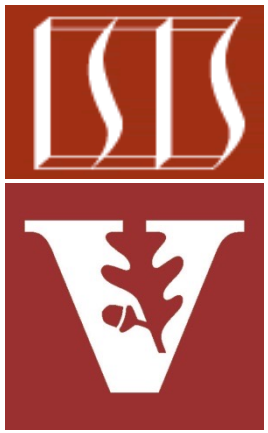
Java Platform Threads vs. Virtual Threads (Part 1)

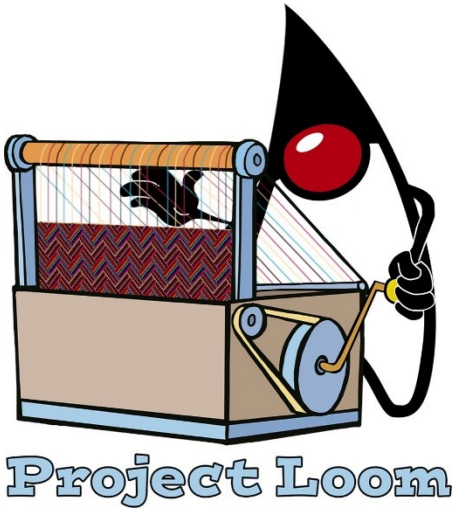


Douglas C. Schmidt
d.schmidt@vanderbilt.edu
www.dre.vanderbilt.edu/~schmidt

Institute for Software Integrated Systems
Vanderbilt University
Nashville, Tennessee, USA

Learning Objectives in this Part of the Lesson

- Know the differences between Java platform & virtual threads



Platform threads

`Thread` supports the creation of *platform threads* that are typically mapped 1:1 to kernel threads scheduled by the operating system. Platform threads will usually have a large stack and other resources that are maintained by the operating system. Platforms threads are suitable for executing all types of tasks but may be a limited resource.

Platform threads are designated *daemon* or *non-daemon* threads. When the Java virtual machine starts up, there is usually one non-daemon thread (the thread that typically calls the application's `main` method). The Java virtual machine terminates when all started non-daemon threads have terminated. Unstarted daemon threads do not prevent the Java virtual machine from terminating. The Java virtual machine can also be terminated by invoking the Runtime.exit(int) method, in which case it will terminate even if there are non-daemon threads still running.

In addition to the daemon status, platform threads have a thread priority and are members of a thread group.

Platform threads get an automatically generated thread name by default.

Virtual threads

`Thread` also supports the creation of *virtual threads*. Virtual threads are typically *user-mode threads* scheduled by the Java virtual machine rather than the operating system. Virtual threads will typically require few resources and a single Java virtual machine may support millions of virtual threads. Virtual threads are suitable for executing tasks that spend most of the time blocked, often waiting for I/O operations to complete. Virtual threads are not intended for long running CPU intensive operations.

Virtual threads typically employ a small set of platform threads used as *carrier threads*. Locking and I/O operations are the *scheduling points* where a carrier thread is re-scheduled from one virtual thread to another. Code executing in a virtual thread will usually not be aware of the underlying carrier thread, and in particular, the currentThread() method, to obtain a reference to the *current thread*, will return the `Thread` object for the virtual thread, not the underlying carrier thread.

