Key Concurrency & Scheduler Operators for the Observable Class (Part 1)

Douglas C. Schmidt

d.schmidt@vanderbilt.edu

www.dre.vanderbilt.edu/~schmidt

Professor of Computer Science

Institute for Software Integrated Systems

Vanderbilt University

Nashville, Tennessee, USA

Learning Objectives in this Part of the Lesson

- Recognize key Observable operators
  - Concurrency & scheduler operators
    - These operators arrange to run other operators in designated threads & thread pools
      - e.g., subscribeOn(), observeOn(), & Schedulers.newThread()

Key Concurrency Operators in the Observable Class

Key Concurrency Operators in the Observable Class

- The subscribeOn() operator
  - Run the subscribe(), request(), & onSubscribe() methods on the specified Scheduler worker

```
Observable<T>
subscribeOn(Scheduler scheduler)
```

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/core/Observable.html#subscribeOn

Key Concurrency Operators in the Observable Class

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  - Run the subscribe(), request(), & onSubscribe() methods on the specified Scheduler worker
    - The scheduler param indicates what thread to perform the operation on

```
Observable<T>
subscribeOn(Scheduler scheduler)
```

Class Scheduler

java.lang.Object
io.reactivex.rxjava3.core.Scheduler

Direct Known Subclasses:
TestScheduler

```
public abstract class Scheduler
extends Object
```

A `Scheduler` is an object that specifies an API for scheduling units of work provided in the form of `Runnables` to be executed without delay (effectively as soon as possible), after a specified time delay or periodically and represents an abstraction over an asynchronous boundary that ensures these units of work get executed by some underlying task-execution scheme (such as custom Threads, event loop, `Executor` or Actor system) with some uniform properties and guarantees regardless of the particular underlying scheme.

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/core/Scheduler.html

Key Concurrency Operators in the Observable Class

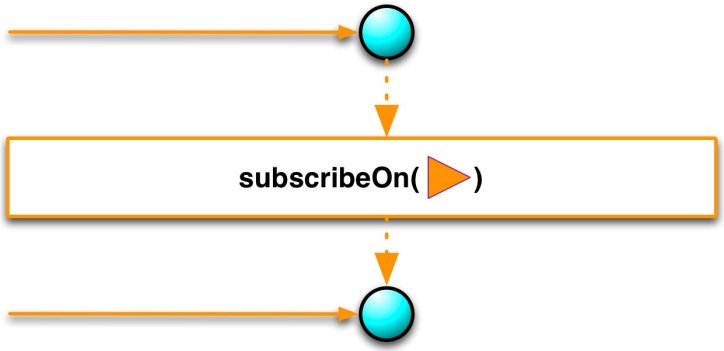
- The subscribeOn() operator
  - Run the subscribe(), request(), & onSubscribe() methods on the specified Scheduler worker
    - The scheduler param indicates what thread to perform the operation on
      - Scheduler is parameterized so that these mechanisms can also be reused in the Single class

```
Observable<T>
subscribeOn(Scheduler scheduler)
```

subscribeOn

```
@CheckReturnValue
 @NonNull
 @SchedulerSupport(value="custom")
public final @NonNull Single<T> subscribeOn(@NonNull Scheduler scheduler)
```

Asynchronously subscribes `SingleObservers` to this `Single` on the specified `Scheduler`.



Scheduler:
You specify which `Scheduler` this operator will use.

