Streaming and event-based programming using Reactive Programming and RxJS

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https://github.com/Reactive-Extensions/FutureJS

OR:
HOW I LEARNED TO STOP WORRYING ABOUT ASYNCHRONOUS PROGRAMMING AND LOVE THE OBSERVABLE

trapd in Monad tutorl
plz help

Reactive Manifesto

http://www.reactivemanifesto.org

Merriam-Webster defines reactive as "*readily responsive to a stimulus*", i.e. its components are "active" and always ready to receive events. This definition captures the essence of reactive applications, focusing on systems that:

react to events

the event-driven nature enables the following qualities

react to load

focus on scalability by avoiding contention on shared resources

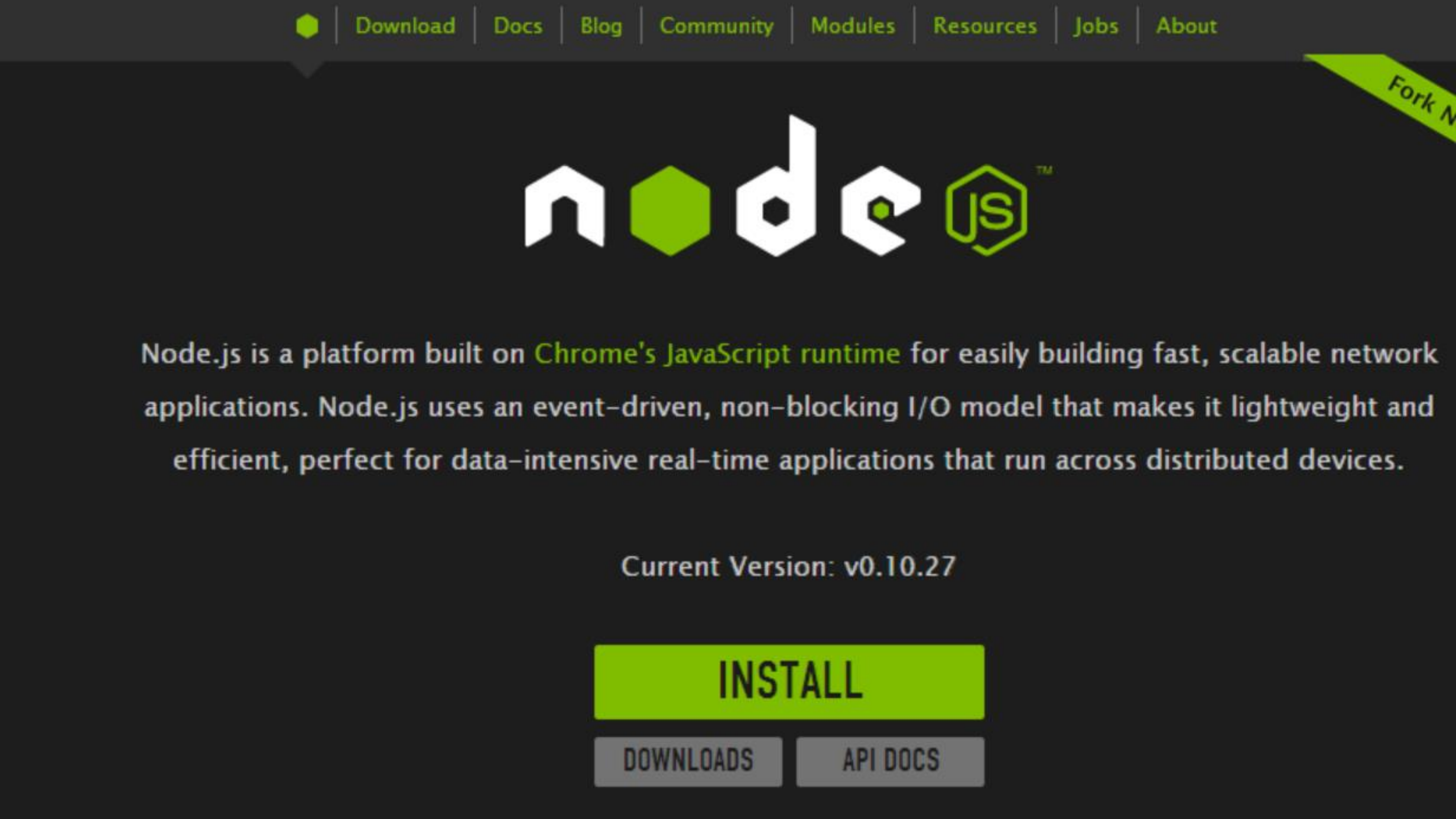
react to failure

build resilient systems with the ability to recover at all levels

react to users

honor response time guarantees regardless of load

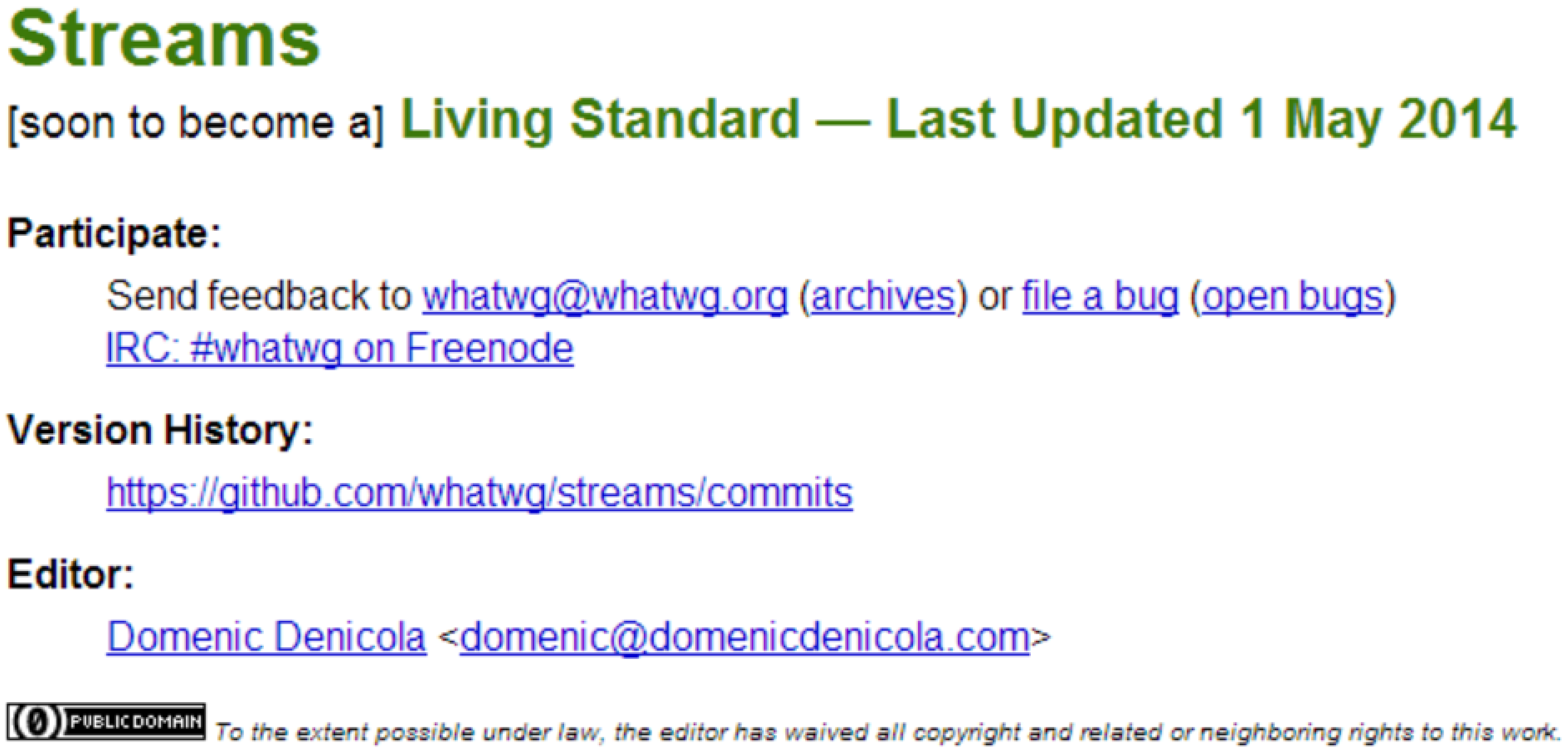
streem prosesing



Node.js is a platform built on Chrome's JavaScript runtime for easily building fast, scalable network applications. Node.js uses an event-driven, non-blocking I/O model that makes it lightweight and efficient, perfect for data-intensive real-time applications that run across distributed devices.

