Mapping Java Reactive Streams Onto Reactive Programming Principles

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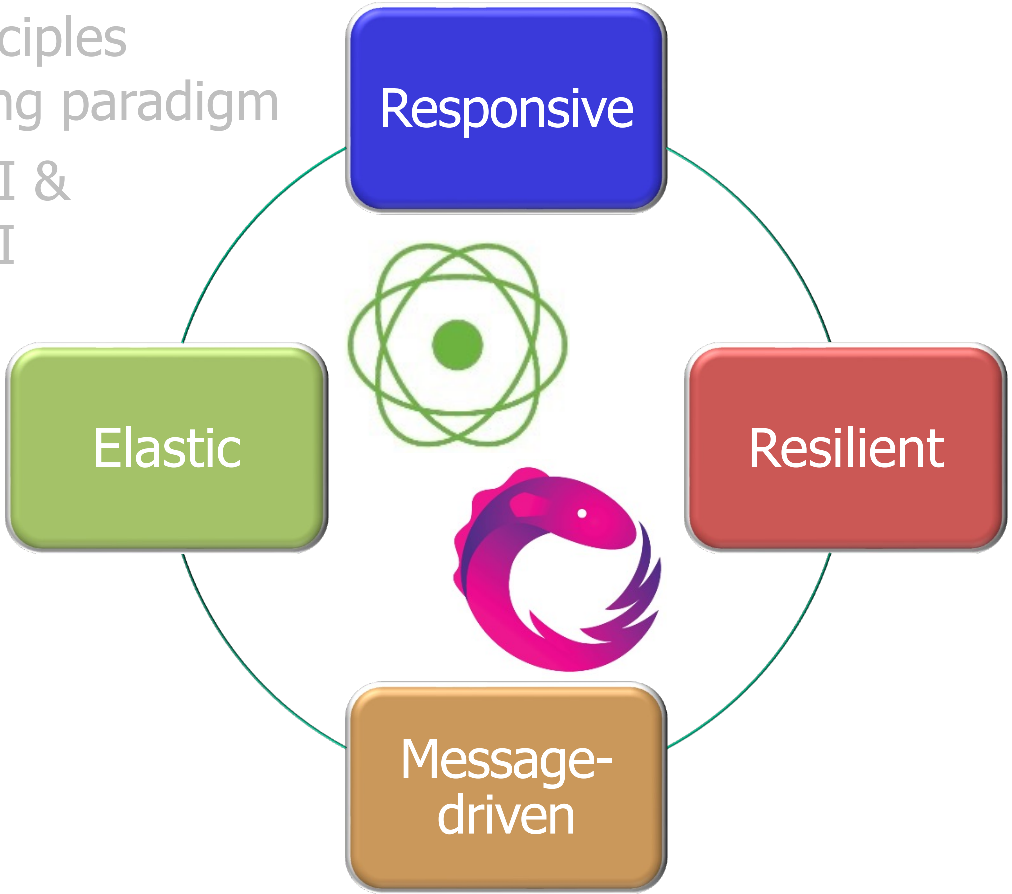
Learning Objectives in this Part of the Lesson