Parameters:
`scheduler` - the `Scheduler` to perform subscription actions on

Returns:
the new `Single` instance

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/core/Single.html

Key Concurrency Operators in the Observable Class

- The subscribeOn() operator
  - Run the subscribe(), request(), & onSubscribe() methods on the specified Scheduler worker
    - The scheduler param indicates what thread to perform the operation on
    - Returns the Observable requesting async processing

```
Observable<T>
subscribeOn(Scheduler scheduler)
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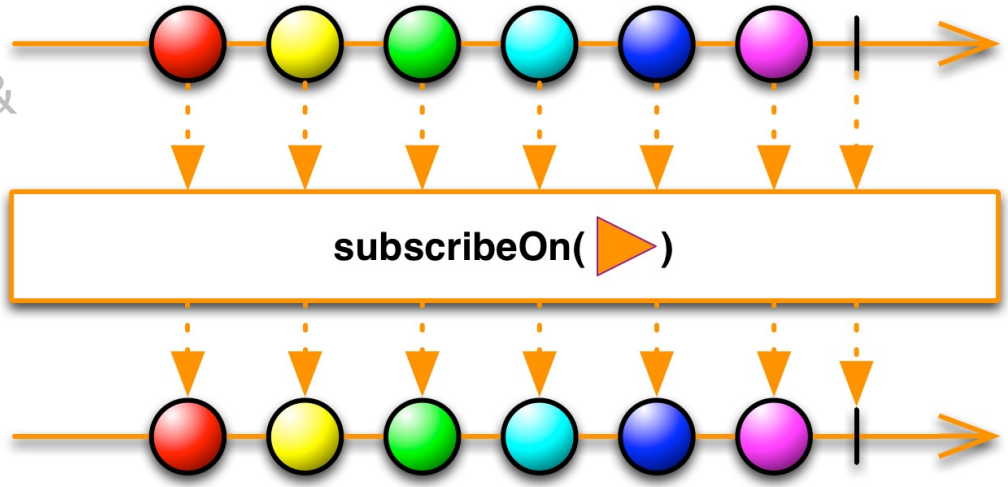
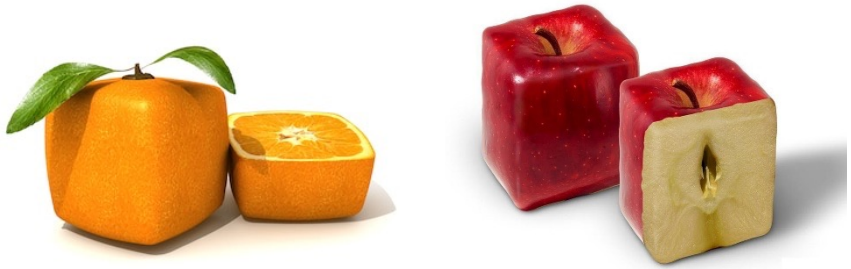
Key Concurrency Operators in the Observable Class

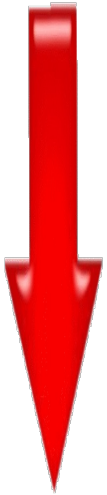
- The subscribeOn() operator
  - Run the subscribe(), request(), & onSubscribe() methods on the specified Scheduler worker
  - The subscribeOn() semantics are a bit unusual





Key Concurrency Operators in the Observable Class

- The subscribeOn() operator
  - Run the subscribe(), request(), & onSubscribe() methods on the specified Scheduler worker
  - The subscribeOn() semantics are a bit unusual
    - Placing this operator in a chain impacts the execution context of the onNext(), onError(), & onComplete() signals