Current Version: v0.10.27

WHATWG Streams



Streams

[soon to become a] Living Standard — Last Updated 1 May 2014

Participate:

Send feedback to whatwg@whatwg.org (archives) or file a bug (open bugs)
IRC: #whatwg on Freenode

Version History:

https://github.com/whatwg/streams/commits

Editor:

Domenic Denicola <domenic@domenicdenicola.com>

Google Dart

Introduced Streams as part of dart:async

Unifies Binary Data

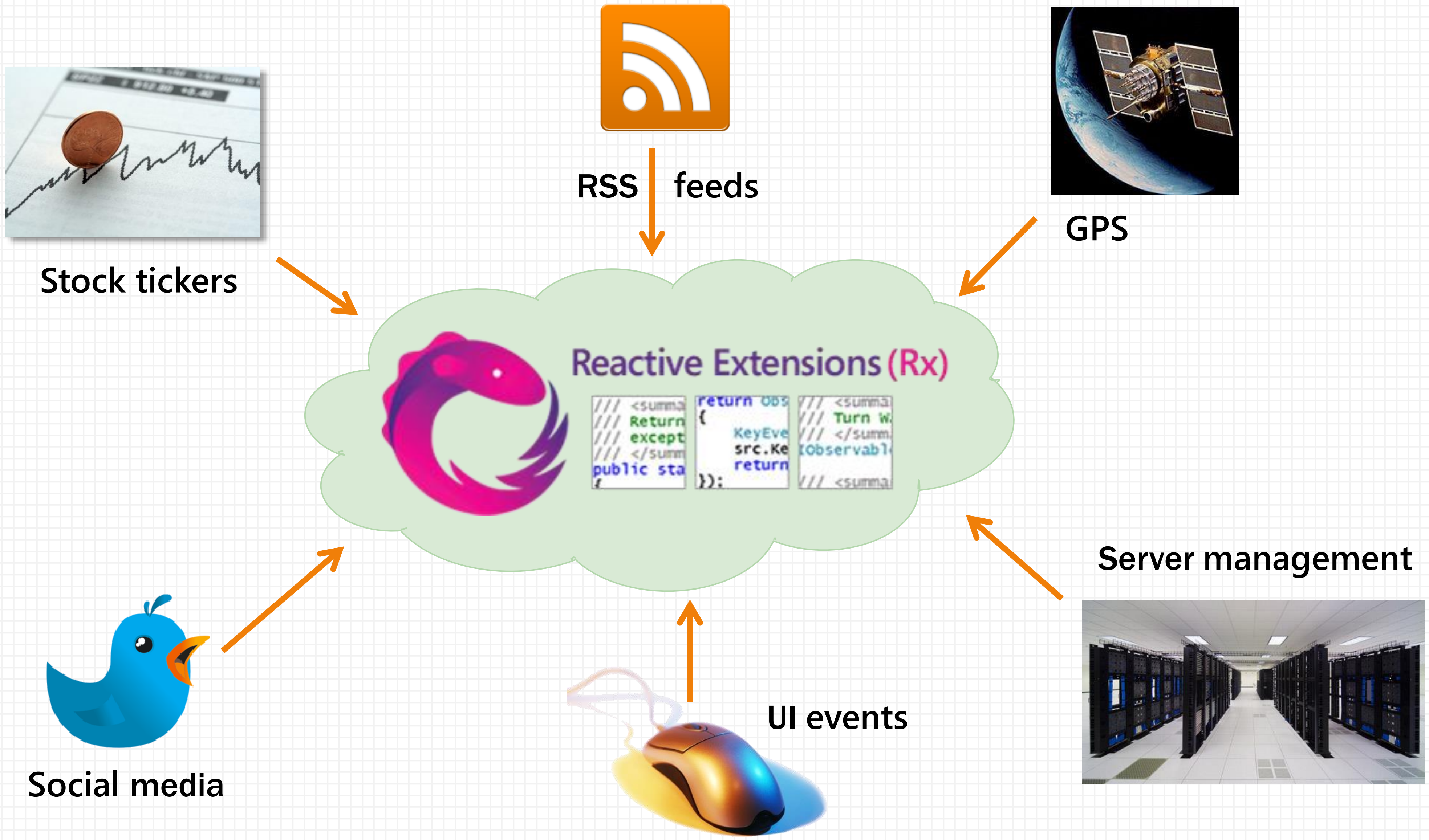
```
Stream<List<int>> stream = new File('quotes.txt').openRead();
stream.transform(UTF8.decoder).listen(print);
```

And Events

```
querySelector('#myButton')
  .onClick.listen((_) => print('Click.'));
```

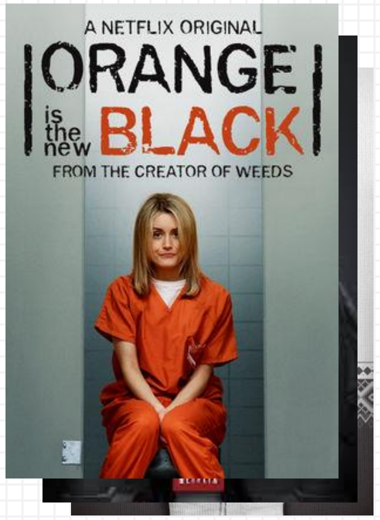
http://news.dartlang.org/2012/11/introducing-new-streams-api.html

Real-time is everywhere…



Top-rated Movies Collection

```
var getTopRatedFilms = function (user) {
  return user.videoLists
    .map(function (videoList) {
      return videoList.videos
        .filter(function (v) { return v.rating === 5; });
    })
    .mergeAll();

getTopRatedFilms(user)
   .subscribe(function (film) { ... });
```



