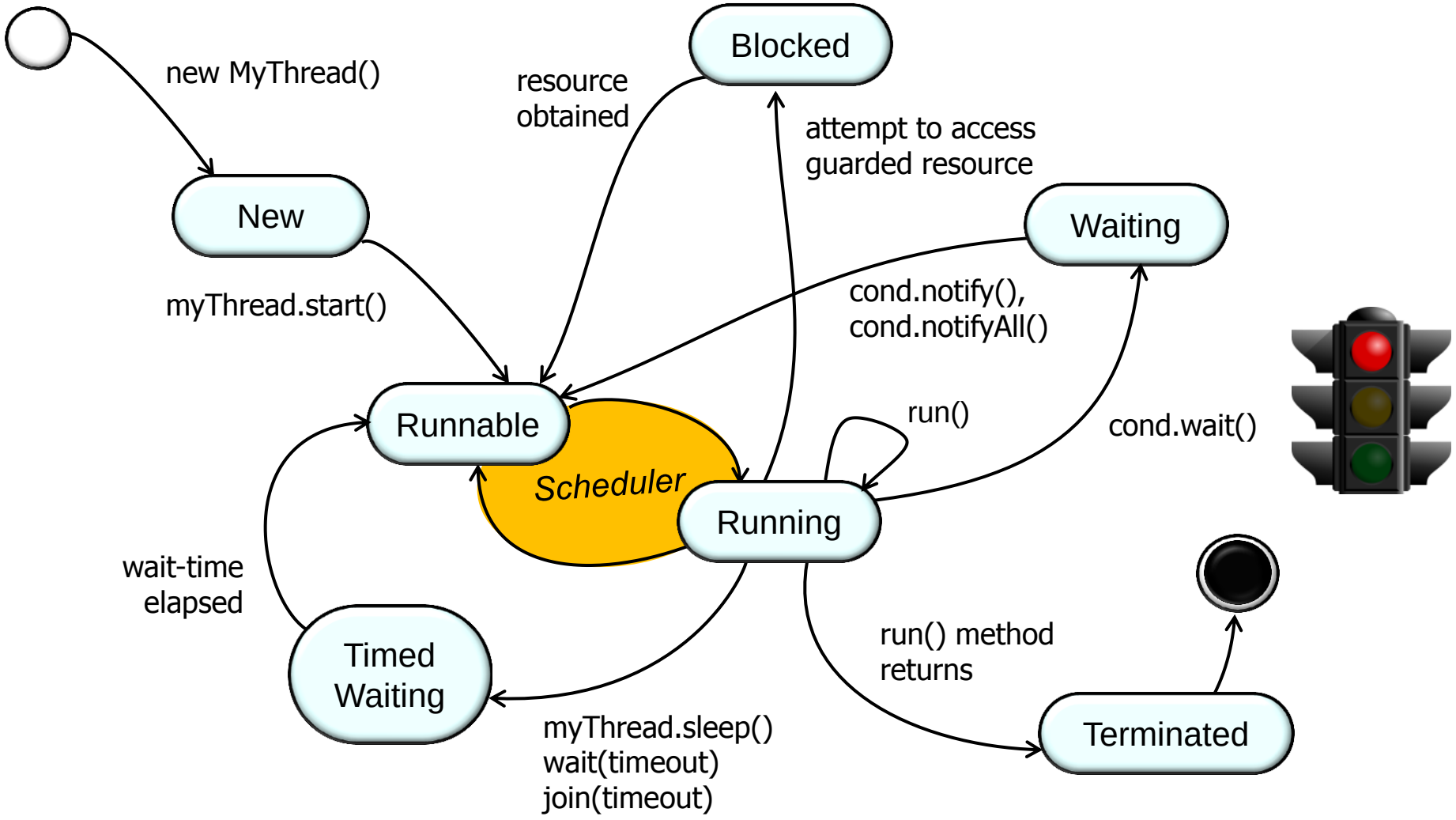


source.android.com/devices/tech/dalvik/art.html has more info on ART

Stopping Java Threads on Android (Part 1)