```
Observable
   .range(1, sMAX_ITERATIONS)
   .subscribeOn(Schedulers
      .newThread())
   .map(__ -> BigInteger
     .valueOf(lowerBound + rand
       .nextInt(sMAX_ITERATIONS)))
   .doOnNext(s ->
        ObservableEx.print(s, sb))
   .subscribe(emitter::next,
              error ->
              emitter.complete(),
              emitter::complete);
```

See Reactive/Observable/ex2/src/main/java/ObservableEx.java

Key Concurrency Operators in the Observable Class

- The subscribeOn() operator
  - Run the subscribe(), request(), & onSubscribe() methods on the specified Scheduler worker
  - The subscribeOn() semantics are a bit unusual
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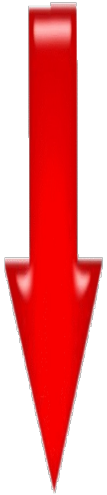

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        ObservableEx.print(s, sb))
   .subscribeOn(Schedulers
     .newThread())
   .subscribe(emitter::next,
              error ->
              emitter.complete(),
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```
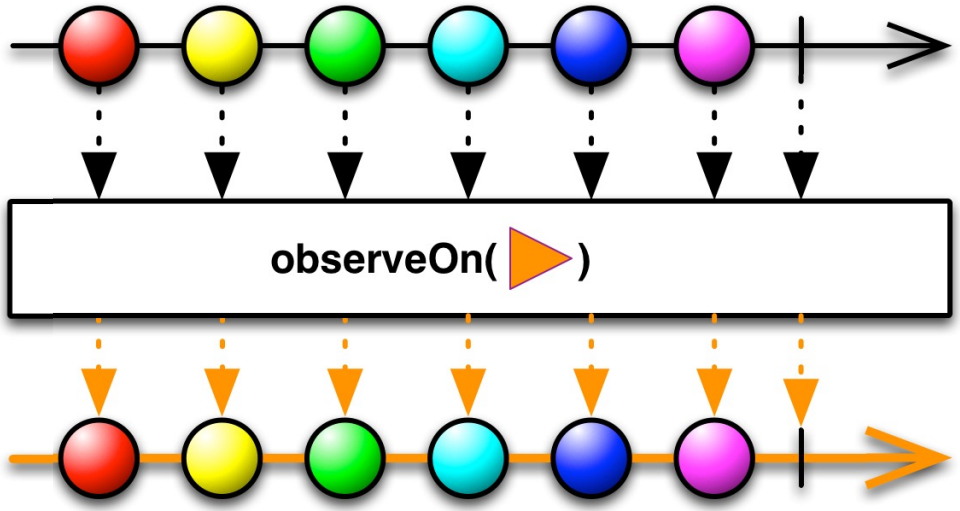

subscribeOn() can appear later in the chain & have the same effect

Key Concurrency Operators in the Observable Class

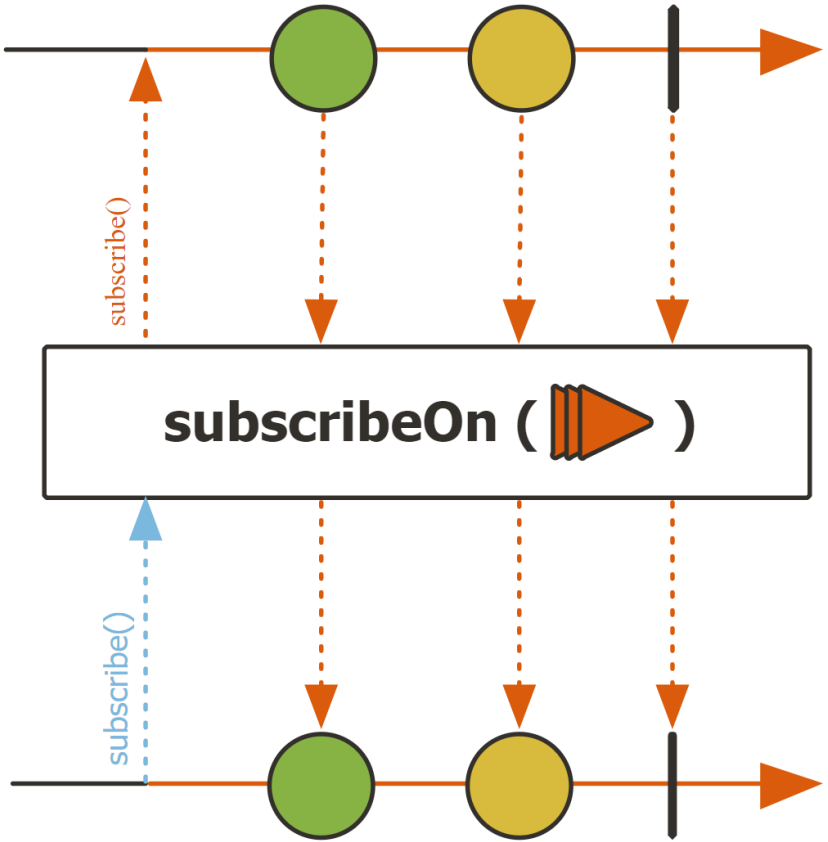
- The subscribeOn() operator
  - Run the subscribe(), request(), & onSubscribe() methods on the specified Scheduler worker
  - The subscribeOn() semantics are a bit unusual
    - Placing this operator in a chain impacts the execution context of the onNext(), onError(), & onComplete() signals
      - However, if an observeOn() operator appears later in the chain that can change the threading context where the rest of the operators in the chain below it execute (observeOn() can appear multiple times)



See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/core/Observable.html#observeOn

Key Concurrency Operators in the Observable Class

- The subscribeOn() operator
  - Run the subscribe(), request(), & onSubscribe() methods on the specified Scheduler worker
  - The subscribeOn() semantics are a bit unusual
  - Project Reactor's operator Flux.subscribeOn() works the same



See projectreactor.io/docs/core/release/api/reactor/core/publisher/Flux.html#subscribeOn

Key Concurrency Operators in the Observable Class

- The observeOn() operator
  - Run the onNext(), onComplete(), & onError() methods on a supplied Scheduler worker