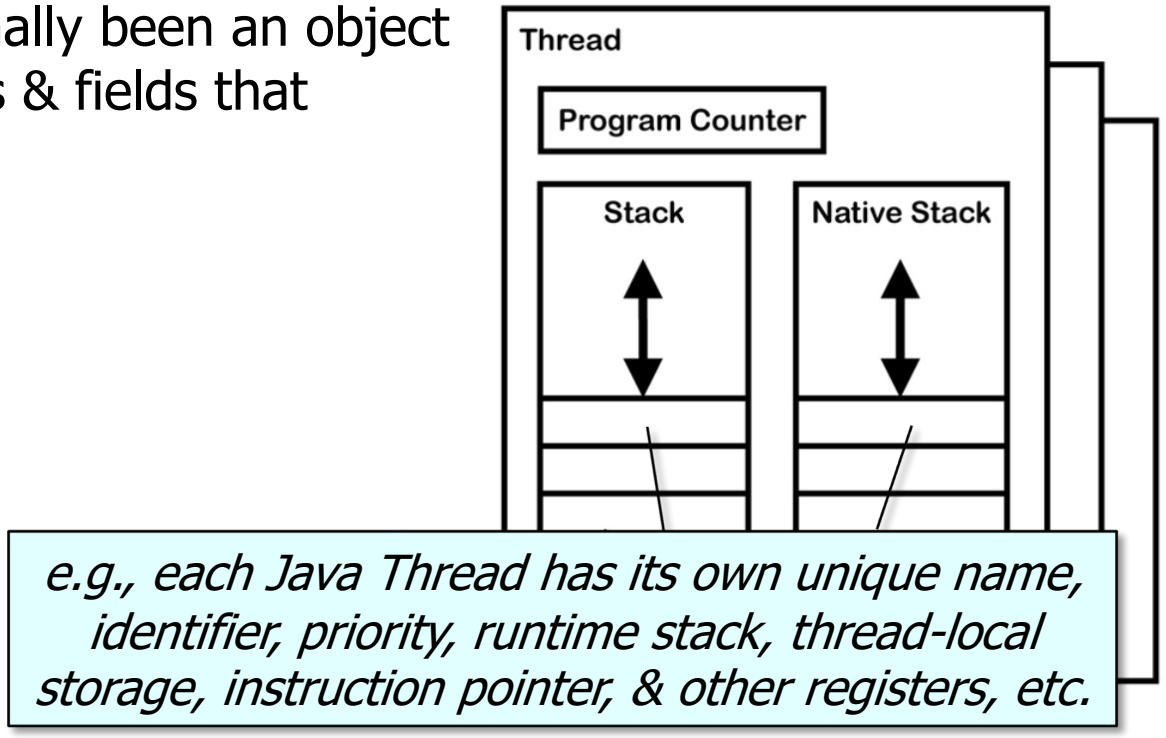
Virtual threads gets a fixed name by default.

See docs.oracle.com/en/java/javase/19/docs/api/java.base/java/lang/Thread.html

Java Platform Threads vs. Virtual Threads

Java Platform Threads vs. Virtual Threads

- A Java Thread has traditionally been an object containing various methods & fields that constitute its "state"



See blog.jamesdbloom.com/JVMInternals.html

Java Platform Threads vs. Virtual Threads

- A Java Thread has traditionally been an obje
  containing various methods & fields that
  constitute its "state"
  - Java 19 now refers to these types
    of Java threads as "platform threads"

See wiki.openjdk.java.net/display/loom/Main

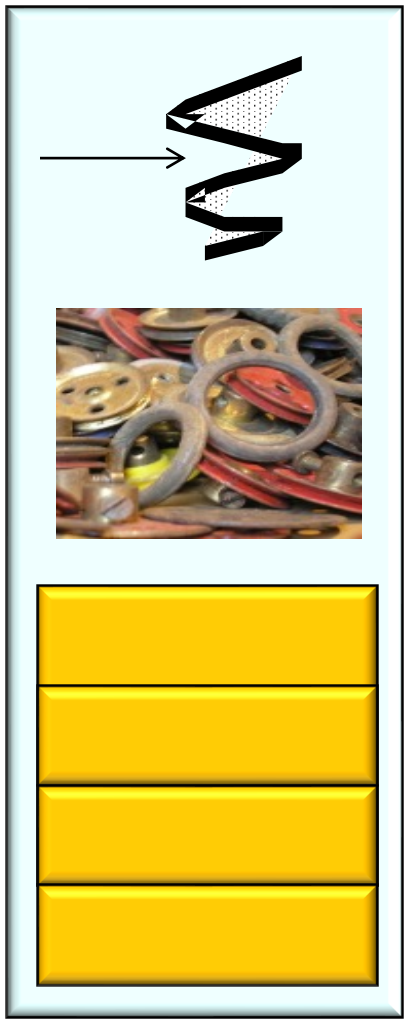
Java Platform Threads vs. Virtual Threads