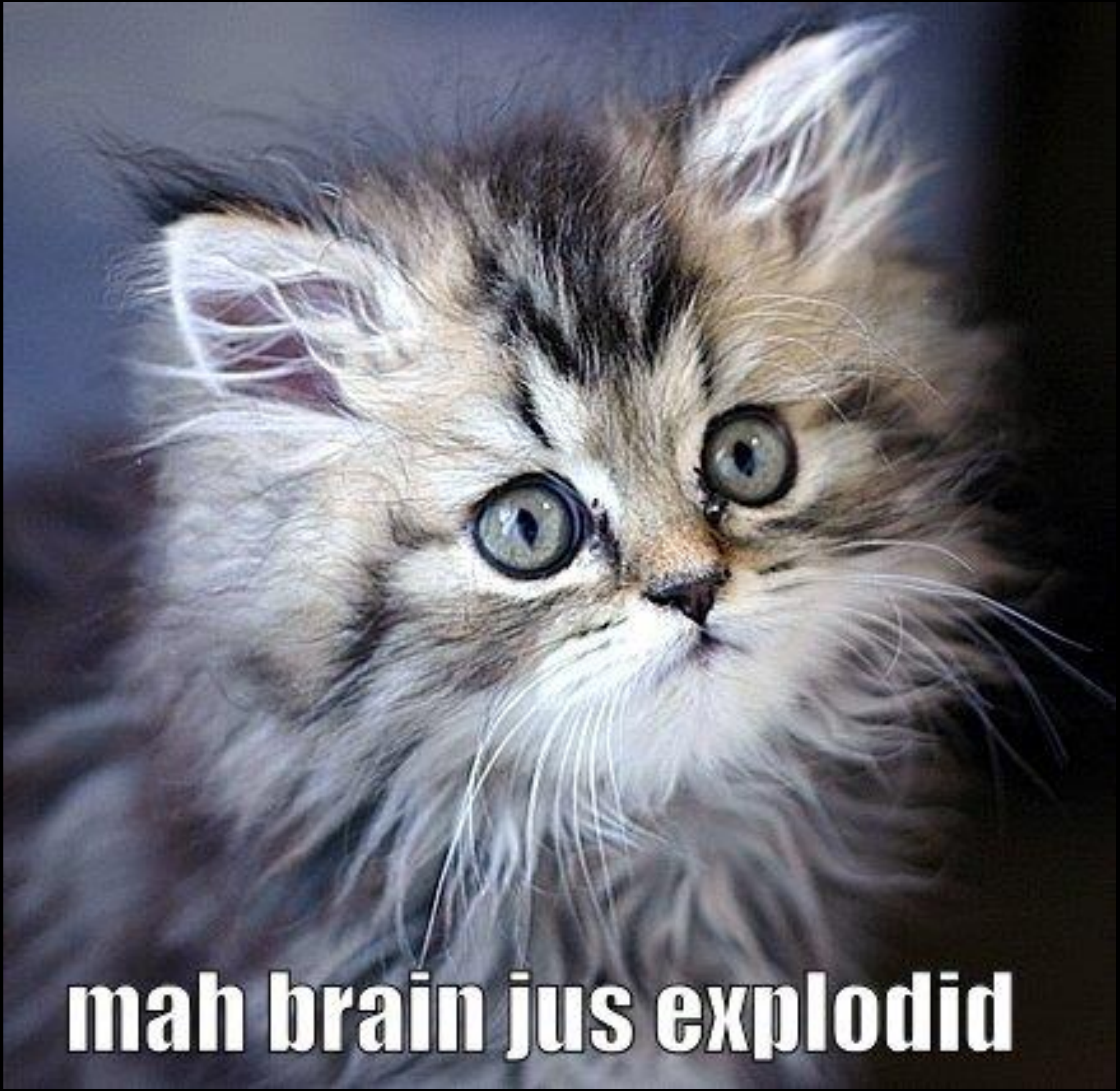
What if I told you…

…that you could create a drag event…

…with the almost the *same code*?

Mouse Drags Collection

```
var getElementDrags = function (elmt) {
  return elmt.mouseDowns()
    .map(function (mouseDown) {
      return mainWindow.mouseMoves()
        ~~filter~~ .takeUntil(elmt.mouseUps());
      })
      .mergeAll();

getElementDrags(image)
   .subscribe(updateImagePosition);
```


mah brain jus explodid

Callback Hell

```
function play(movieId, callback) {
    var movieTicket, playError,
        tryFinish = function () {
            if (playError) {
                callback(null, playError);
            } else if (movieTicket && player.initialized) {
                callback(null, ticket);
            }
        };
    if (!player.initialized) {
        player.init(function (error) {
            playError = error;
            tryFinish();
        }
    }
    authorizeMovie( function (error, ticket) {
        playError = error;
        movieTicket = ticket;
        tryFinish();
    });
});
```

Asynchronous Programming is Annoying

Each framework has its own way of expressing async/event-based programming

- Node.js has callbacks, then we have Promises, and then events
- Each concept covers only part of the story

Wouldn't it be great to have a unifying concept to generalize how we think about concurrent/reactive programming?

OnNext:
Reactive Applications Demo

Ordinary Interactive Programming

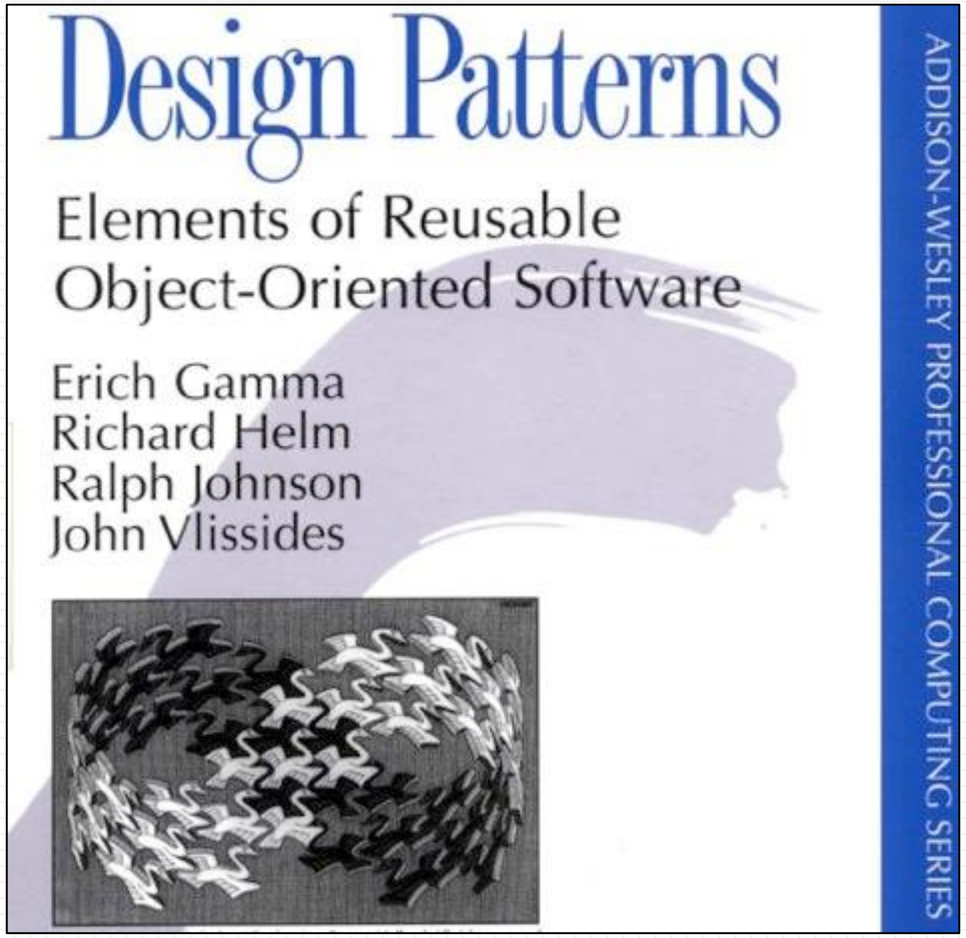
```
try {
    for (var item in collection)
        doSomething(item);
} catch (e) {
    handleOrThrow(e);
}

doCleanup();
```

OnNext(T)

OnError()

OnCompleted()

That was the iterator pattern


Design Patterns

Elements of Reusable Object-Oriented Software

Erich Gamma
Richard Helm
Ralph Johnson
John Vlissides

ADDISON-WESLEY PROFESSIONAL COMPUTING SERIES

Making it push-based

```
var collection = Observable.fromEvent(e, 'click');

var obs = Observer.create(
            onNext:      x  => doSomething(x),
            onError:     e  => handleError(e),
            onCompleted: () => doCleanup());

var subscription = collection.subscribe(obs);

// deterministically cleans up all resources
subscription.dispose();
```

Rx Grammar Police

OnNext ● * (OnError ✗ | OnCompleted ▮) ?