Stopping Java Threads



www.songlyrics.com/sound-of-music/so-long-farewell-lyrics

Stopping Java Threads

- Stopping Threads is surprisingly hard

www.youtube.com/watch?v=5rzyuY8-Ao8 has more examples ;-)

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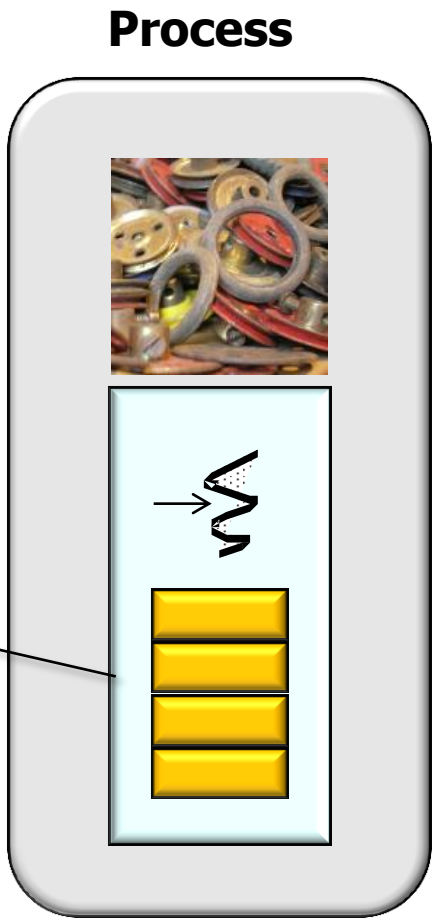
- There's no safe way to stop a Java thread involuntarily
  - Long running operations in a Thread must be coded to stop voluntarily!

```
public void run(){
  while (true) {
    // Check to see
    // if the thread
    // should stop
  }
}
```



Stopping Java Threads

- Stopping Threads is surprisingly hard
- There's no safe way to stop a Java thread involuntarily
- One way to stop a thread is to use a "stop" flag

```
public class MyRunnable
             implements Runnable
{

  public void run() {
    while(isStopped != true) {
      // a long-running operation
    }
    ...
```

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- One way to stop a thread is to use a "stop" flag
  - Add a volatile boolean flag "isStopped" to a class that implements Runnable

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public class MyRunnable
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{
  private volatile boolean
                isStopped = false;

  public void stopMe() {
    isStopped = true;
  }

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    while(isStopped != true) {
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en.wikipedia.org/wiki/Volatile_variable#In_Java has more on volatile

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Blocking operations won't be awakened, which impedes shutdown processing

Stopping Java Threads on Android (Part 2)

Stopping Java Threads

- Another way to stop a Thread is to use interrupt()

Stopping Java Threads

- Another way to stop a Thread is to use interrupt()
  - Posts an interrupt request to a Thread

Interrupts

An *interrupt* is an indication to a thread that it should stop what it is doing and do something else. It's up to the programmer to decide exactly how a thread responds to an interrupt, but it is very common for the thread to terminate. This is the usage emphasized in this lesson.

A thread sends an interrupt by invoking `interrupt` on the `Thread` object for the thread to be interrupted. For the interrupt mechanism to work correctly, the interrupted thread must support its own interruption.

See developer.android.com/reference/java/lang/Thread.html#interrupt()

Stopping Java Threads

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static int main(String args[]) {
  Thread t1 =
    new Thread(new Runnable() {
      public void run(){
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  t1.start();
  ... // Run concurrently
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    - e.g., wait(), join(), sleep() & blocking I/O calls