- Each Java platform thread is associated 1-to-1 with an OS kernel thread

See en.wikipedia.org/wiki/Thread_(computing)#Kernel_threads

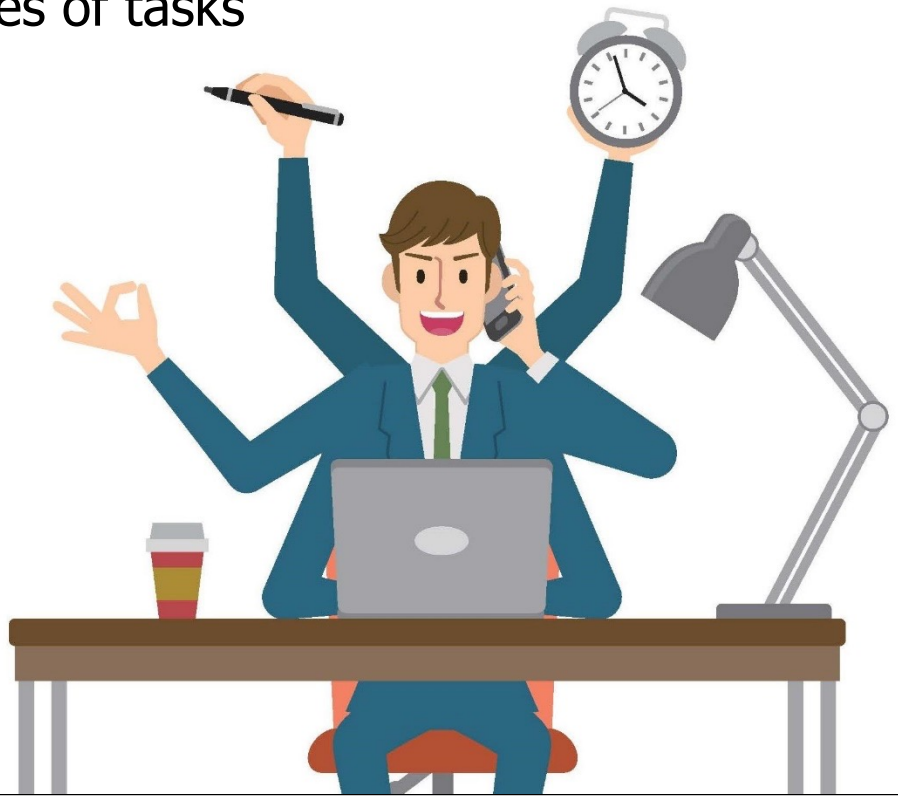
Java Platform Threads vs. Virtual Threads

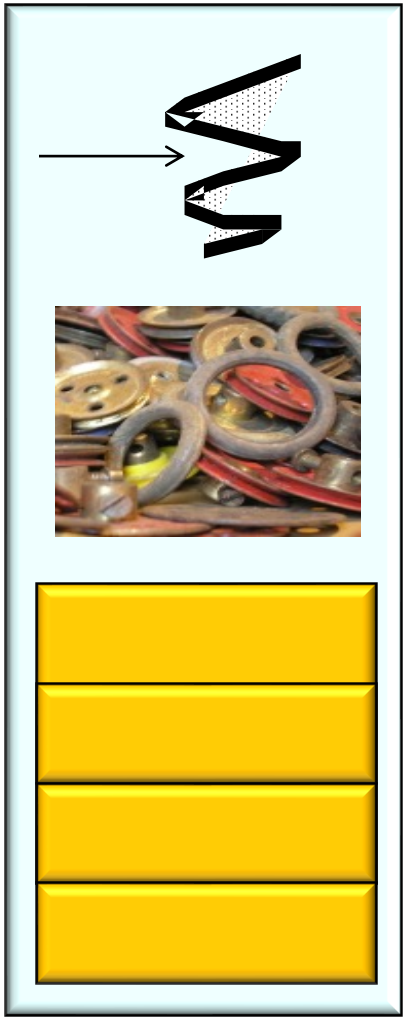
- Each Java platform thread is associated 1-to-1 with an OS kernel thread
  - It contains the same unique "state" as a traditional Java Thread object