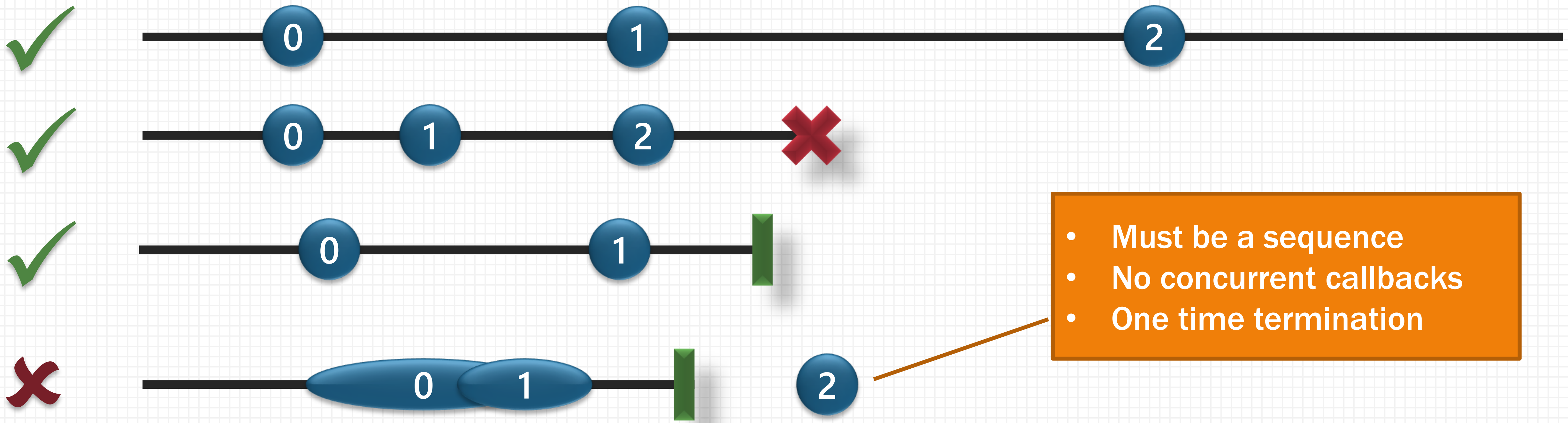
Zero or more values

E.g. events are ∞ sequences

Calls can fail

Resource management

Sequencing

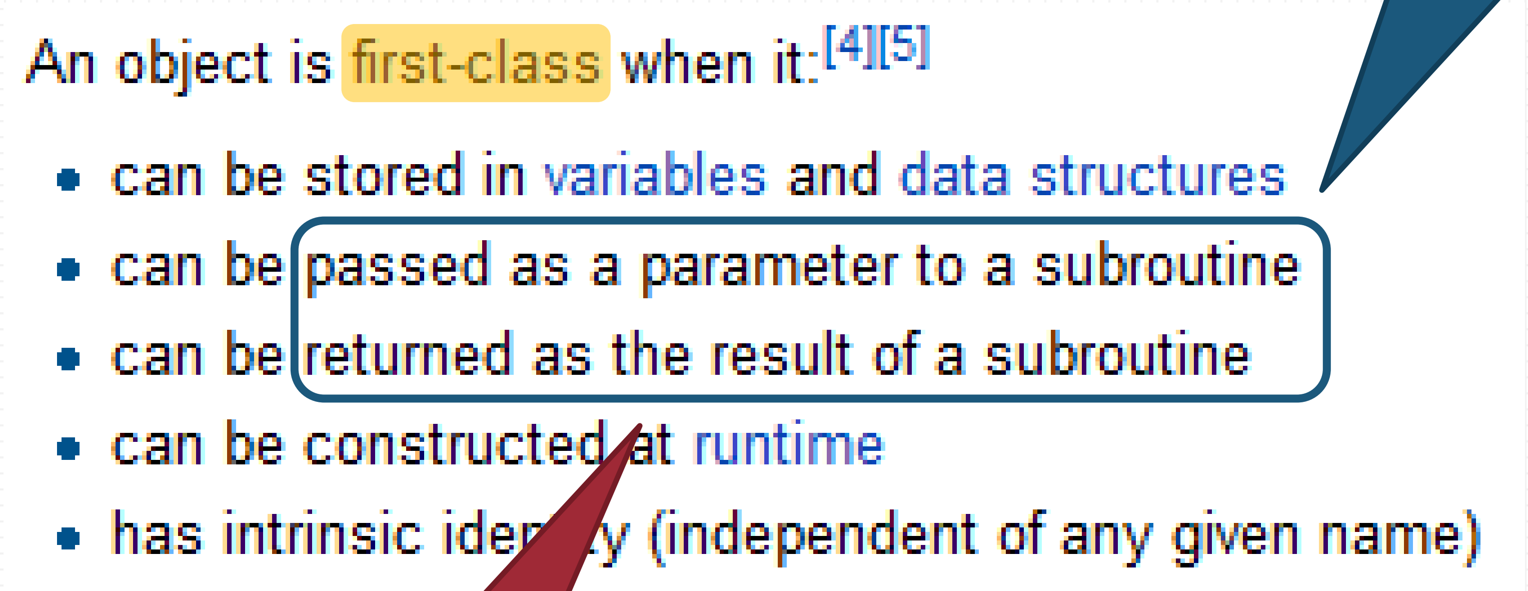


- Must be a sequence
- No concurrent callbacks
- One time termination

First-Class Events

Objects to the rescue

How about a query library?



An object is first-class when it:[4][5]

- can be stored in variables and data structures
- can be passed as a parameter to a subroutine
- can be returned as the result of a subroutine
- can be constructed at runtime
- has intrinsic identity (independent of any given name)

Or mocking for testing...?

WIKIPEDIA
The Free Encyclopedia

What is Rx?

Language neutral model with 3 concepts:

1. Observer/Observable
2. Query operations (map/filter/reduce)
3. How/Where/When
   - Schedulers: a set of types to parameterize concurrency

Rx is everywhere*

.NET

JavaScript (RxJS)

Java (RxJava)

+ Scala, Groovy, Clojure

Objective-C (ReactiveCocoa)