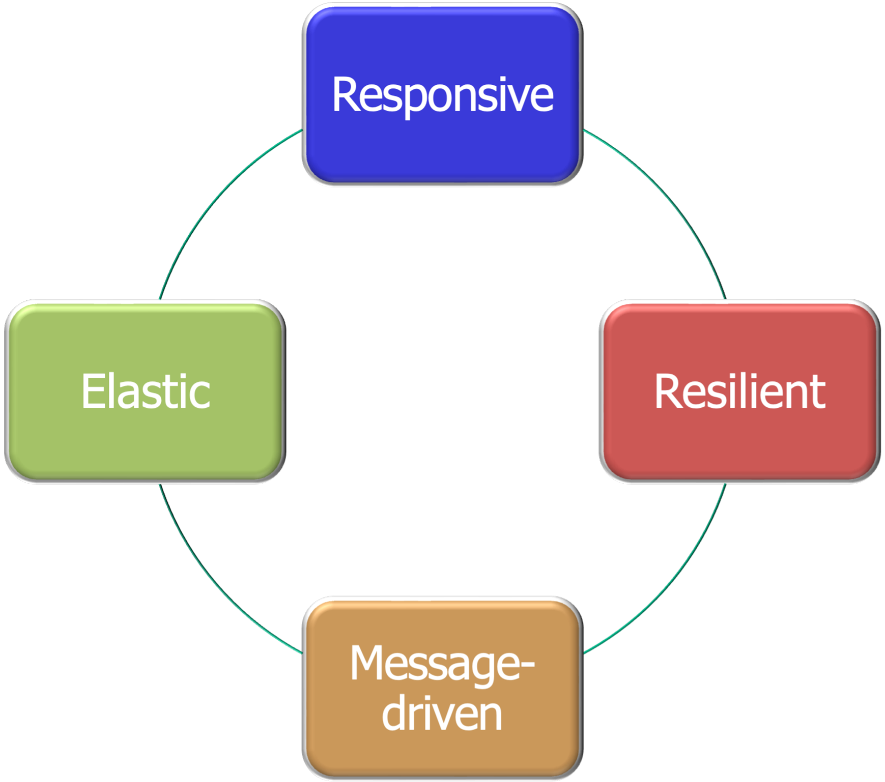
- Understand the key benefits & principles underlying the reactive programming paradigm
- Know the Java reactive streams API & popular implementations of this API
- Learn how Java reactive streams maps to key reactive programming principles



Mapping Reactive Streams to Reactive Programming Principles

Mapping Reactive Streams to Reactive Programming Principles

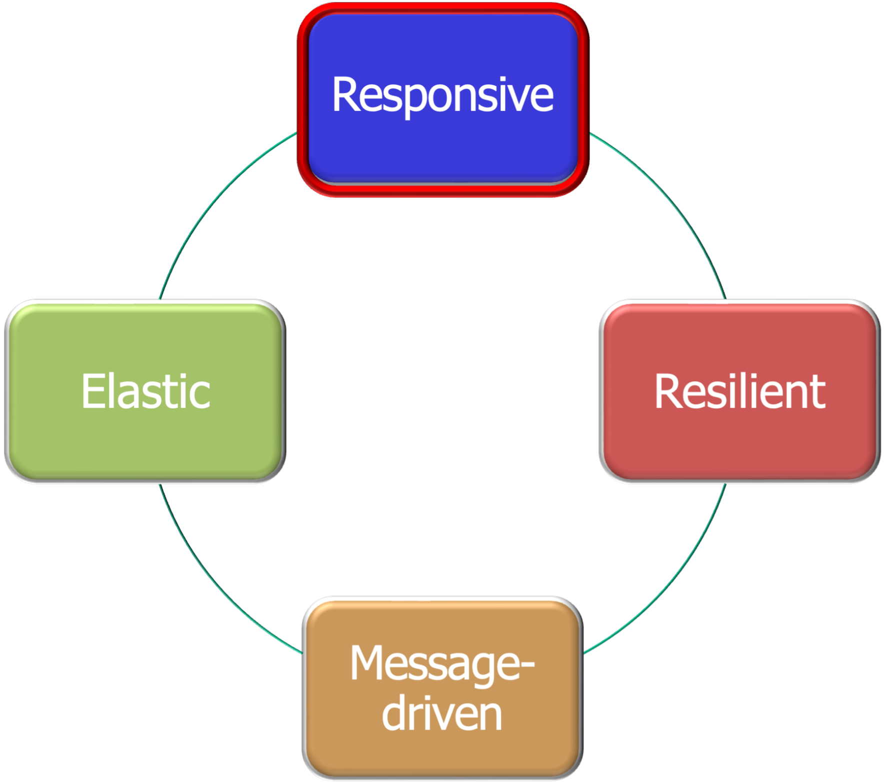
- Mapping reactive programming principles onto reactive streams features



