A Gentle Introduction to Reactive Extensions

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What and Whatnot

Why?

The Reactive Manifesto

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Organisations working in disparate domains are independently discovering patterns for building software that look the same. These systems are more robust, more resilient, more flexible and better positioned to meet modern demands.

These changes are happening because application requirements have changed dramatically in recent years. Only a few years ago a large application had tens of servers, seconds of response time, hours of offline maintenance and gigabytes of data. Today applications are deployed on everything from mobile devices to cloud-based clusters running thousands of multi-core processors. Users expect millisecond response times and 100% uptime. Data is measured in Petabytes. Today's demands are simply not met by yesterday's software architectures.

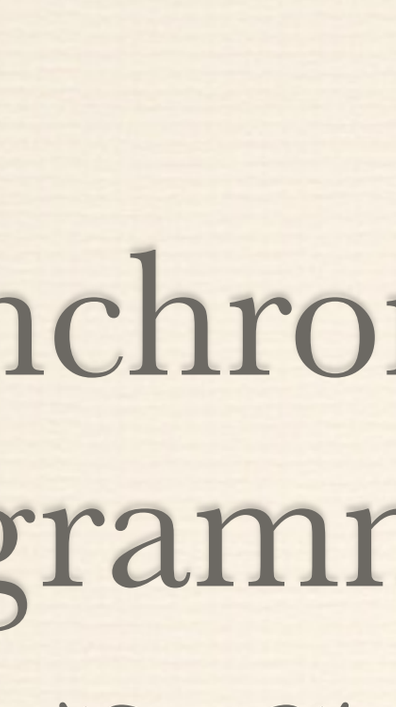
We believe that a coherent approach to systems architecture is needed, and we believe that all necessary aspects are already recognised individually: we want systems that are Responsive, Resilient, Elastic and Message Driven. We call these Reactive Systems.

Systems built as Reactive Systems are more flexible, loosely-coupled and scalable. This makes them easier to develop and amenable to change. They are significantly more tolerant of failure and when failure does occur they meet it with elegance rather than disaster. Reactive Systems are highly responsive, giving users effective interactive feedback.