C++

Python

Ruby

PHP

Dart

Haskell

* Varying levels of completeness – YMMV

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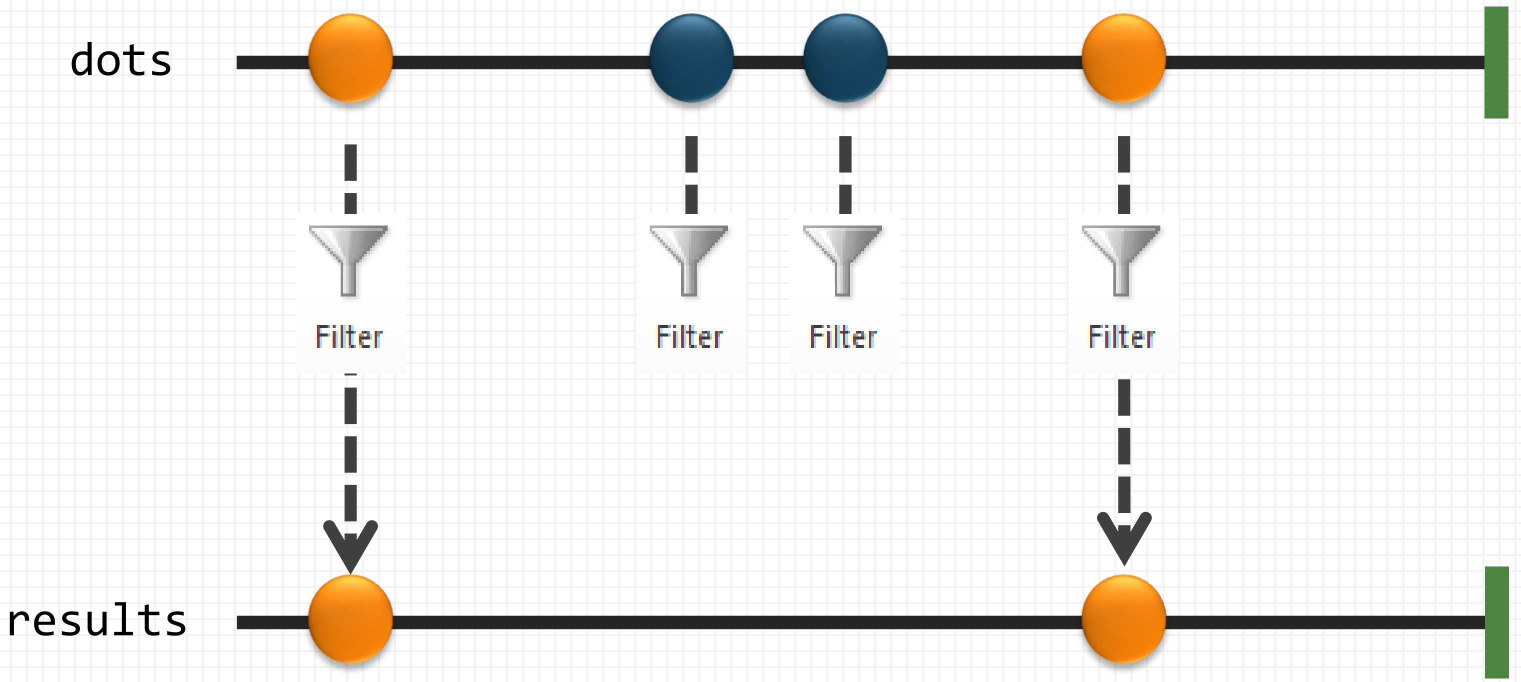
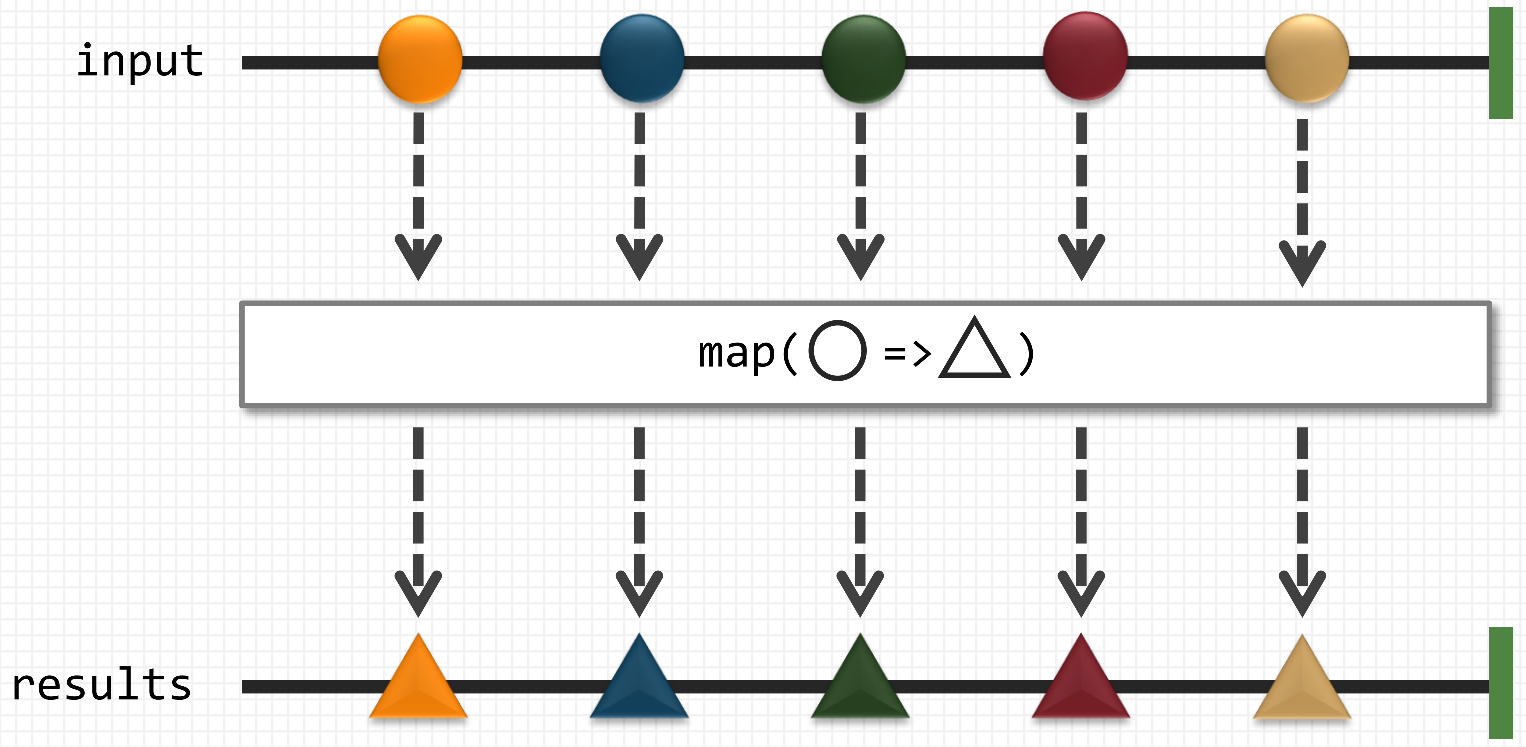
Marble diagram: filter



```
.filter(function (dot) {
  return dot.isOrange();
})
```