```
Observable<T>
observeOn(Scheduler scheduler)
```

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/core/Observable.html#observeOn

Key Concurrency Operators in the Observable Class

- The observeOn() operator
  - Run the onNext(), onComplete(), & onError() methods on a supplied Scheduler worker
    - The scheduler param indicates what thread to perform the operation on

```
Observable<T>
observeOn(Scheduler scheduler)
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Class Scheduler

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See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/core/Scheduler.html

Key Concurrency Operators in the Observable Class

- The observeOn() operator
  - Run the onNext(), onComplete(), & onError() methods on a supplied Scheduler worker
    - The scheduler param indicates what thread to perform the operation on
    - Returns the Observable requesting async processing

```
Observable<T>
observeOn(Scheduler scheduler)
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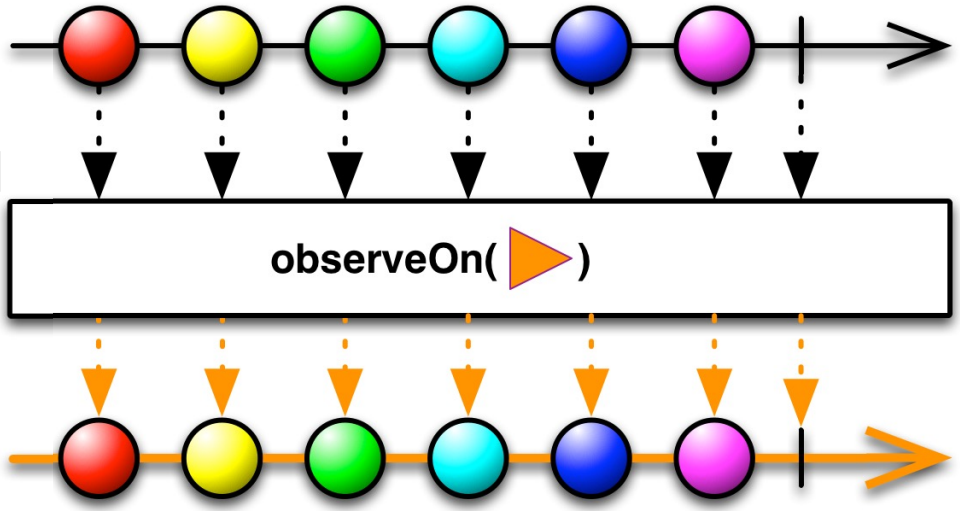
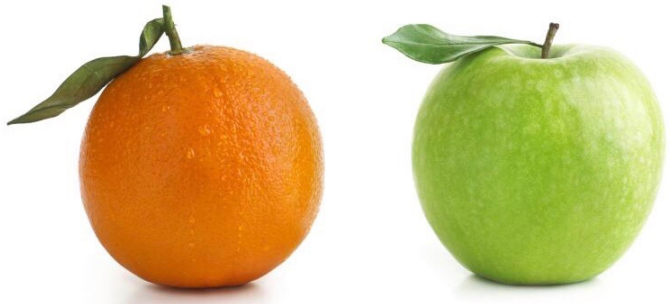
Key Concurrency Operators in the Observable Class

- The observeOn() operator
  - Run the onNext(), onComplete(), & onError() methods on a supplied Scheduler worker
  - The observeOn() semantics are fairly straightforward





Key Concurrency Operators in the Observable Class

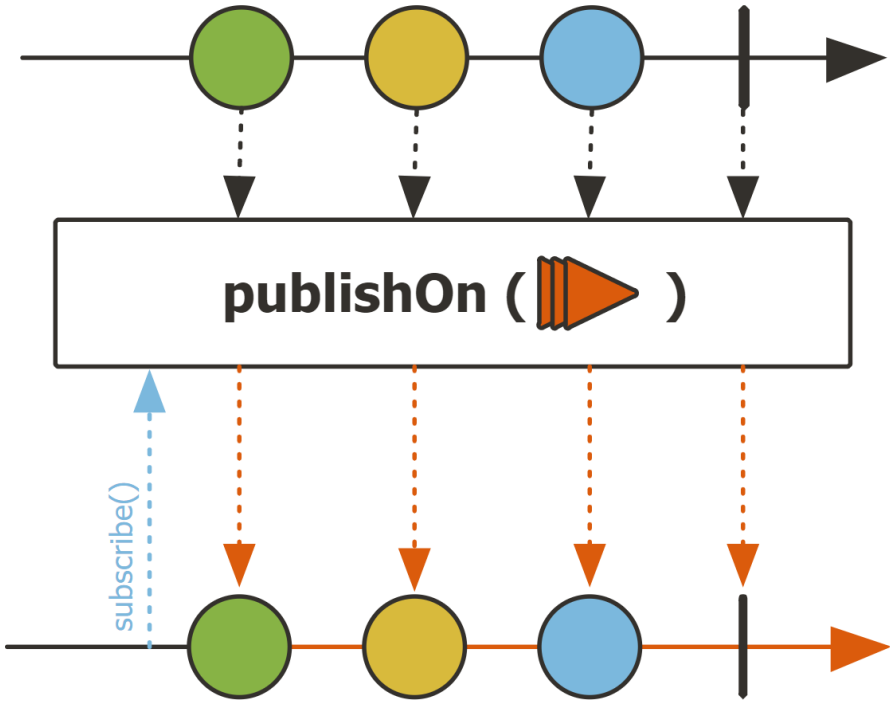
- The observeOn() operator
  - Run the onNext(), onComplete(), & onError() methods on a supplied Scheduler worker
  - The observeOn() semantics are fairly straightforward