Java Platform Threads vs. Virtual Threads

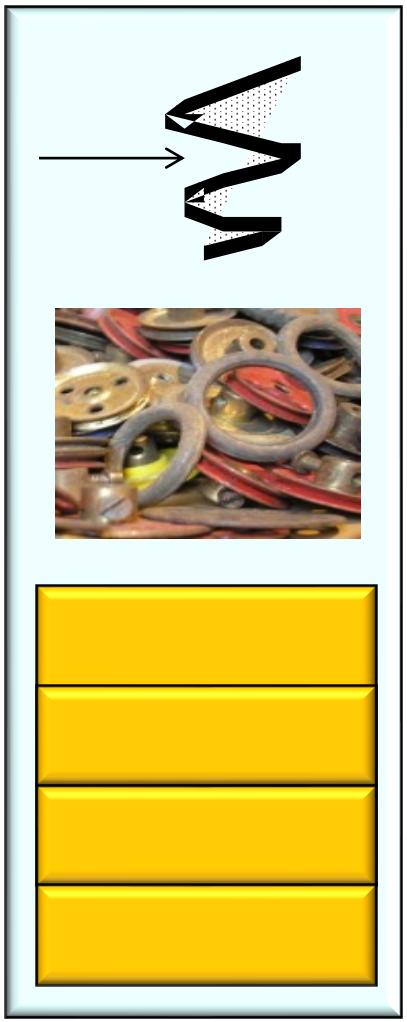
- Each Java platform thread is associated 1-to-1 with an OS kernel thread
  - It contains the same unique "state" as a traditional Java Thread object
  - Platforms threads are suitable for executing all types of tasks





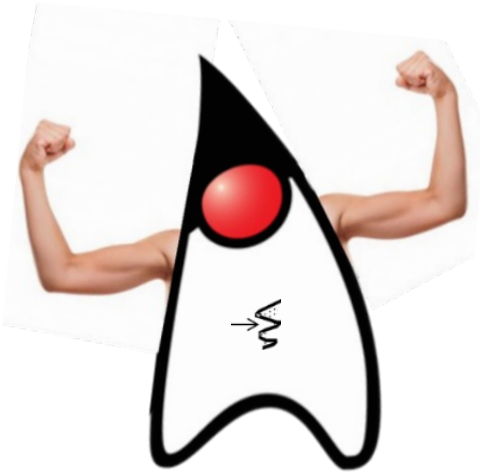
Java Platform Threads vs. Virtual Threads

- Each Java platform thread is associated 1-to-1 with an OS kernel thread
  - It contains the same unique "state" as a traditional Java Thread object
  - Platforms threads are suitable for executing all types of tasks
    - However, they are a limited resource due to their non-trivial runtime stack size