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void processBlocking(String input) {
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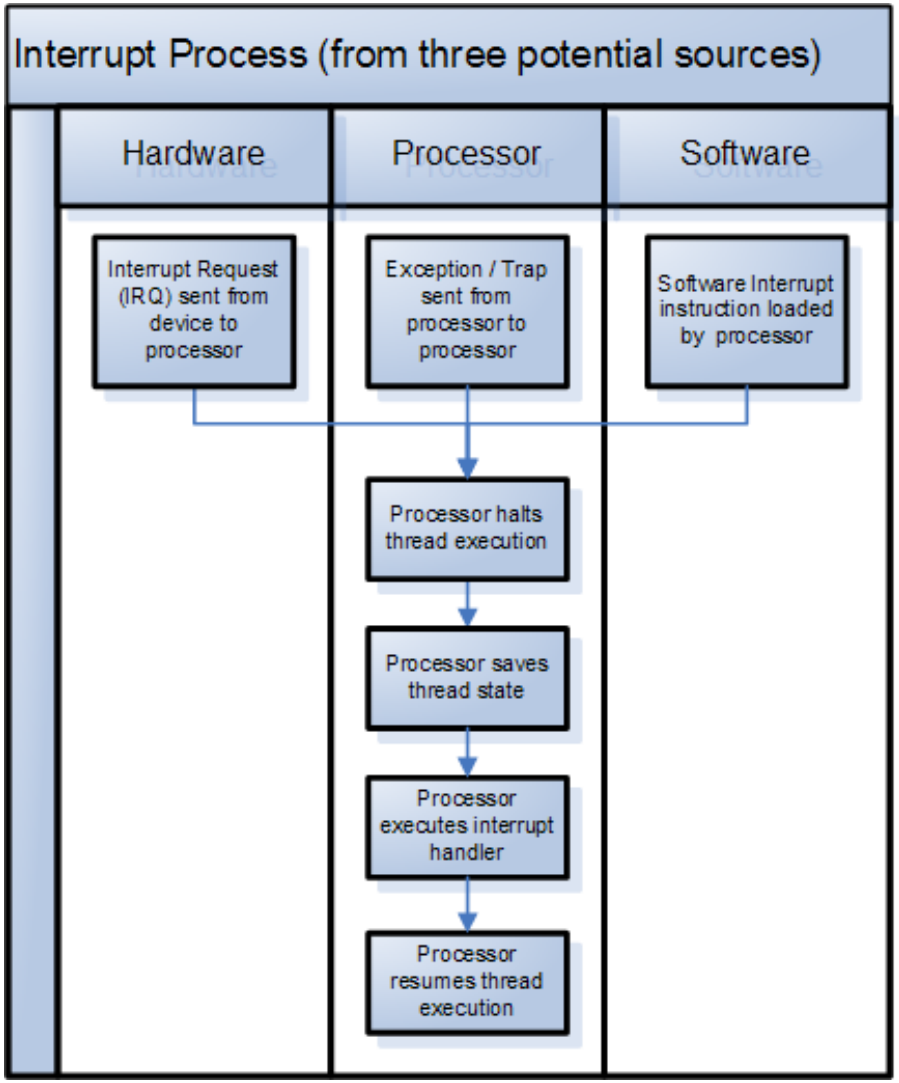
