PROJECT LOOM / VTHREADS

EXPLORING CONCURRENCY IN JAVA 21

CHALLENGES

- Blocking operations e.g. http connections
- Web Servers / thread-per-request model / throughput not speed
- Synchronous I/O anti-pattern
    - Blocking the calling thread while I/O completes
    - Can reduce performance and affect vertical scalability

CONCURRENCY IS HARD

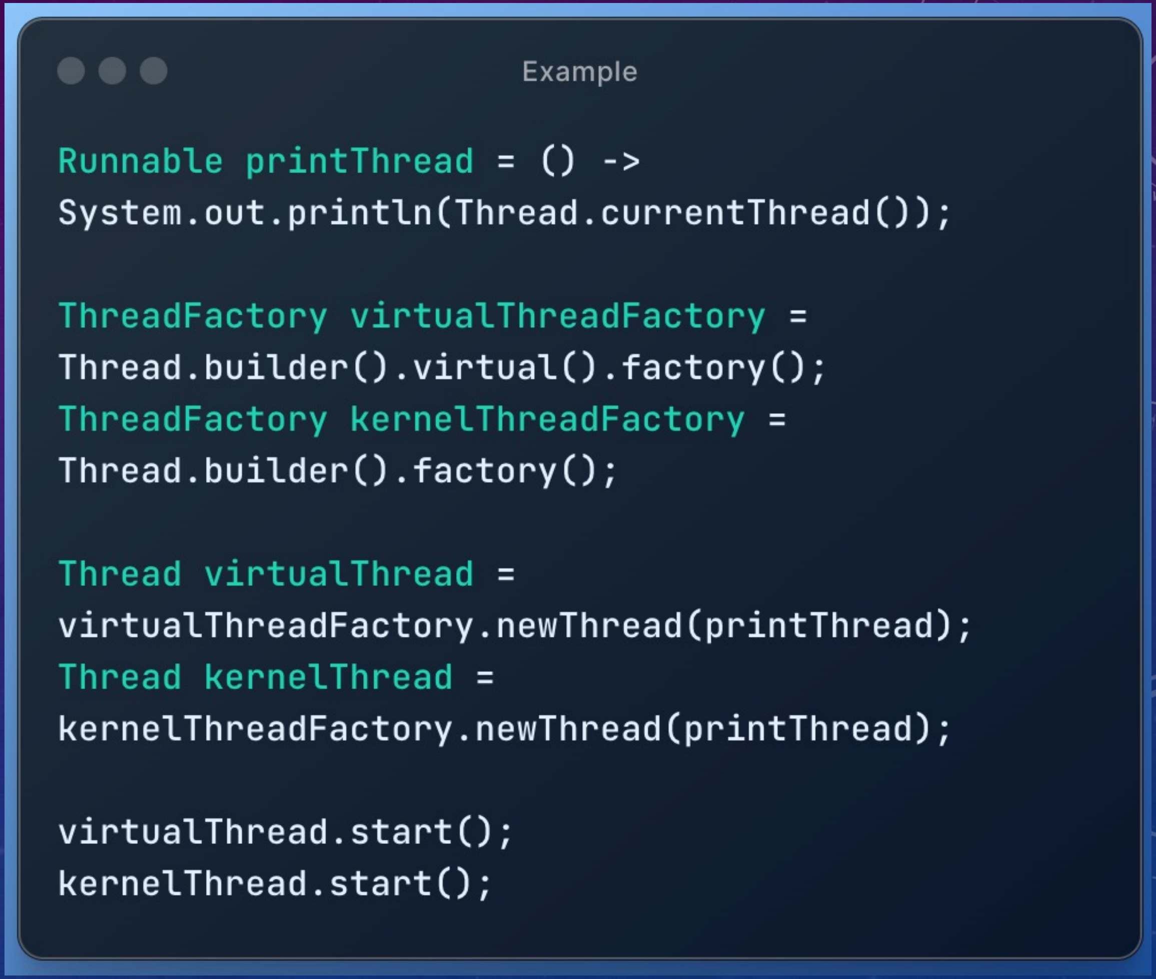
- Expensive
- Thread pools
- Memory errors
- Sharing resources (Atomic)
- Blocking operations
- Semaphores / Mutex / Locks
- Hard to maintain
- Error handling

WHAT ARE THE ALTERNATIVES?