    - It influences the threading context where the rest of the operators in the chain below it execute
      - i.e., up to a new occurrence of observeOn() in a chain (if any)

```
return Observable
   .create(ObservableEx::emitAsync)
   .observeOn(Schedulers
      .newThread())
   .map(bi -> ObservableEx
        .checkIfPrime(bi, sb))
   .doOnNext(bi -> ObservableEx
      .processResult(bi, sb))
   .doOnComplete(() ->
         BigFractionUtils
         .display(sb.toString()))
   .count()
   .ignoreElement();
```

See Reactive/Observable/ex2/src/main/java/ObservableEx.java

Key Concurrency Operators in the Observable Class

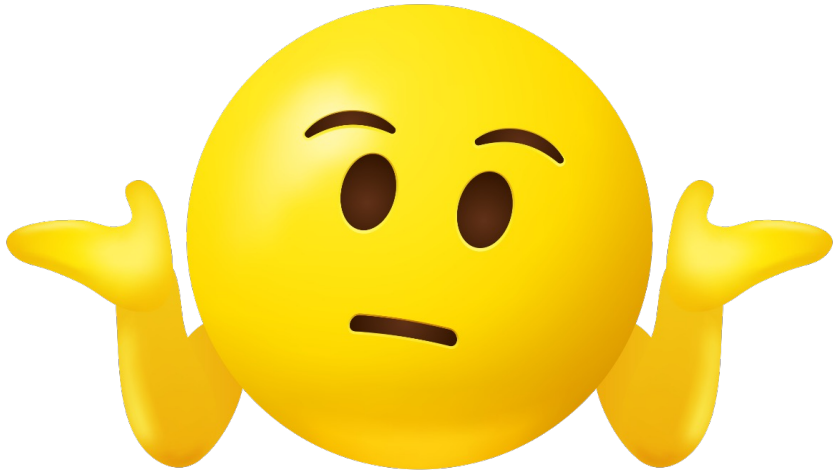
- The observeOn() operator
  - Run the onNext(), onComplete(), & onError() methods on a supplied Scheduler worker
  - The observeOn() semantics are fairly straightforward
  - Project Reactor's operator Flux.publishOn() works the same



See projectreactor.io/docs/core/release/api/reactor/core/publisher/Flux.html#publishOn

Key Concurrency Operators in the Observable Class

- The observeOn() operator
  - Run the onNext(), onComplete(), & onError() methods on a supplied Scheduler worker
  - The observeOn() semantics are fairly straightforward
  - Project Reactor's operator Flux. publishOn() works the same
    - It's unclear why this operator is named differently from RxJava's observeOn() operator



Key Scheduler Operators for the Observable Class

Key Scheduler Operators for the Observable Class

- The Schedulers.newThread() operator
  - Creates a new, single-threaded ScheduledExecutorService on each invocation