See www.baeldung.com/rx-java, projectreactor.io, & www.reactivemanifesto.org

Mapping Reactive Streams to Reactive Programming Principles

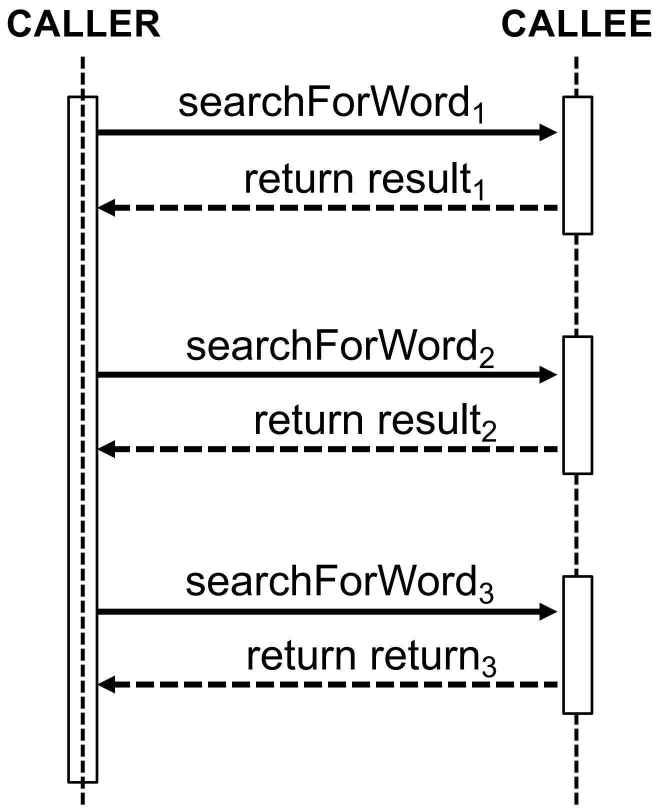
- Mapping reactive programming principles onto reactive streams features, e.g.
  - **Responsive**



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

Mapping Reactive Streams to Reactive Programming Principles

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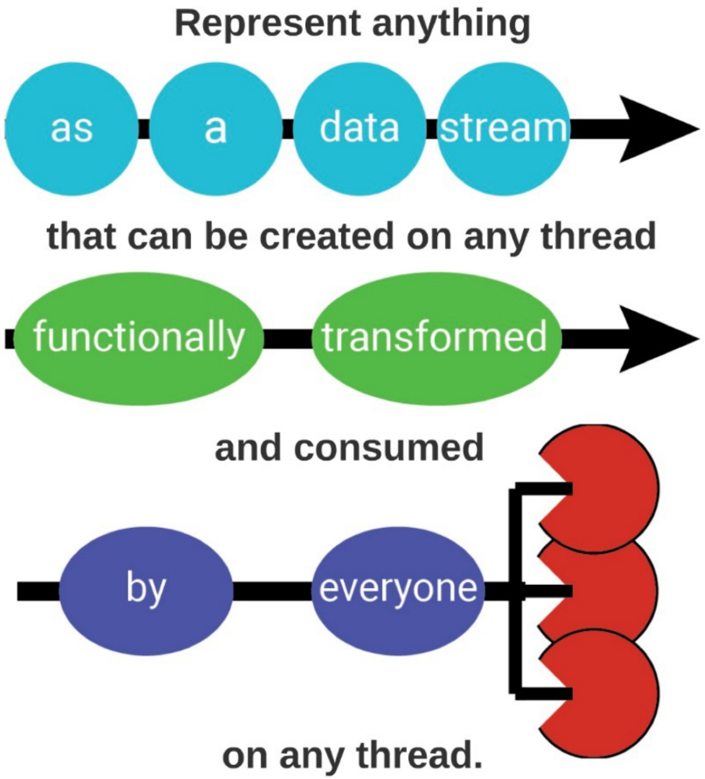

Operators like subscribeOn(), publishOn(), & observeOn() can be used to avoid blocking caller code