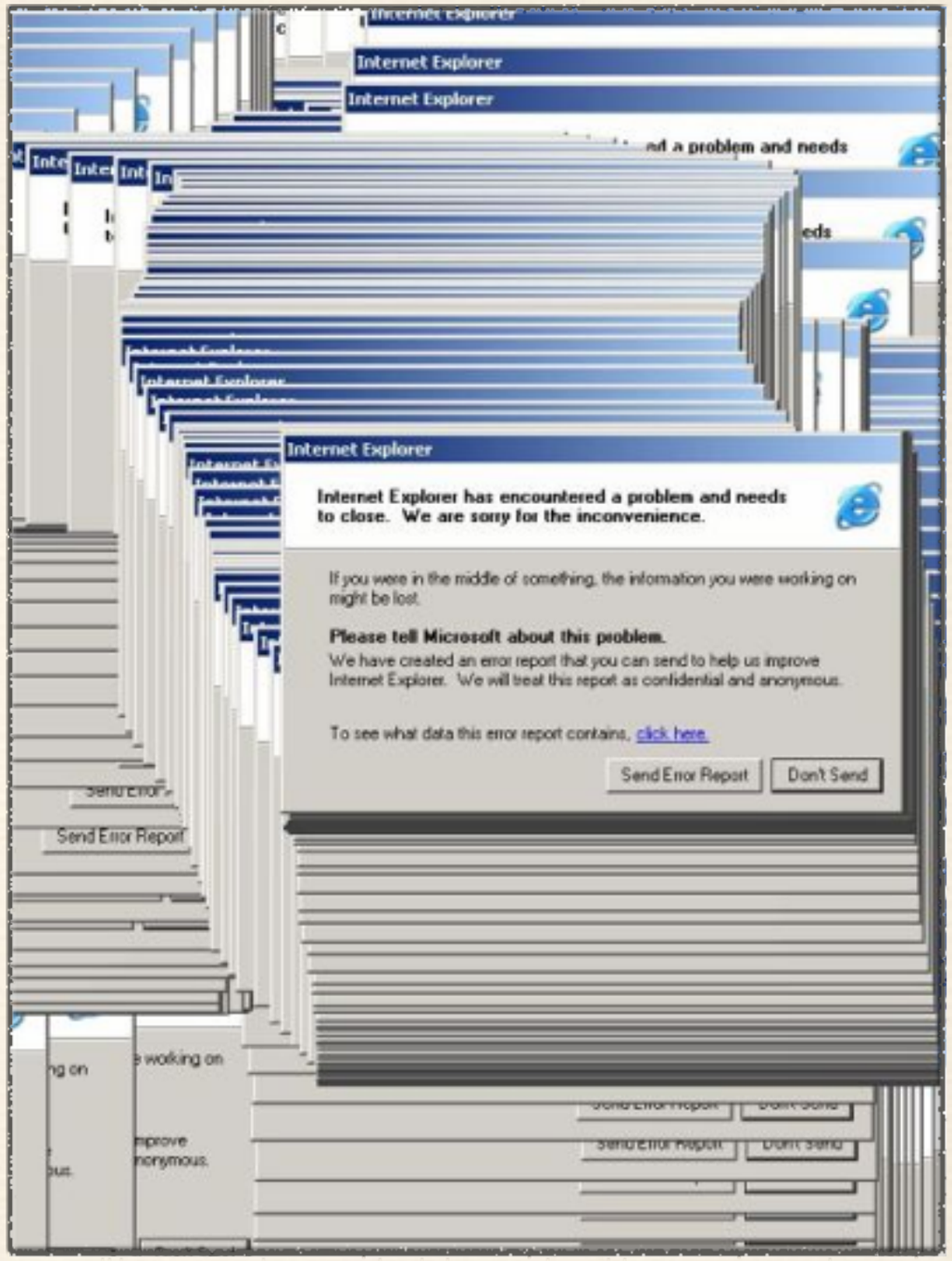
The Manifesto

- Responsive
- Resilient
- Elastic
- Message Driven

Asynchronous Programming



…is hard



Applications require it

- Desktop
- Mobile
- Web
- Server-Side

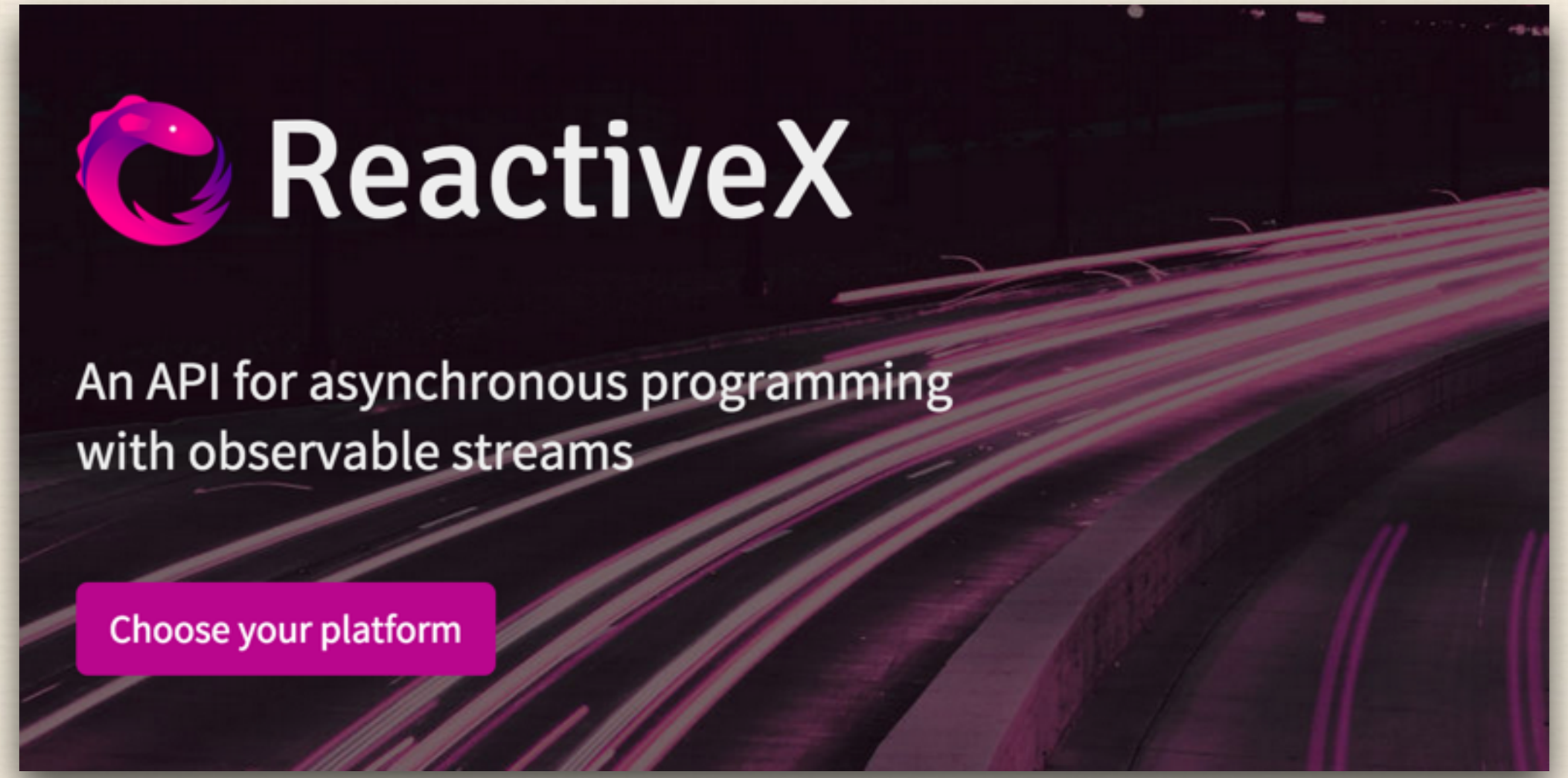
Attempts to ease it

- Threading
- Async/Await
- Futures
- Callbacks
- Promises

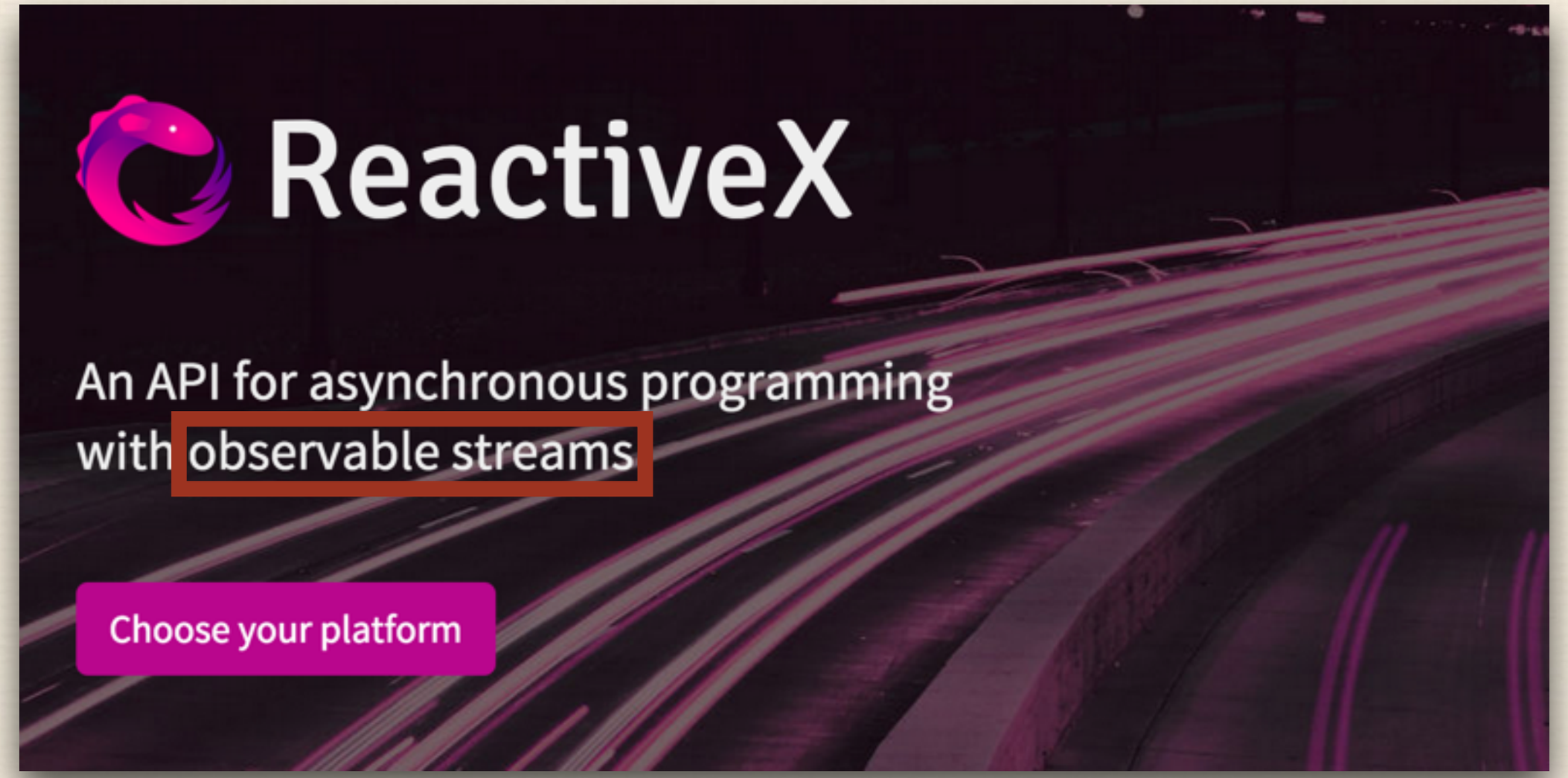
Issues…

- Combining async operations
- Different techniques for different languages

Reactive Extensions



Reactive Extensions



Everything. Is. A. Stream

And. It's. Observable.


DOGS
MUST KEEP
OWNERS ON
A LEASH

Let’s take a step back…

What is Programming?

An Art.

We are Crafts People

Actually we just process data

Data Processing

In Stages

Data comes in various forms…

- **Scalars**: Date of Birth, Sales Amount, Names
- **Collections**: List of Countries, Collection of Customers

Demo

Processing Data Functionally

Iterating Over Data

```
public trait Iterable<out T> {
    public fun iterator(): Iterator<T>
}

public trait Iterator<out T> {
    /**
     * Returns the next element in the iteration.
     */