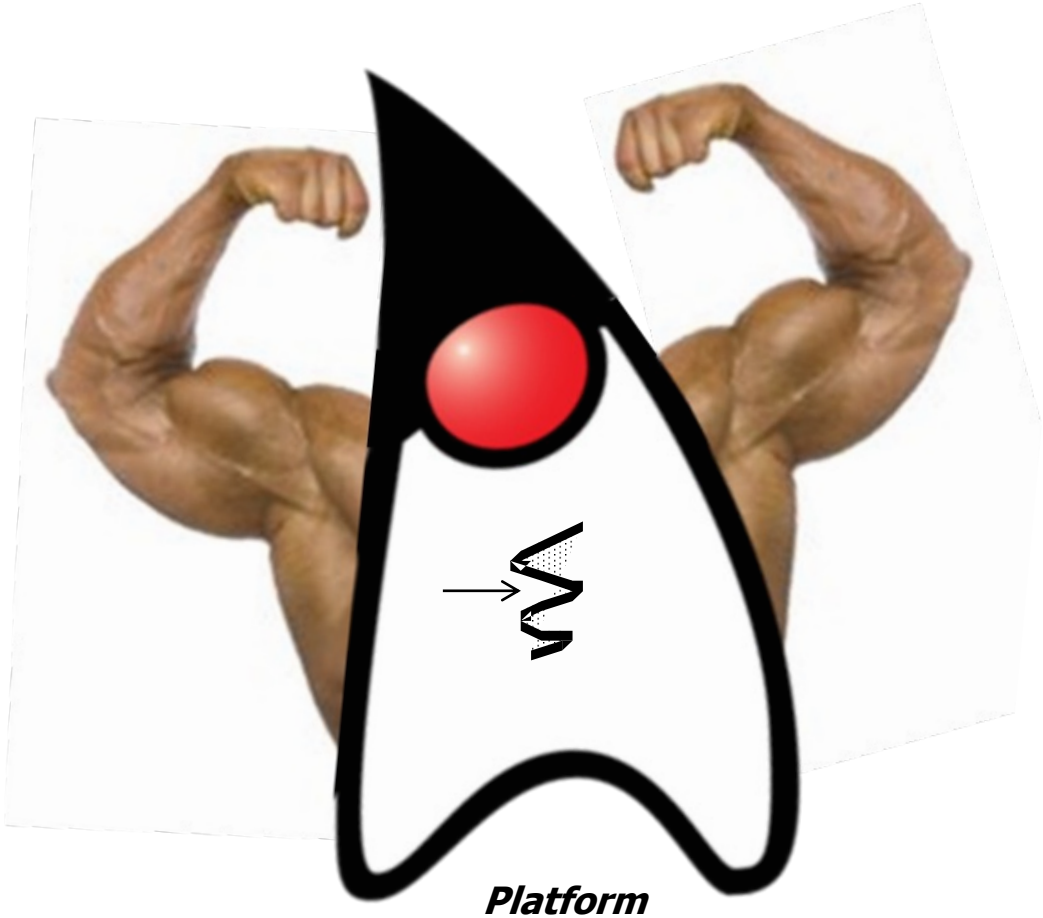


Java Platform Threads vs. Virtual Threads

- In contrast, each Java virtual thread is a "lightweight" concurrency object



Virtual Thread

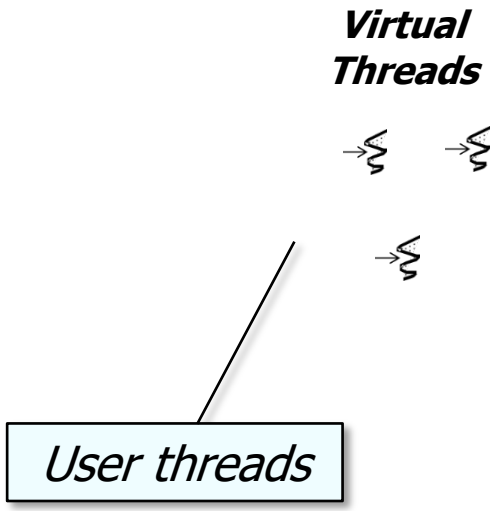


Platform Thread

See www.infoq.com/articles/java-virtual-threads

Java Platform Threads vs. Virtual Threads

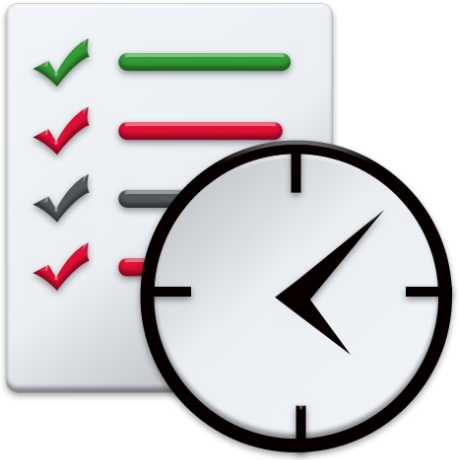
- In contrast, each Java virtual thread is a "lightweight" concurrency object
  - It is a user thread rather than a kernel thread