See spring.io/blog/2019/12/13/flight-of-the-flux-3-hopping-threads-and-schedulers

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

Mapping Reactive Streams to Reactive Programming Principles

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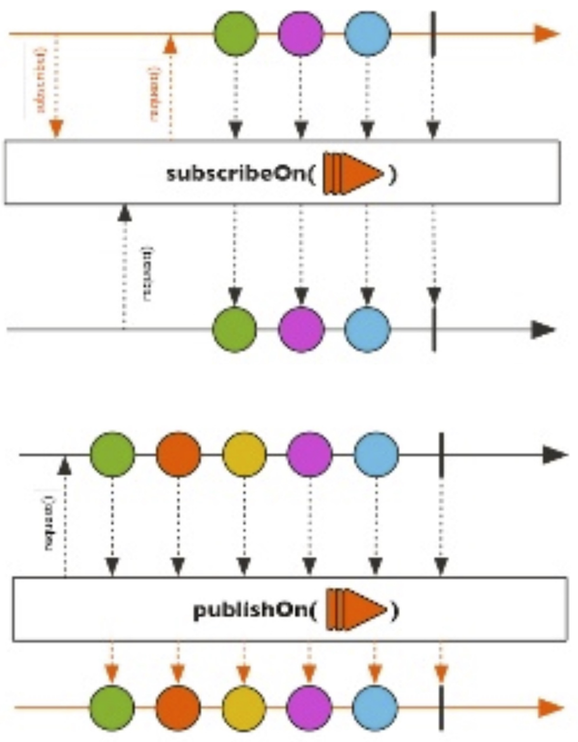
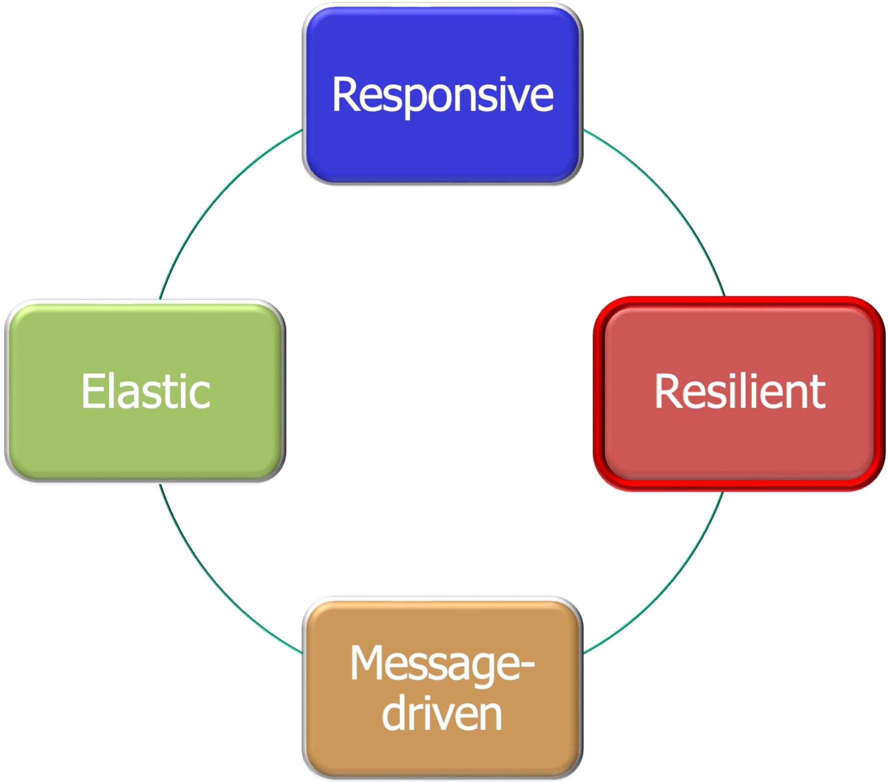


Operators like subscribeOn(), publishOn(), & observeOn() provide fine-grained control over mapping events to threads