- Async – The JS Model.. Completable Futures
- Reactive Programming?? WebClient / Flux / Mono
- Give up

PROJECT LOOM

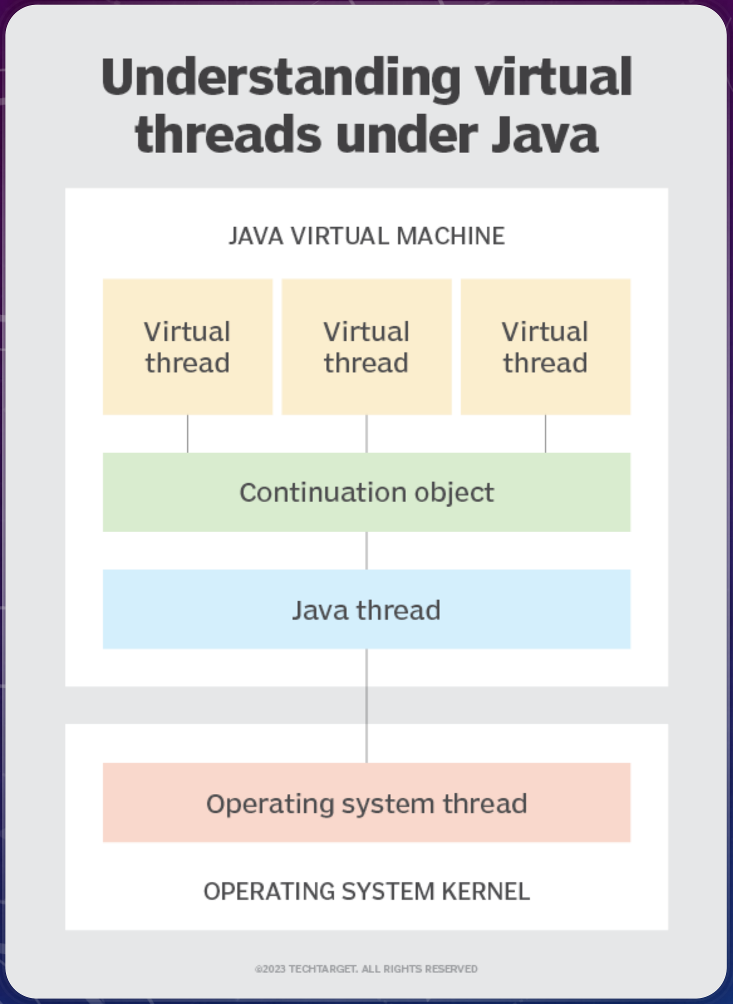
- Incubating since Java 19
- Released in Java 21 (JEP: 444)
- Same API / existing code



```
Runnable printThread = () ->
System.out.println(Thread.currentThread());

ThreadFactory virtualThreadFactory =
Thread.builder().virtual().factory();
ThreadFactory kernelThreadFactory =
Thread.builder().factory();

Thread virtualThread =
virtualThreadFactory.newThread(printThread);
Thread kernelThread =
kernelThreadFactory.newThread(printThread);

virtualThread.start();
kernelThread.start();
```