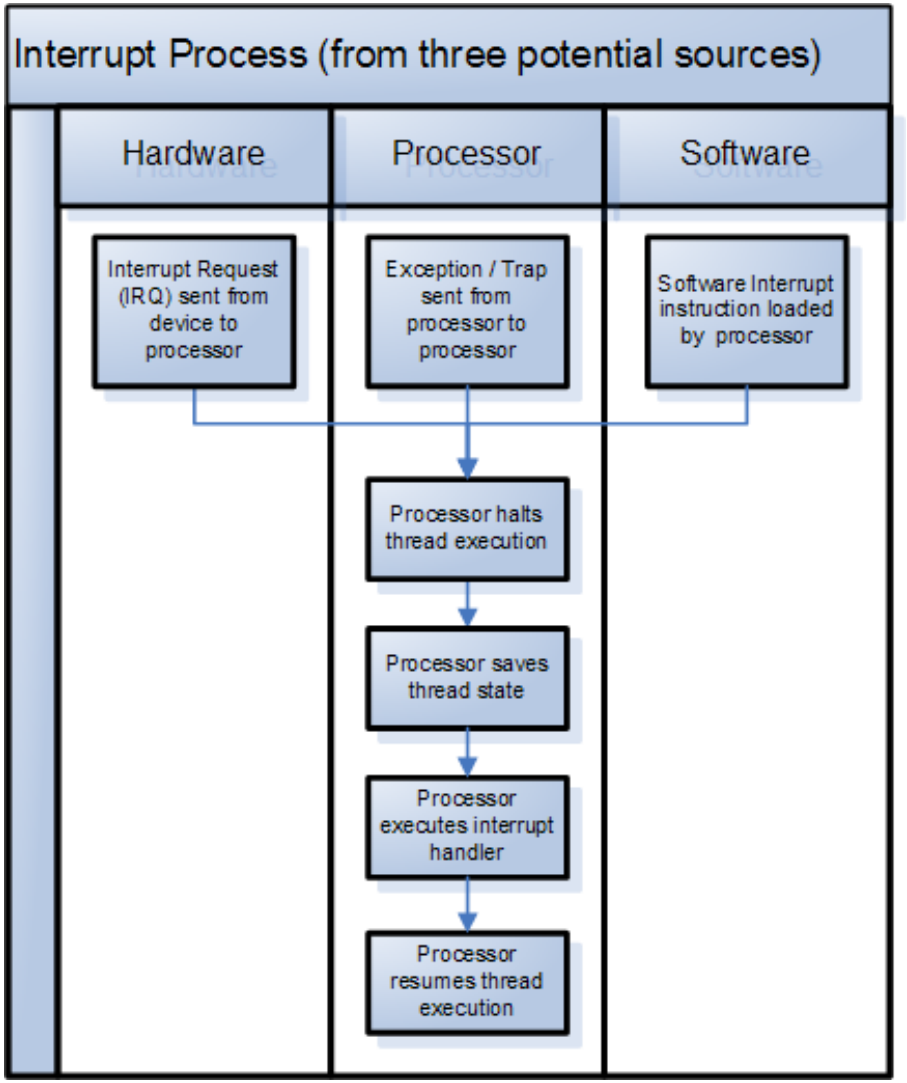
- Another way to stop a Thread is to use interrupt()
- Thread interrupts don't behave like traditional hardware or operating system interrupts