See zoltanaltfatter.com/2018/08/26/subscribeOn-publishOn-in-Reactor

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

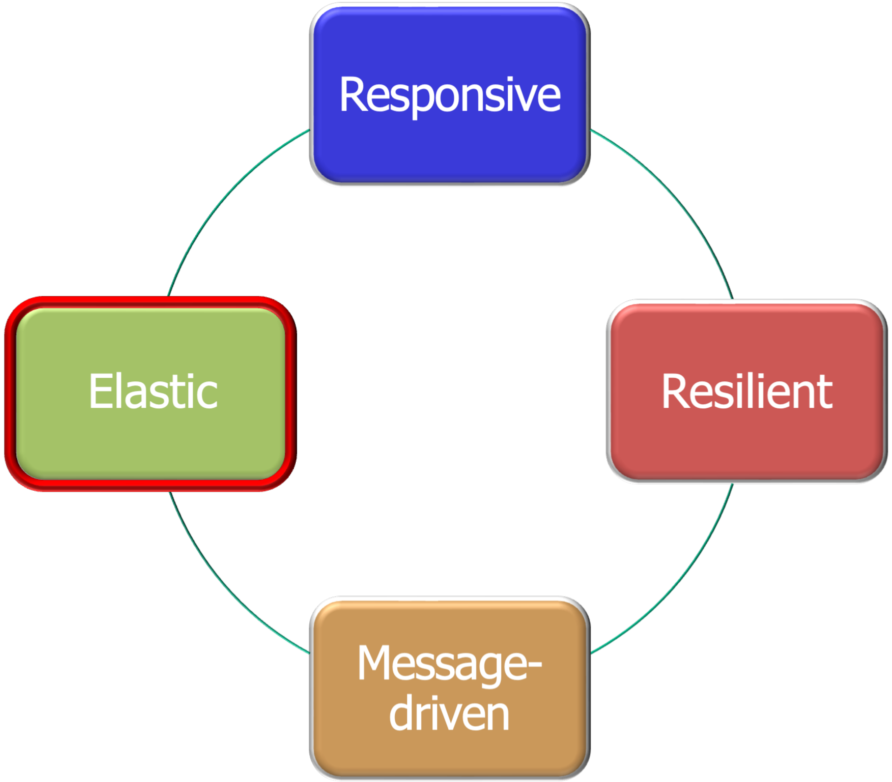
- Mapping reactive programming principles onto reactive streams features, e.g.
  - **Resilient**
    - Exception methods make more programs resilient to failures

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

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

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

See 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 command. 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:

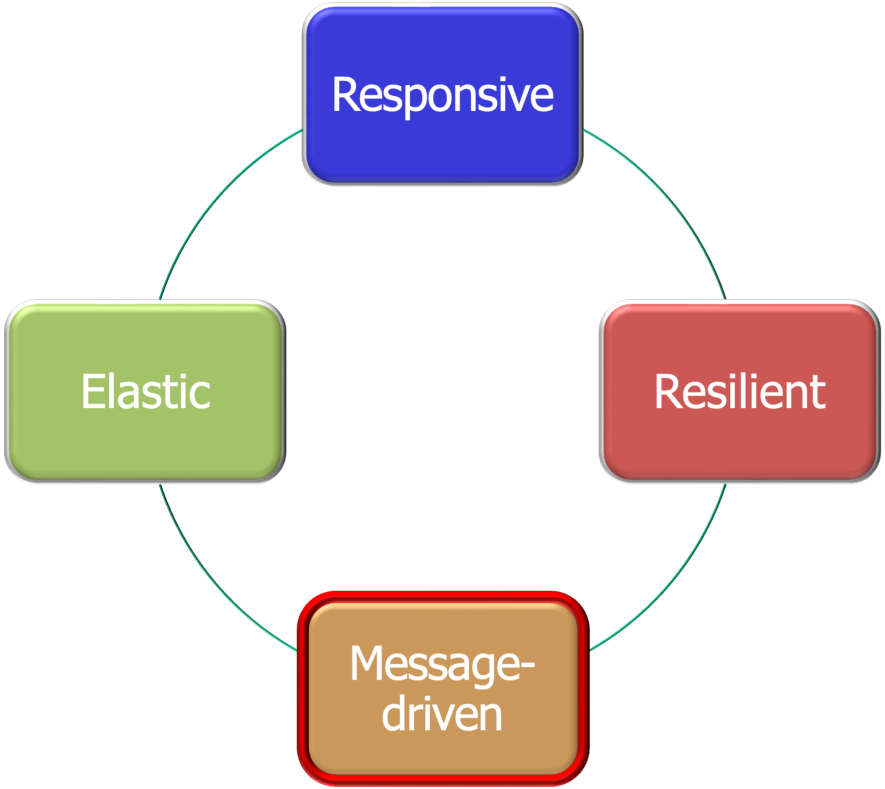
```
public static void main(String[] args) throws InterruptedException {
  final Mono<String> mono = Mono.just("hello "); 1

  Thread t = new Thread(() -> mono
      .map(msg -> msg + "thread ")
      .subscribe(v -> 2
          System.out.println(v + Thread.currentThread().getName()) 3
      )
  )
  t.start();
  t.join();

}
```