    public fun next(): T

    /**
     * Returns `true` if the iteration has more elements.
     */
    public fun hasNext(): Boolean
}
```

In Synchronous Operations

```
fun main(args: Array<String>) {

    val numbers = listOf(1, 2, 3, 4, 5, 6, 7, 8)

    numbers.forEach { number -> println(number) }


}
```

Blocking Call

Some long running process

```
val customers = Database.getCustomersByCountry(“Spain”)


customers.filter { it.profession == “Agriculture” }
         .getGrowthFigures(it.city)
         .displayGrowth(it)
```

Blocking Calls

We shouldn’t block!

We’re waiting for data…

Why not just get notified?

i.e. onDataReady event

"What's the difference between an array and events?"

–Erik Meijer

Observer Pattern

Pulling Data

```
public trait Iterable<out T> {
    public fun iterator(): Iterator<T>
}

public trait Iterator<out T> {
    /**
     * Returns the next element in the iteration.
     */
    public fun next(): T

    /**
     * Returns `true` if the iteration has more elements.
     */
    public fun hasNext(): Boolean
}
```

Pushing Data

```
public trait Observable<out T> {
    public fun Subscribe(observer: Observer<T>)
}
```

```
public trait Observer<in T> {
    public fun onNext(t: T)
    public fun onError(e: Exception)
    public fun onCompleted()
}
```

Duality

In mathematics, a duality, generally speaking, translates concepts, theorems or mathematical structures into other concepts, theorems or structures, in a one-to-one fashion, often (but not always) by means of an involution* operation: if the dual of A is B, then the dual of B is

Involution Function: f(f(x)) = x

Law of De Morgan

```
!(a && b)==!a || !b
```

```
!(a || b) ==!a && !b
```

Reactive Extensions is

- Extension of Observer Pattern
- Operators to work with sequences of data and their composition
- Abstracts low-level threading, etc.

Reactive Extensions

- Languages
  - Java: RxJava
  - JavaScript: RxJS
  - C#: Rx.NET
  - C#(Unity): UniRx
  - Scala: RxScala
  - Clojure: RxClojure
  - C++: RxCpp
  - Ruby: Rx.rb
  - Python: RxPY
  - Groovy: RxGroovy
  - JRuby: RxJRuby
  - Kotlin: RxKotlin
- Frameworks
  - RxNetty
  - RxReact
  - RxAndroid
  - RxUI

Now it's all just Demos

Is this the Silver Bullet?