DEMO

ARCHITECTURE

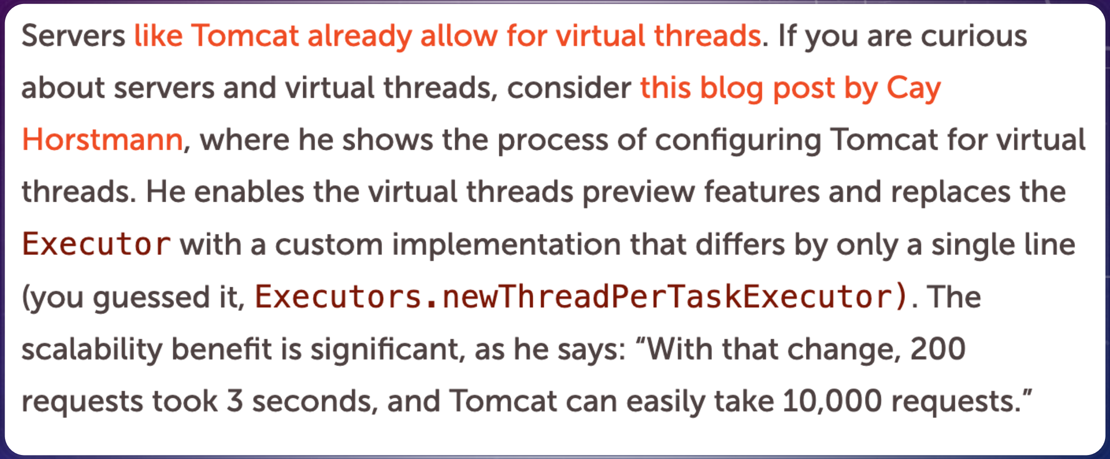


https://www.theserverside.com/tip/A-primer-on-Java-21-virtual-threads-with-examples

- Platform threads vs virtual threads
- Continuation object
  - https://commons.apache.org/sandbox/commons-javaflow/apidocs/index.html
- Better utilization of resources
  - Unmount and remount as needed

EXISTING SUPPORT

- VirtualThreadExecutor is now available with Tomcat 10.1.10.
- Spring Boot 3.2 support - significant scalability improvements
  - I recommend checking out Dan Vega's video or blog post
  - https://youtu.be/THavIYnlwck?si=z2Sp-OAW-yRCc2id
  - https://www.danvega.dev/blog/virtual-threads-spring-boot
- Test frameworks
  - Browser / API / Performance / Load



Servers like Tomcat already allow for virtual threads. If you are curious about servers and virtual threads, consider this blog post by Cay Horstmann, where he shows the process of configuring Tomcat for virtual threads. He enables the virtual threads preview features and replaces the `Executor` with a custom implementation that differs by only a single line (you guessed it, `Executors.newThreadPerTaskExecutor)`. The scalability benefit is significant, as he says: "With that change, 200 requests took 3 seconds, and Tomcat can easily take 10,000 requests."

InfoWorld

WHAT NEXT?

JEP 428: Structured Concurrency (Incubating)

- Simplify multithreaded programming by introducing an API for structured concurrency
- Treats multiple tasks running in different threads as a single unit of work
- Will streamline error handling and cancellation
- Improved reliability and enhanced observability

https://openjdk.org/jeps/428

BONUS DEMO

REFERENCES

InfoWorld – Intro to Virtual Threads
https://www.infoworld.com/article/3678148/intro-to-virtual-threads-a-new-approach-to-java-concurrency.html

Microsoft - Synchronous I/O antipattern

https://learn.microsoft.com/en-us/azure/architecture/antipatterns/synchronous-io/

TheServerSide – Virtual Threads Primer

https://www.theserverside.com/tip/A-primer-on-Java-21-virtual-threads-with-examples

Baeldung – Virtual Threads vs Platform Threads

https://www.baeldung.com/java-virtual-thread-vs-thread

Aseem Savio – Thread-per-Request model

https://blog.aseemsavio.com/is-the-thread-per-request-model-a-good-thing-after-project-loom/

Aseem Savio – 5 million virtual threads

https://blog.aseemsavio.com/how-i-spun-up-5-million-virtual-threads-without-stalling-the-jvm/