```
static Scheduler
  newThread()
```

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/schedulers/Schedulers.html#newThread

Key Scheduler Operators for the Observable Class

- The Schedulers.newThread() operator
  - Creates a new, single-threaded ScheduledExecutorService on each invocation
    - Returns a shared Scheduler instance that creates a new Thread for each unit of work

```
static Scheduler
  newThread()
```

Class Schedulers

java.lang.Object
    io.reactivex.rxjava3.schedulers.Schedulers

```
public final class Schedulers
extends Object
```

Static factory methods for returning standard Scheduler instances.

The initial and runtime values of the various scheduler types can be overridden via the `RxJavaPlugins.setInit(scheduler name)SchedulerHandler()` and `RxJavaPlugins.set(scheduler name)SchedulerHandler()` respectively.

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/schedulers/Schedulers.html

Key Scheduler Operators for the Observable Class

- The Schedulers.newThread() operator
  - Creates a new, single-threaded ScheduledExecutorService on each invocation
  - This thread is not reused, so it's only intended for limited situations

See www.baeldung.com/rxjava-schedulers

Key Scheduler Operators for the Observable Class

- The Schedulers.newThread() operator
  - Creates a new, single-threaded ScheduledExecutorService on each invocation
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```
...
Observable
   .rangeLong(1,
                sMAX_ITERATIONS)
   .subscribeOn(Schedulers
                  .newThread())
```

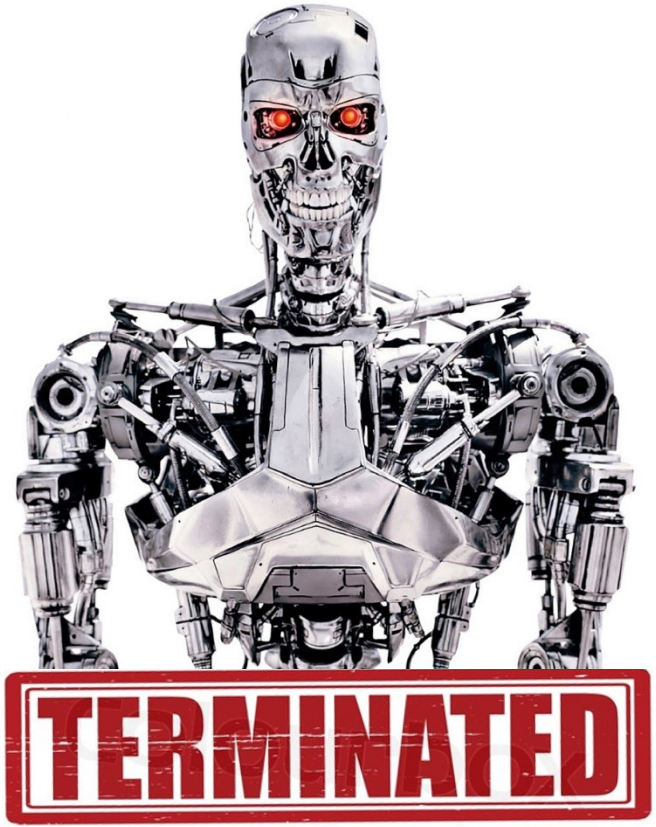
Arrange to emit the random big integers in a new "publisher" thread

```
   .map(sGenRandomBigInteger)
   ...
```

