Mapping Java Reactive Streams Onto Reactive Programming Principles

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Learning Objectives in this Part of the Lesson

• Understand the key benefits & principles underlying the reactive programming paradigm
• Know the Java reactive streams API & popular implementations of this API
• Learn how Java reactive streams maps to key reactive programming principles
Mapping Reactive Streams to Reactive Programming Principles
Mapping Reactive Streams to Reactive Programming Principles

- Mapping reactive programming principles onto reactive streams features

See www.baeldung.com/rx-java, projectreactor.io, & www.reactivemanifesto.org
Mapping Reactive Streams to Reactive Programming Principles

• Mapping reactive programming principles onto reactive streams features, e.g.
  • Responsive

See en.wikipedia.org/wiki/Responsiveness
Mapping Reactive Streams to Reactive Programming Principles

- Mapping reactive programming principles onto reactive streams features, e.g.

- **Responsive**
  - Avoid blocking caller code
  - Blocking underutilizes cores, impedes inherent parallelism, & complicates program structure

See [www.nastel.com/10-reasons-your-java-apps-are-slow](http://www.nastel.com/10-reasons-your-java-apps-are-slow)
Mapping Reactive Streams to Reactive Programming Principles

- Mapping reactive programming principles onto reactive streams features, e.g.
  - **Responsive**
    - Avoid blocking caller code
    - Blocking underutilizes cores, impedes inherent parallelism, & complicates program structure

Operators like `subscribeOn()`, `publishOn()`, & `observeOn()` can be used to avoid blocking caller code

See [spring.io/blog/2019/12/13/flight-of-the-flux-3-hopping-threads-and-schedulers](https://spring.io/blog/2019/12/13/flight-of-the-flux-3-hopping-threads-and-schedulers)
Mapping Reactive Streams to Reactive Programming Principles

- Mapping reactive programming principles onto reactive streams features, e.g.
  - **Responsive**
    - Avoid blocking caller code
    - Avoid changing threads
    - Incurs excessive overhead wrt synchronization, context switching, & memory/cache management

See [gee.cs.oswego.edu/dl/papers/fj.pdf](gee.cs.oswego.edu/dl/papers/fj.pdf)
Mapping Reactive Streams to Reactive Programming Principles

- Mapping reactive programming principles onto reactive streams features, e.g.
  - **Responsive**
    - Avoid blocking caller code
    - Avoid changing threads
      - Incurs excessive overhead wrt synchronization, context switching, & memory/cache management

Operators like `subscribeOn()`, `publishOn()`, & `observeOn()` provide fine-grained control over mapping events to threads

Mapping Reactive Streams to Reactive Programming Principles

- Mapping reactive programming principles onto reactive streams features, e.g.
  - Resilient

See en.wikipedia.org/wiki/Resilience_(network)
Mapping Reactive Streams to Reactive Programming Principles

- Mapping reactive programming principles onto reactive streams features, e.g.
  - **Resilient**
    - Exception methods make more programs resilient to failures

Exception handling operators decouple error processing from normal operations

Reactive streams are localized to a single process, *not* a cluster!
Mapping Reactive Streams to Reactive Programming Principles

• Mapping reactive programming principles onto reactive streams features, e.g.
  • Elastic

See en.wikipedia.org/wiki/Autoscaling
Mapping Reactive Streams to Reactive Programming Principles

- Mapping reactive programming principles onto reactive streams features, e.g.
  - **Elastic**
    - Async computations can run scalably in a pool of threads atop a set of cores

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schedulers.computation()</td>
<td>Schedules computation bound work (ScheduledExecutorService with pool size = NCPU, LRU worker select strategy)</td>
</tr>
<tr>
<td>Schedulers.immediate()</td>
<td>Schedules work on current thread</td>
</tr>
<tr>
<td>Schedulers.io()</td>
<td>I/O bound work (ScheduledExecutorService with growing thread pool)</td>
</tr>
<tr>
<td>Schedulers.trampoline()</td>
<td>Queues work on the current thread</td>
</tr>
<tr>
<td>Schedulers.newThread()</td>
<td>Creates new thread for every unit of work</td>
</tr>
<tr>
<td>Schedulers.test()</td>
<td>Schedules work on scheduler supporting virtual time</td>
</tr>
<tr>
<td>Schedulers.from(Executor e)</td>
<td>Schedules work to be executed on provided executor</td>
</tr>
</tbody>
</table>

RxJava schedulers support many types of threads and/or thread pools

See [www.baeldung.com/rxjava-schedulers](http://www.baeldung.com/rxjava-schedulers)
Mapping Reactive Streams to Reactive Programming Principles

- Mapping reactive programming principles onto reactive streams features, e.g.
  - **Elastic**
    - Async computations can run scalably in a pool of threads atop a set of cores
  
  Reactor, like RxJava, can be considered to be *concurrency-agnostic*. That is, it does not enforce a concurrency model. Rather, it leaves you, the developer, in control. However, that does not prevent the library from helping you with concurrency.

  Obtaining a Flux or a Mono does not necessarily mean that it runs in a dedicated Thread. Instead, most operators continue working in the Thread on which the previous operator executed. Unless specified, the topmost operator (the source) itself runs on the Thread in which the subscribe() call was made.

  The following example runs a Mono in a new thread:

  ```java
  public static void main(String[] args) throws InterruptedException {
    final Mono<String> mono = Mono.just("hello");

    Thread t = new Thread(() -> mono
          .map(msg -> msg + " thread ")
          .subscribe(System.out::println, v -> System.out.println(v + Thread.currentThread().getName()));

    t.start();
    t.join();
  }
  ```

  Project Reactor’s schedulers also support threads and/or thread pools

  See [projectreactor.io/docs/core/release/reference/#schedulers](http://projectreactor.io/docs/core/release/reference/#schedulers)
Mapping Reactive Streams to Reactive Programming Principles

- Mapping reactive programming principles onto reactive streams features, e.g.
  - **Message-driven**

See [en.wikipedia.org/wiki/Message-oriented_middleware](http://en.wikipedia.org/wiki/Message-oriented_middleware)
Mapping Reactive Streams to Reactive Programming Principles

- Mapping reactive programming principles onto reactive streams features, e.g.
  - **Message-driven**
    - Implementations of reactive streams & Java-based thread pools pass messages internally.
    - e.g., Java’s fork-join pool supports “work-stealing” between deques.

See [en.wikipedia.org/wiki/Work_stealing](en.wikipedia.org/wiki/Work_stealing)
End of Mapping Java Reactive Streams onto Reactive Programming Principles