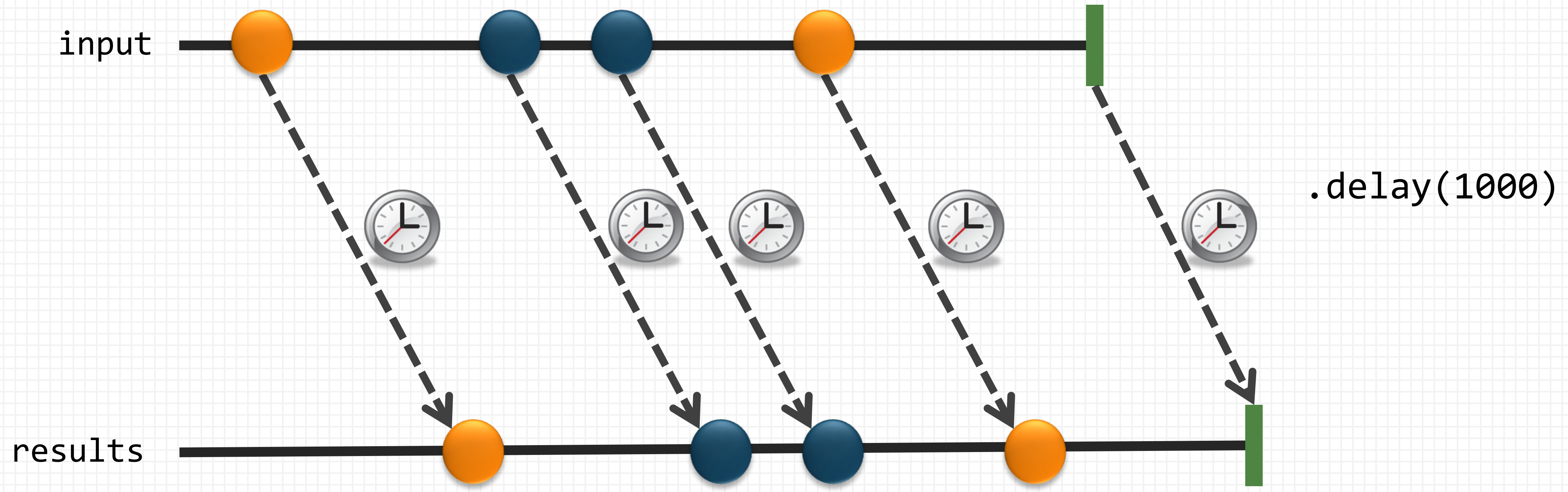
Marble diagram: map



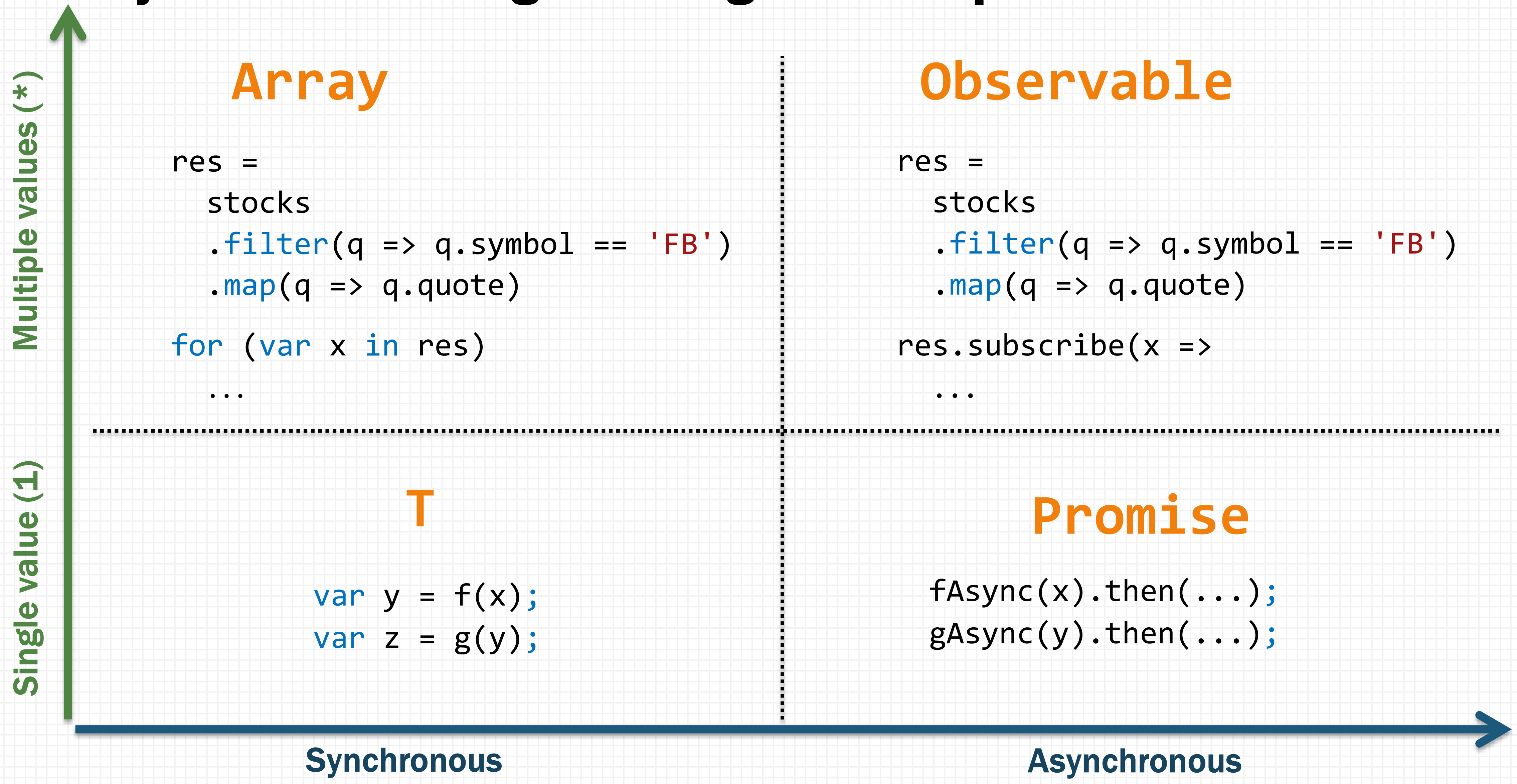
```
.map(function (item) {
  return transform(item);
})
```

Marble diagram: delay

Since Observables are asynchronous, they have a notion of time



The Asynchronous Programming Landscape



Array

```
res =
  stocks
  .filter(q => q.symbol == 'FB')
  .map(q => q.quote)

for (var x in res)
  ...
```

Observable

```
res =
  stocks
  .filter(q => q.symbol == 'FB')
  .map(q => q.quote)

res.subscribe(x =>
  ...
```

T

```
var y = f(x);
var z = g(y);
```

Promise

```
fAsync(x).then(...);
gAsync(y).then(...);
```

Querying UI Events

```
var mousedrag = mousedown.flatMap(function (md) {

    // calculate offsets when mouse down
    var startX = md.offsetX,
        startY = md.offsetY;








});
```

1

For each mouse down

Querying UI Events

```
var mousedrag = mousedown.flatMap(function (md) {

    // calculate offsets when mouse down
    var startX = md.offsetX,
        startY = md.offsetY;

    // calculate diffs until mouse up
    return mousemove.map(function (mm) {
        return {
            left: mm.clientX - startX,
            top:  mm.clientY - startY
        };
    })
});
```

1 For each mouse down

2 Take mouse moves

Querying UI Events

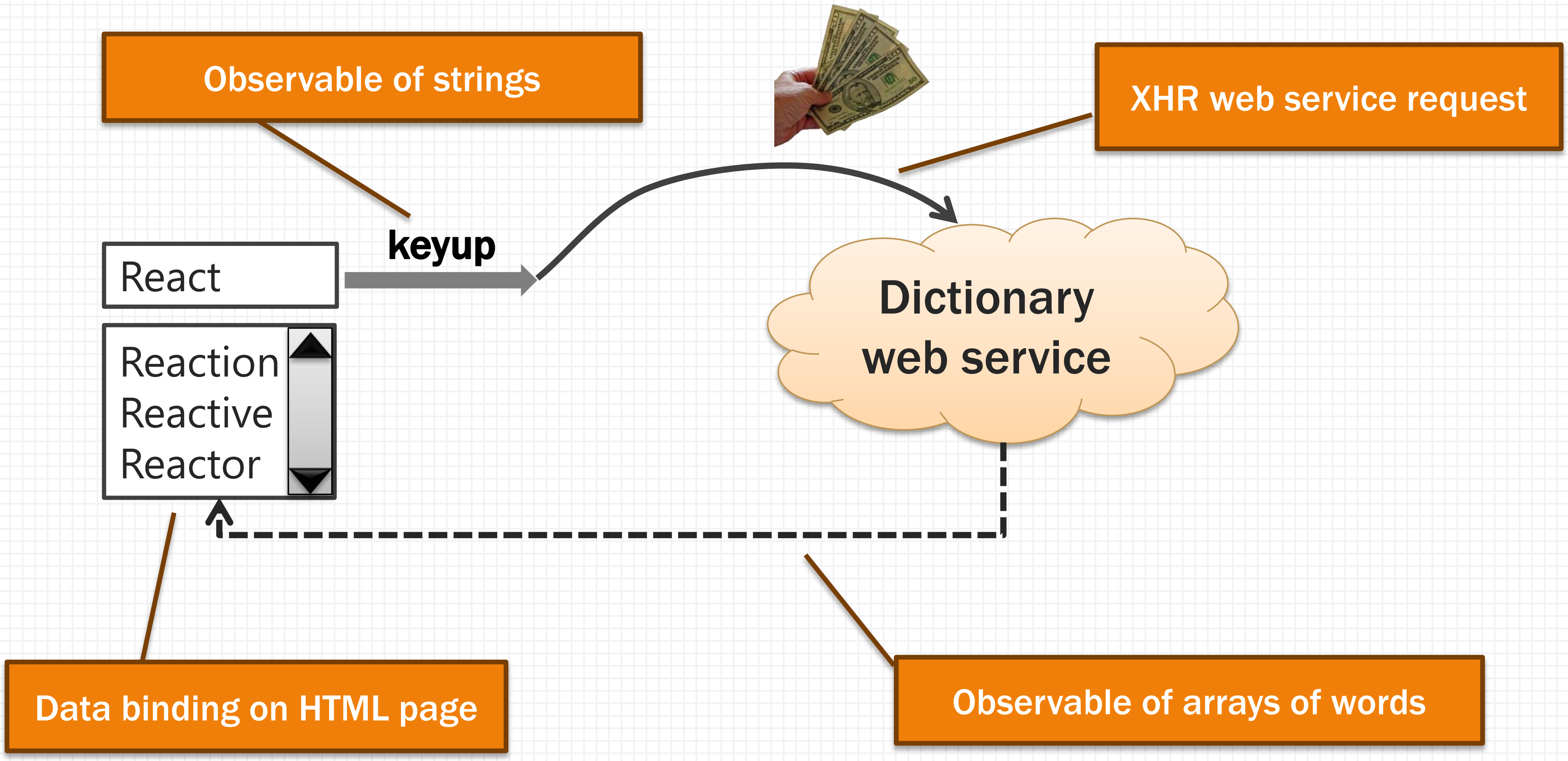
```
var mousedrag = mousedown.flatMap(function (md) {

    // calculate offsets when mouse down
    var startX = md.offsetX,
        startY = md.offsetY;

    // calculate diffs until mouse up
    return mousemove.map(function (mm) {
        return {
            left: mm.clientX - startX,
            top:  mm.clientY - startY
        };
    }).takeUntil(mouseup);
});
```