See Reactive/Observable/ex2/src/main/java/ObservableEx.java

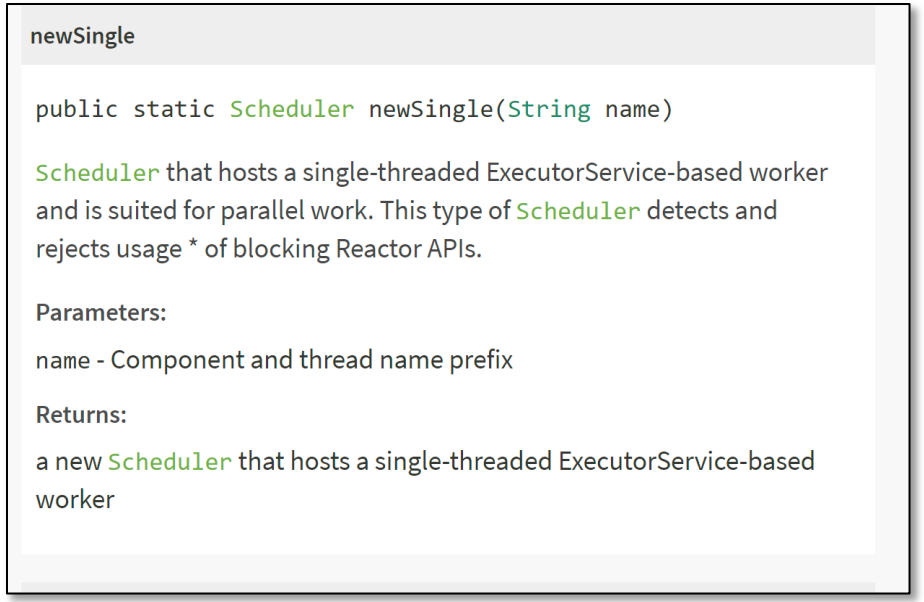
Key Scheduler Operators for the Observable Class

- The Schedulers.newThread() operator
  - Creates a new, single-threaded ScheduledExecutorService on each invocation
  - This thread is not reused, so it's only intended for limited situations
  - When the work is done, the thread is terminated



Key Scheduler Operators for the Observable Class

- The Schedulers.newThread() operator
  - Creates a new, single-threaded ScheduledExecutorService on each invocation
  - This thread is not reused, so it's only intended for limited situations
  - When the work is done, the thread is terminated
  - Project Reactor's Schedulers. newSingle() operator is similar



newSingle

```
public static Scheduler newSingle(String name)
```

`Scheduler` that hosts a single-threaded ExecutorService-based worker and is suited for parallel work. This type of `Scheduler` detects and rejects usage * of blocking Reactor APIs.

Parameters:

`name` - Component and thread name prefix

Returns:

a new `Scheduler` that hosts a single-threaded ExecutorService-based worker

See projectreactor.io/docs/core/release/api/reactor/core/scheduler/Schedulers.html#newSingle

Key Scheduler Operators for the Observable Class

- The Schedulers.newThread() operator
  - Creates a new, single-threaded ScheduledExecutorService on each invocation
  - This thread is not reused, so it's only intended for limited situations
  - When the work is done, the thread is terminated
  - Project Reactor's Schedulers. newSingle() operator is similar
    - However, its return value must be disposed of properly

See projectreactor.io/docs/core/snapshot/api/reactor/core/Disposable.html

End of Key Concurrency & Scheduler Operators for the Observable Class (Part 1)