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

See projectreactor.io/docs/core/release/reference/#schedulers

Mapping Reactive Streams to Reactive Programming Principles

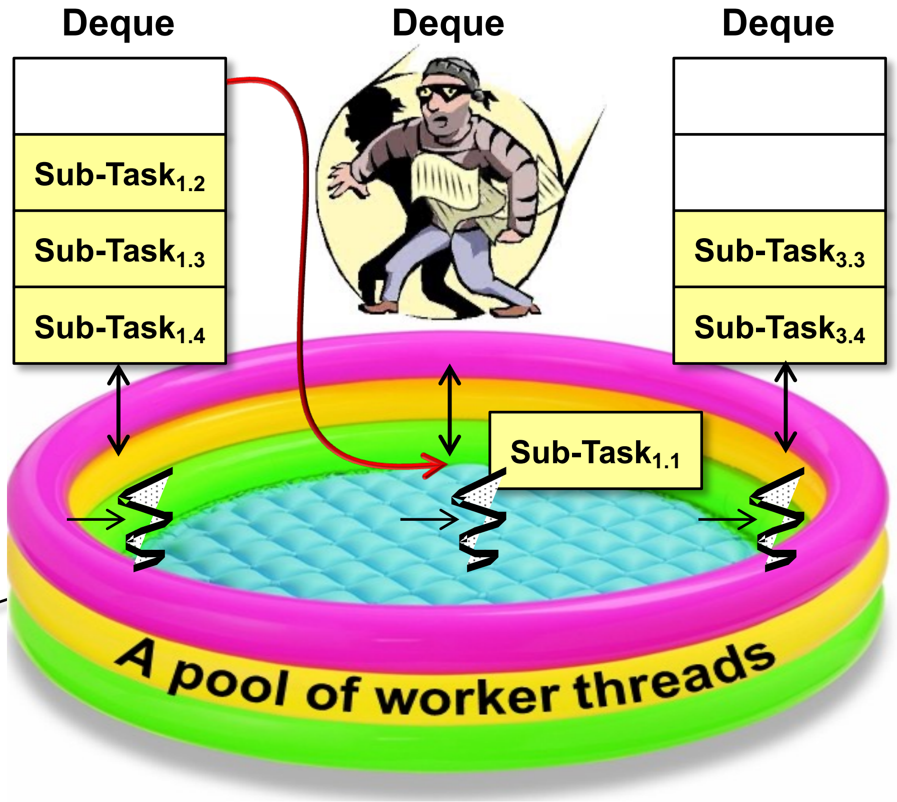
- Mapping reactive programming principles onto reactive streams features, e.g.
  - **Message-driven**



See en.wikipedia.org/wiki/Message-oriented_middleware

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

End of Mapping Java Reactive Streams onto Reactive Programming Principles