1 For each mouse down

2 Take mouse moves

3 until mouse up

Composing Events and Promises



Composing Events and Promises

```
var words = Rx.Observable.fromEvent(
               input, "keyup")
            .map(function() { return input.value; })
            .throttle(500)
            .distinctUntilChanged()
            .flatMapLatest(
               function(term) { return search(term); }
            );

words.subscribe(function(data) {
   // Bind data to the UI
});
```

DOM events as a sequence of strings

Reducing data traffic / volume

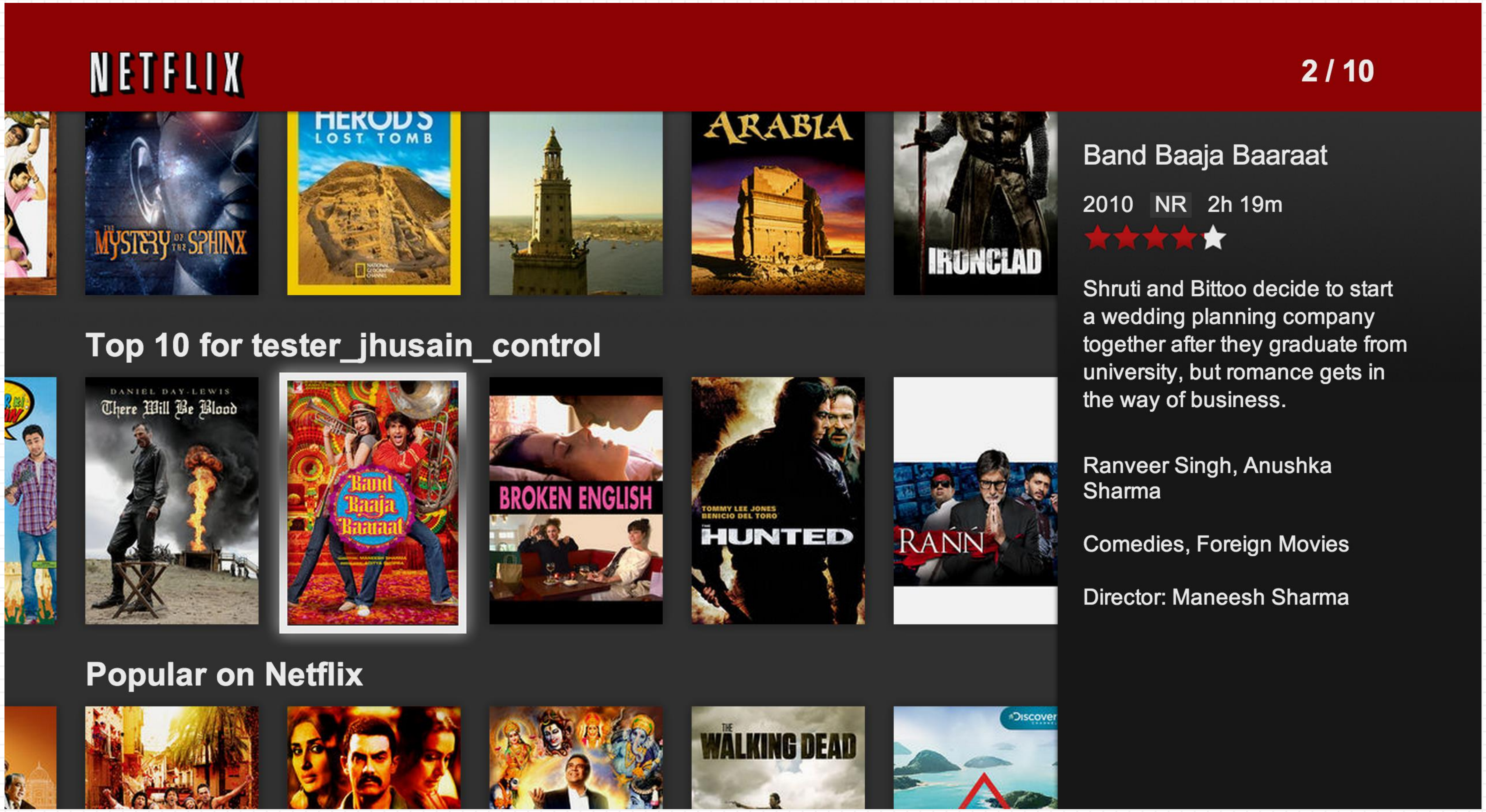
Latest response as word arrays

Web service call returns single value sequence

Binding results to the UI

Your Netflix Video Lists

Netflix Row Update Polling



Top 10 for tester_jhusain_control

Popular on Netflix

Band Baaja Baaraat

2010 NR 2h 19m

Shruti and Bittoo decide to start a wedding planning company together after they graduate from university, but romance gets in the way of business.

Ranveer Singh, Anushka Sharma

Comedies, Foreign Movies

Director: Maneesh Sharma

Client: Polling for Row Updates

```
function getRowUpdates(row) {
    var scrolls = Rx.Observable.fromEvent(document, "scroll");
    var rowVisibilities =
        scrolls.throttle(50)
             .map(function (scrollEvent) { return row.isVisible(scrollEvent.offset); })
             .distinctUntilChanged()
             .publish().refCount();
    var rowShows = rowVisibilities.filter(function (v) { return v; });
    var rowHides = rowVisibilities.filter(function (v) { return !v) });

    return rowShows
       .flatMap(Rx.Observable.interval(10))
       .flatMap(function () { return row.getRowData().takeUntil(rowHides); })
       .toArray();
};
```

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3. How/Where/When
   – Schedulers: a set of types to parameterize concurrency

The Role of Schedulers

Key questions:

- How to run timers?
- Where to produce events?
- Need to synchronize with the UI?

Schedulers are the answer:

- Schedulers introduce concurrency
- Operators are parameterized by schedulers
- Provides test benefits as well

Cancellation

Many implementations

```
d = scheduler.schedule(
  function () {
    // Asynchronously
    // running work
  },
  1000);
```

Optional time

Testing concurrent code: made easy!

```
var scheduler = new TestScheduler();

var input = scheduler.createColdObservable(
    onNext(300, "FutureJS"),
    onNext(400, "2014"),
    onCompleted(500));

var results = scheduler.startWithCreate(function () {
    input.map(function (x) { return x.length; })
});

results.messages.assertEqual(
    onNext(300, 8),
    onNext(400, 4),
    onCompleted(500));
```