Where Rx helps

- Asynchronous code
- Combining results
- Events
- Errors

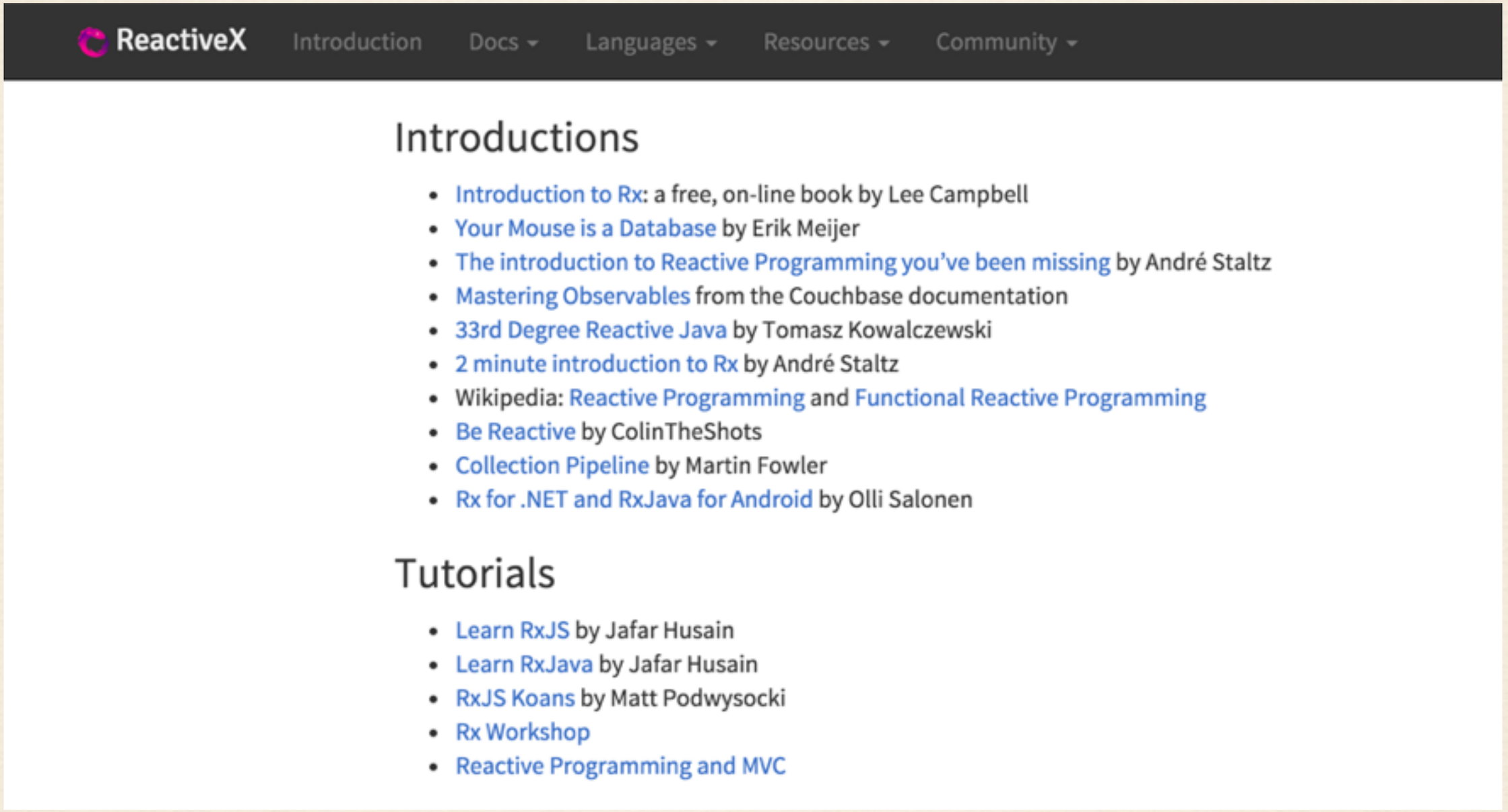
Most importantly…

It adds a layer of abstraction

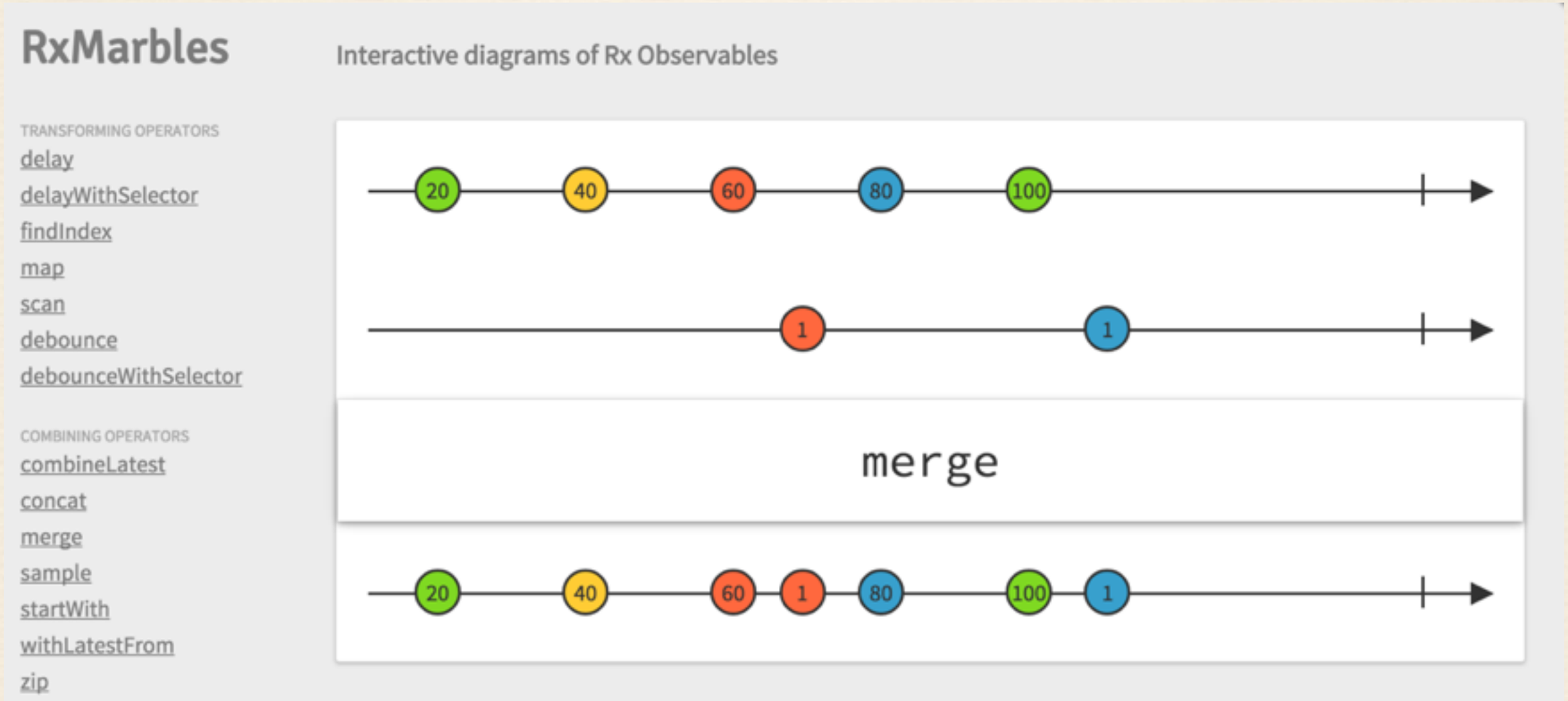
Some issues…

- Learning Curve
  - Thinking in Functions
  - Thinking in Streams
- Can still cause havoc in your code
  - Dealing with Schedulers
  - Doesn’t automatically give you parallelism

Learning more



RxMarbles


RxMarbles
Interactive diagrams of Rx Observables
TRANSFORMING OPERATORS
delay
delayWithSelector
findIndex
map
scan
debounce
debounceWithSelector
COMBINING OPERATORS
combineLatest
concat
merge
sample
startWith
withLatestFrom
zip
20
40
60
80
100
1
1
merge
20
40
60
1
80
100
1

Thank you!

Credits

- Dog Sign http://upload.wikimedia.org/wikipedia/commons/c/c5/Dogs_must_keep_owners_on_a_leash_(Butchart_Gardens)-WTF.jpg
- Call Center http://upload.wikimedia.org/wikipedia/commons/7/7c/Callcentre.jpg
- Open Office Layout http://upload.wikimedia.org/wikipedia/commons/a/a4/TradeMe_offices.jpg