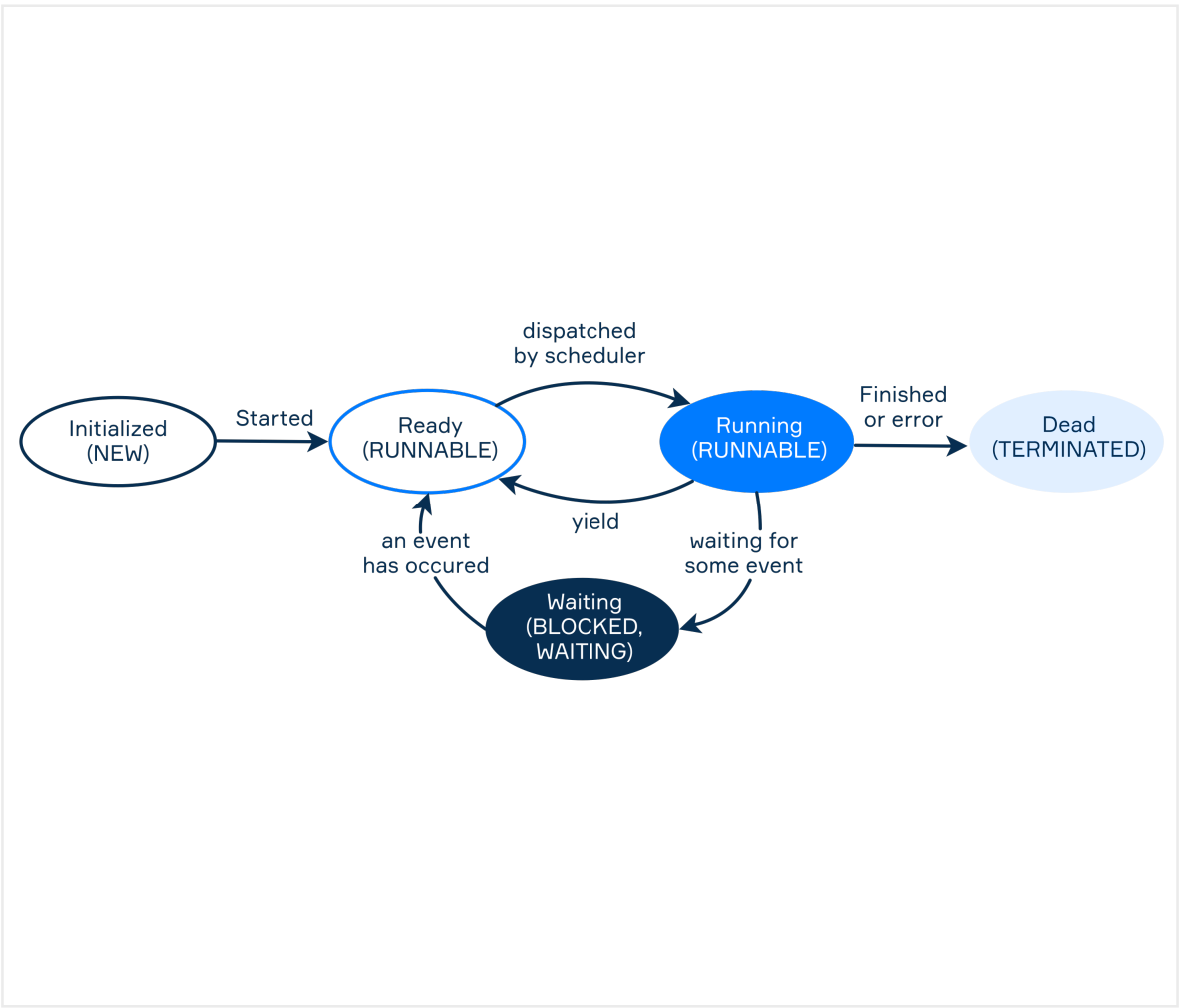
States of a Thread

Throughout its life cycle, a thread's state changes. This is caused both by the actions of the programmer and internal events of the operating system.

The Thread.State enum

In Java, the state of a thread is presented by the Thread.State enum with six possible values:

- **NEW:** an instance of the class Thread has been created, but it has not yet started;
- **RUNNABLE:** a thread is executing in JVM but it may be waiting for OS resources such as processor;
- **BLOCKED:** a thread that is blocked waiting for a monitor lock (we will consider it later);
- **WAITING:** a thread is waiting for another thread indefinitely long to perform a task (e.g., join without timeout);
- **TIMED_WAITING:** a thread is waiting for another thread for a specified waiting time (e.g., sleep, join with timeout);
- **TERMINATED:** a thread is terminated when run method completely executes itself or an uncaught exception occurs. Once a thread terminates it never gets back to its runnable state.



The simplified lifecycle of a thread in the operating system

To obtain the current state of a thread there is an instance method getState(). Let's look at how these states are changed depending on the programmer's actions.

```
Thread worker = ... // new worker to make a difficult task
System.out.println(worker.getState()); // NEW

worker.start(); // start the worker
System.out.println(worker.getState()); // RUNNABLE

worker.join();  // waiting for completing the worker
System.out.println(worker.getState()); // TERMINATED
```

When a thread is created its state is NEW. When a thread is started its state is RUNNABLE (the method run may not be called yet). Finally, when a thread is completed the state is TERMINATED. At the same time, the main thread also went through the state WAITING (indefinitely long) after invoking the thread.join() method.

The (almost) real lifecycle of a thread

The states discussed above are specific to Java's point of view. The real lifecycle of a thread is slightly different. As an example, the RUNNABLE state is actually more complicated than it might seem. In this state, a thread might actually be running or it might be ready to run.

Below you may see the simplified lifecycle of a thread related to the OS terminology. The diagram includes five states and events that cause the thread to jump from one state to another. Please, do not confuse these states with the corresponding states in Java (those are in UPPERCASE).

After initialisation, the thread is ready to run (**Ready**). It is the responsibility of the **thread scheduler** to give some instants of time for a thread to run (**Running**) and then move it again to **Ready**. This is used to share the processor time between multiple threads concurrently. Otherwise, one thread could capture all the available processor time.

The **Waiting** state means that a thread is temporarily inactive (for example, a thread may be waiting for another thread or completing I/O).

A thread in this state cannot continue its execution any further until it is moved to the **Ready** state.