More about Rx

Open-sourced by MS Open Tech in Nov 2012

- Rx.NET
- RxJS
- RxCpp

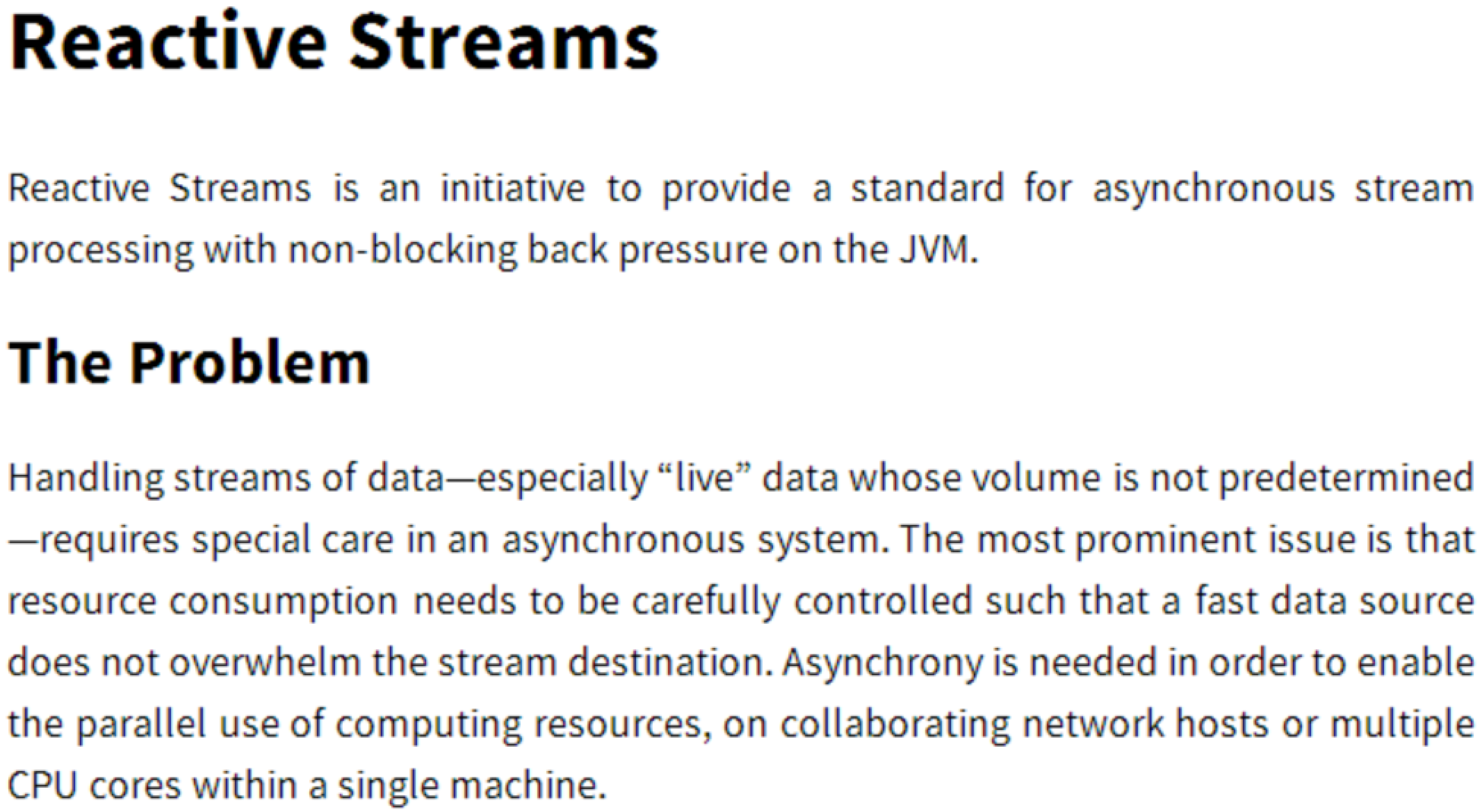
Who uses Rx?

- Netflix ported it to Java (RxJava)
  - Heavily used in back-end
  - Use RxJS/Rx.NET on clients
- GitHub
  - GitHub for Windows (ReactiveUI + Rx.NET)
  - GitHub for Mac (ReactiveCocoa)

RxJS and the future…

What are the problems we're looking at next?

- **Backpressure**
- **Distributed Rx**
- **Query Expressions in JavaScript**
- **Reactive-Streams**
- **Generators**



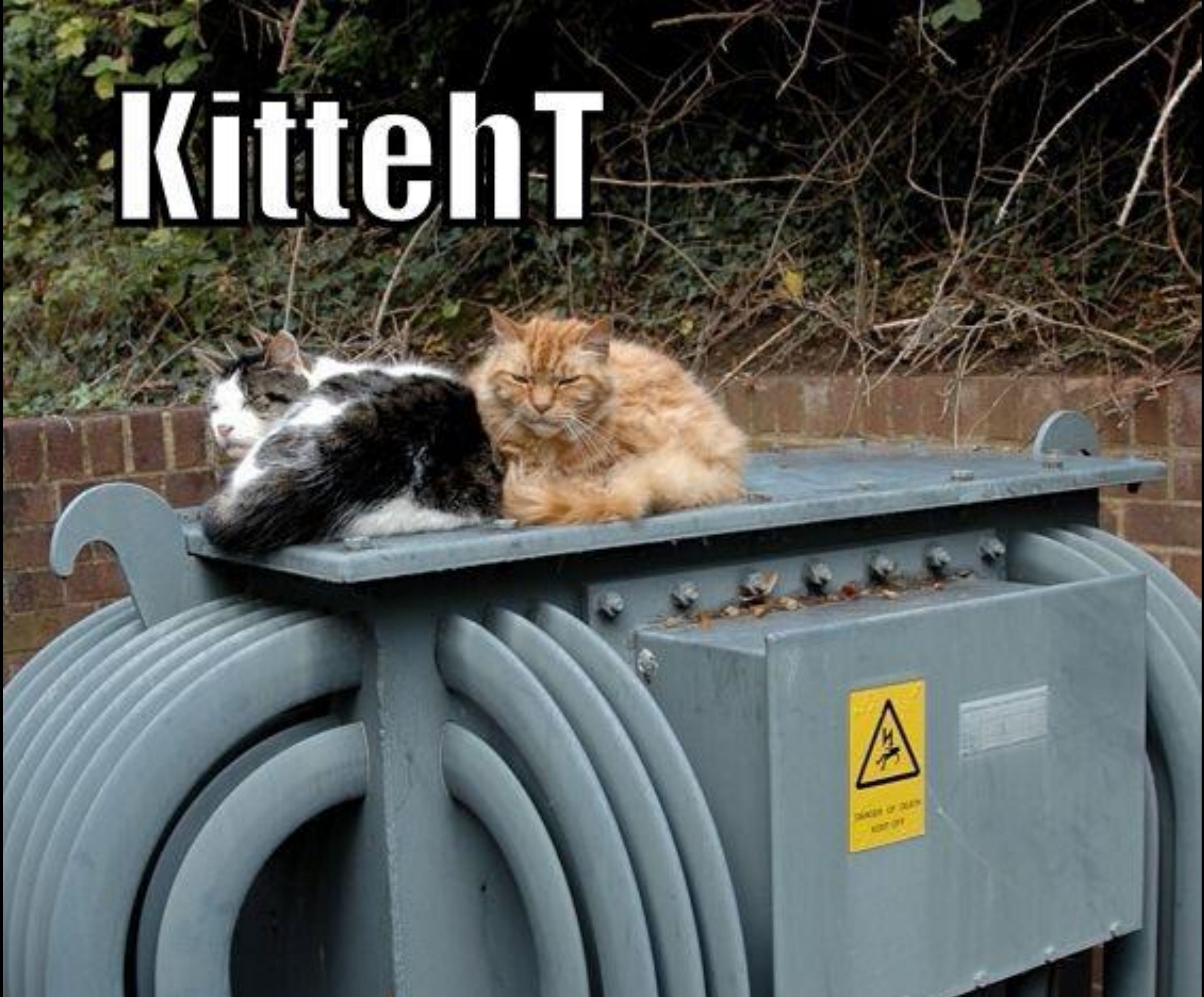
Reactive Streams

Reactive Streams is an initiative to provide a standard for asynchronous stream processing with non-blocking back pressure on the JVM.

The Problem

Handling streams of data—especially “live” data whose volume is not predetermined —requires special care in an asynchronous system. The most prominent issue is that resource consumption needs to be carefully controlled such that a fast data source does not overwhelm the stream destination. Asynchrony is needed in order to enable the parallel use of computing resources, on collaborating network hosts or multiple CPU cores within a single machine.

http://www.reactive-streams.org/


KittehT

A Glimpse into the Future - RxJS and Generators

```
var Rx = require('rx');
var request = require('request');

var get = Rx.Observable.fromNodeCallback(request);

Rx.spawn(function* () {
    var a = yield get('http://localhost/stocks1.csv').retry(3);
    console.log(a.length);

    try {
        var b = yield get('http://invalidhost');
    } catch (e) {
        console.log(e.code);
    }
});
```

OnCompleted: Rx

Language neutral model with 3 concepts:

1. **Observer/Observable**
2. **Query operations (map/filter/reduce)**
3. **Schedulers: a set of types to parameterize concurrency**

```
@ReactiveX
rx.codeplex.com
github.com/Reactive-Extensions
```