Spring Boot gibt Gas

Virtual Threads

Motivation

- Traditional model: One thread per request → simple but resource-heavy
- Limitation of platform threads: high memory & CPU cost, expensive to create
- Scalability follows Little’s Law: throughput = concurrency / latency
- Reactive Programming: scales well but is harder to read, debug, and profile
- Virtual threads: Lightweight, efficient, massively scalable

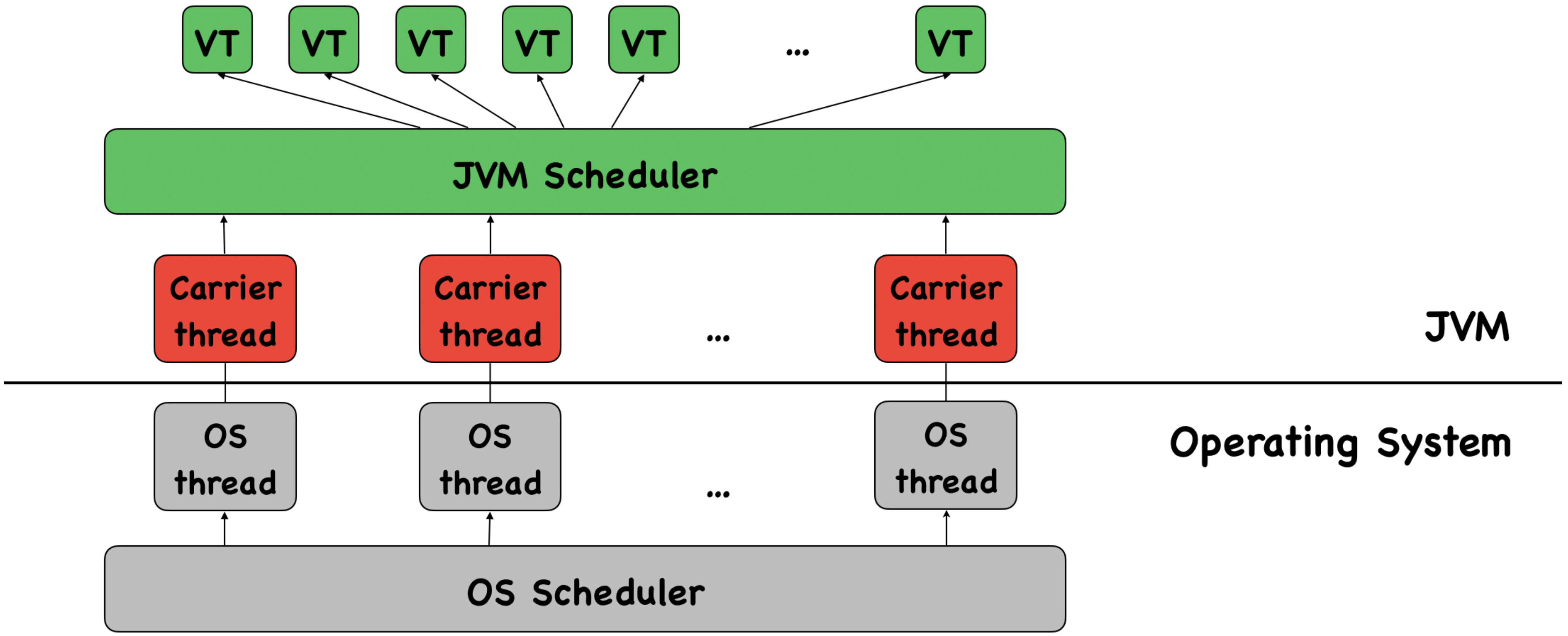
Java

- Project Loom: introduce a lightweight concurrency construct to Java
- September '22: Virtual threads introduced as a preview feature (JDK 19, JEP 425)
- September '23: Virtual threads became stable (JDK 21, JEP 444)
- Scoped Values (JEP 446): efficient alternative to ThreadLocal for passing contextual data across threads

Spring Boot

- October '22: experimental support for virtual threads
- November '23: full support for virtual threads with release 3.2.0
- Easy to use by enabling the flag spring.threads.virtual.enabled
  - Tomcat and Jetty use virtual threads for request handling

Architecture



Advantages

- Ideal for I/O-bound workloads: ideal for high-throughput, I/O-heavy workloads
- Lightweight & Scalable: millions of threads with minimal memory overhead
- Simplified Concurrency Model: maintains the familiar thread-per-request model
- Better Debugging & Profiling: works with JFR, JStack, and existing tools.
- Compatibility: works with existing java.lang.ThreadAPI
- Improved Context Propagation: Scoped Values replace ThreadLocal

Disadvantages

- Not for CPU-bound Tasks: no speedup for compute-heavy workloads
- Scheduler Overhead: JVM mapping adds some cost
- Synchronization Challenges: lock contention can hurt performance
- Not a Replacement for Reactive Programming
- Requires JDK 21+ / Spring Boot 3.2.0+

Examples and Benchmark

- Show in IDE

Comparison

	Platform Threads	Virtual Threads
Implementation	Managed by the OS	Managed by the JVM (userland)
Pooling	Threads should be pooled	No pooling, new thread per task
Lifetime	Long-lived, reused	Short-lived, created per task
Usage	Multiple tasks per thread	One task per virtual thread
Thread Cost	Heavyweight (more RAM, CPU …)	Lightweight (very low overhead)
Blocking I/O	Blocks the OS thread	Parks the virtual thread
Scalability	Limited by OS resources	Millions of concurrent threads