See en.wikipedia.org/wiki/Thread_(computing)#User_threads

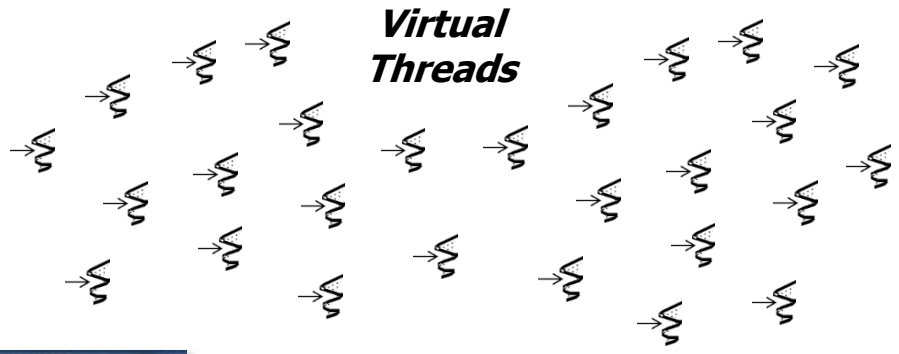
Java Platform Threads vs. Virtual Threads

- In contrast, each Java virtual thread is a "lightweight" concurrency object
  - It is a user thread rather than a kernel thread
    - It is scheduled by the Java execution environment rather than the underlying OS



Java Platform Threads vs. Virtual Threads

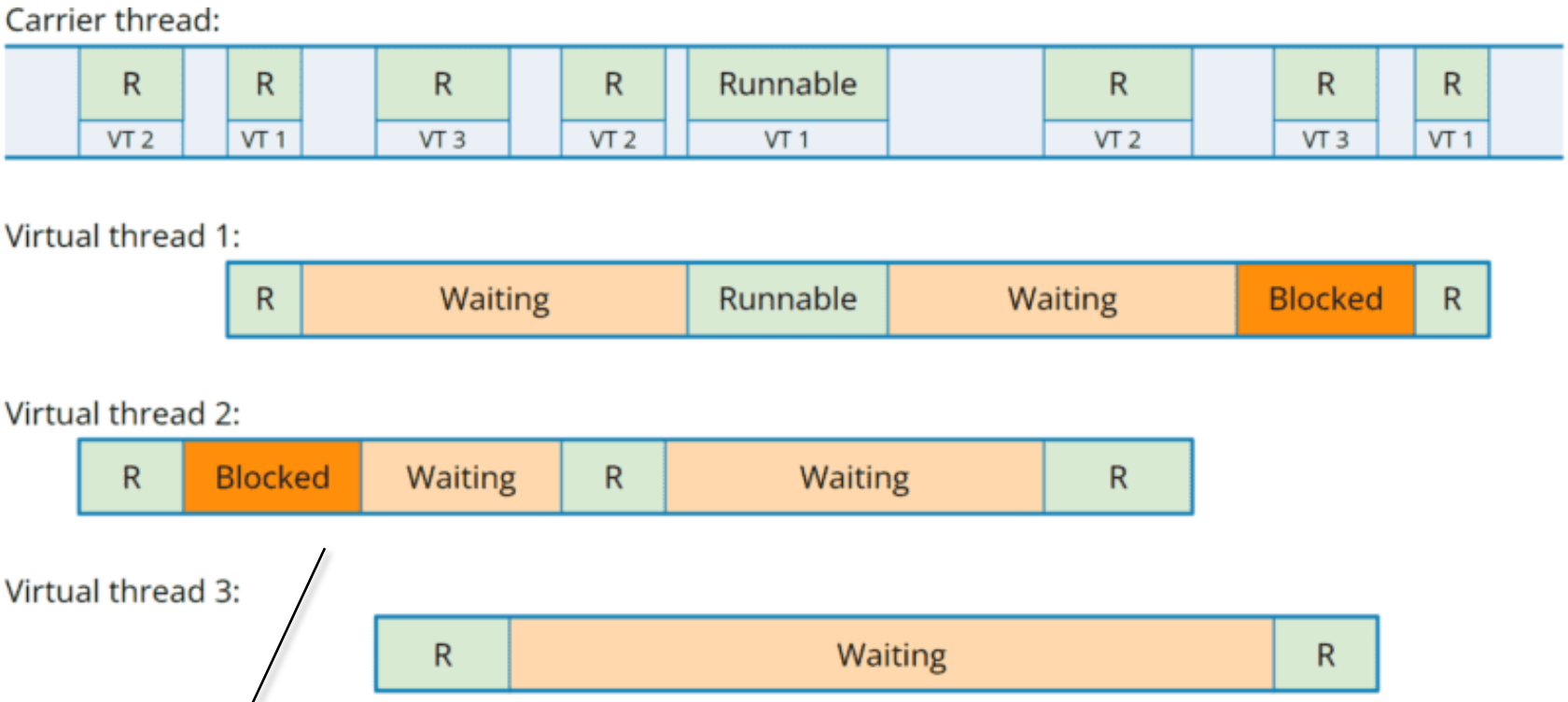
- In contrast, each Java virtual thread is a "lightweight" concurrency object
  - It is a user thread rather than a kernel thread
    - It is scheduled by the Java execution environment rather than the underlying OS
    - A very large # of virtual threads can therefore be created