en.wikipedia.org/wiki/Interrupt has more on interrupts

Stopping Java Threads

- Another way to stop a Thread is to use interrupt()
- Thread interrupts don't behave like traditional hardware or operating system interrupts
  - They aren't delivered asynchronously or preemptively



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- Both solutions require Threads to cooperate when stopping them
  - This approach can be tedious, but it's the recommended way of stopping Java & Android Threads

stackoverflow.com/questions/8505707/android-best-and-safe-way-to-stop-thread

Summary

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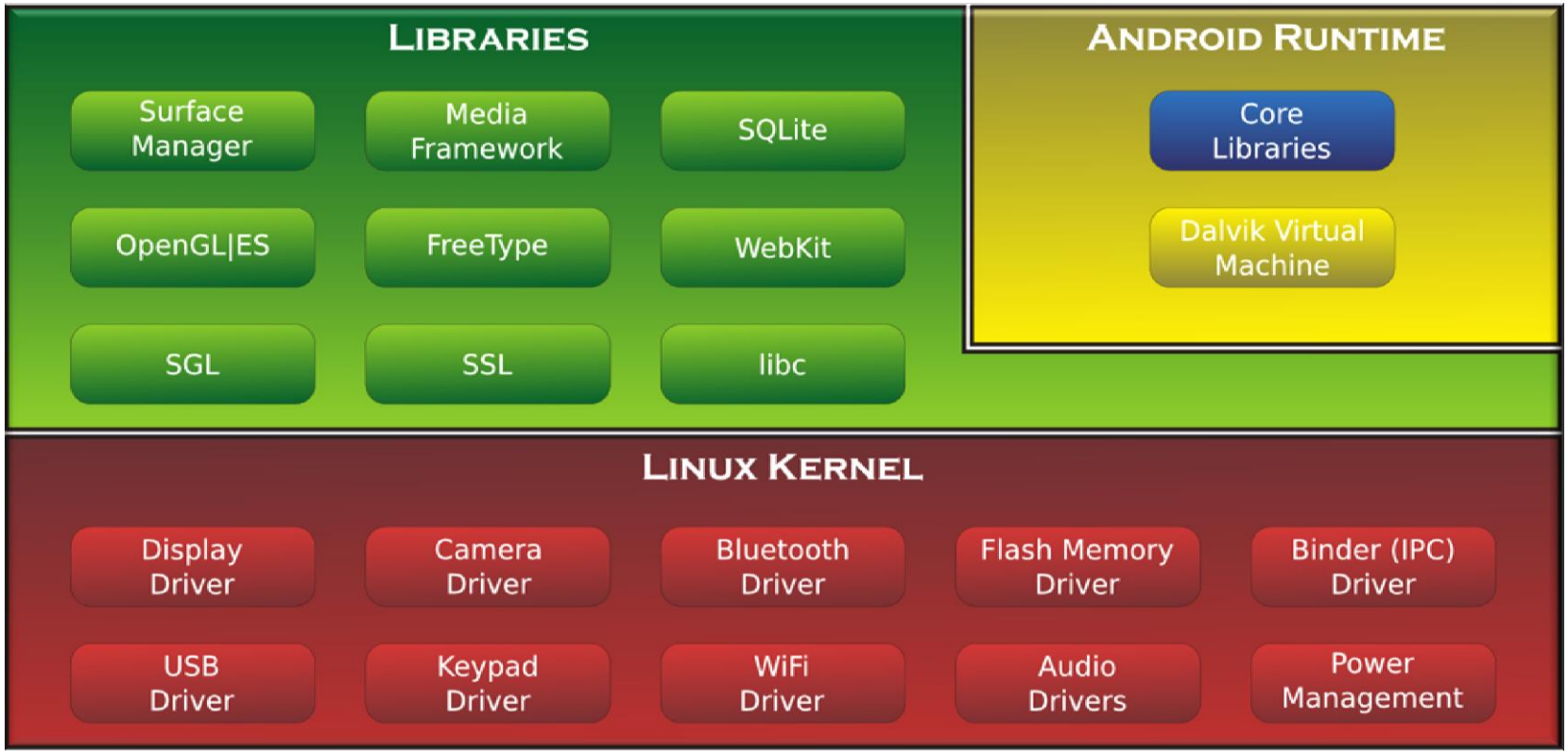
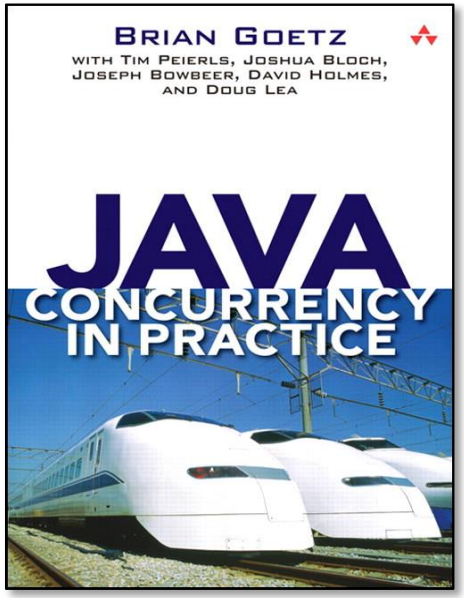
- Java Threads are implemented using various mechanisms defined by lower layers of the Android software stack

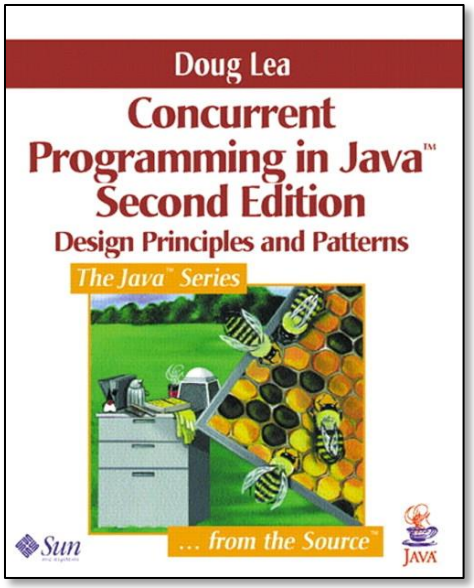


en.wikipedia.org/wiki/Dalvik_(software) has more info on the Dalvik VM

Summary

- Java Threads are implemented using various methods & functions defined by lower layers of the Android software stack
- There are good books on Java concurrency mechanisms that also cover key patterns & best practices of programming multi-threaded software in Java





See online supplement at gee.cs.oswego.edu/dl/cpj