See www.youtube.com/watch?v=Ul50FFmOzU4

Java Platform Threads vs. Virtual Threads

- In contrast, each Java virtual thread is a "lightweight" concurrency object
  - It is a user thread rather than a kernel thread
  - Virtual threads are multiplexed atop a pool of "carrier" threads

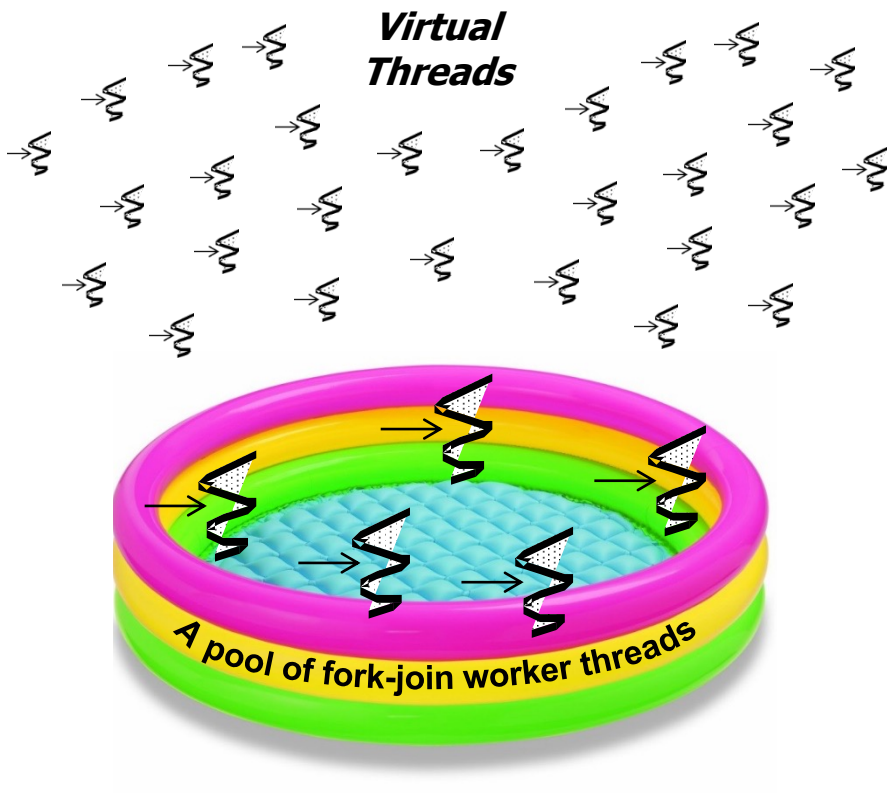


Blocking operations no longer block the executing thread, which enables the processing of a large # of requests in parallel with a small pool of carrier threads

See www.happycoders.eu/java/virtual-threads

Java Platform Threads vs. Virtual Threads

- In contrast, each Java virtual thread is a "lightweight" concurrency object
  - It is a user thread rather than a kernel thread
  - Virtual threads are multiplexed atop a pool of "carrier" threads
    - The Java fork-join framework is currently used to implement the "carrier" threads



See theboreddev.com/understanding-java-virtual-threads

End of Java Platform Threads vs. Virtual Threads (Part 1)