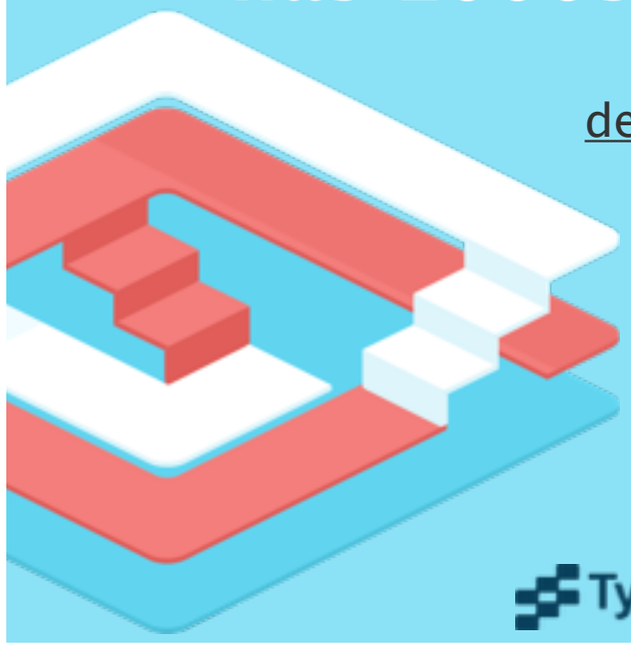
Reactive Applications: What if Your Internet of Things has 1000s of Things?

dean.wampler@typesafe.com

@deanwampler



Typesafe

Photographs licensed from iStock unless otherwise noted.

Characteristics of Large IoT

- Large number of “nodes”.
- Potentially large number of messages to/from service providers and managers.
- Message sizes usually small.
- Resilience requirements vary.

Characteristics of IoT

- Response times from:
  - *Real time*: µ-seconds for avionics.
  - *Human time*: 10s-100s of milliseconds.
  - *Phoning home*: no response or slow response okay.
- *Connectivity*: Intermittent to always on.

Examples

Med. Devices, IT Appliances

Typesafe

Photos:
http://www.oncolink.org/treatment/images/us-machine.jpg
http://img.directindustry.com/images_di/photo-g/network-communications-appliances-55504-2715577.jpg

Med. Devices, IT Appliances

- *Phone home* with status updates.
  - Diagnose pending problems.
  - Learn client usage patterns.
- Stable internet connection.

Typesafe

Most of the time, the messages are fire and forget. Round-trip messages might include queries for updates and subsequent downloads.

Trucks, Farm Equipment

Typesafe

image: http://upload.wikimedia.org/wikipedia/commons/6/60/Modern-tractor.jpg

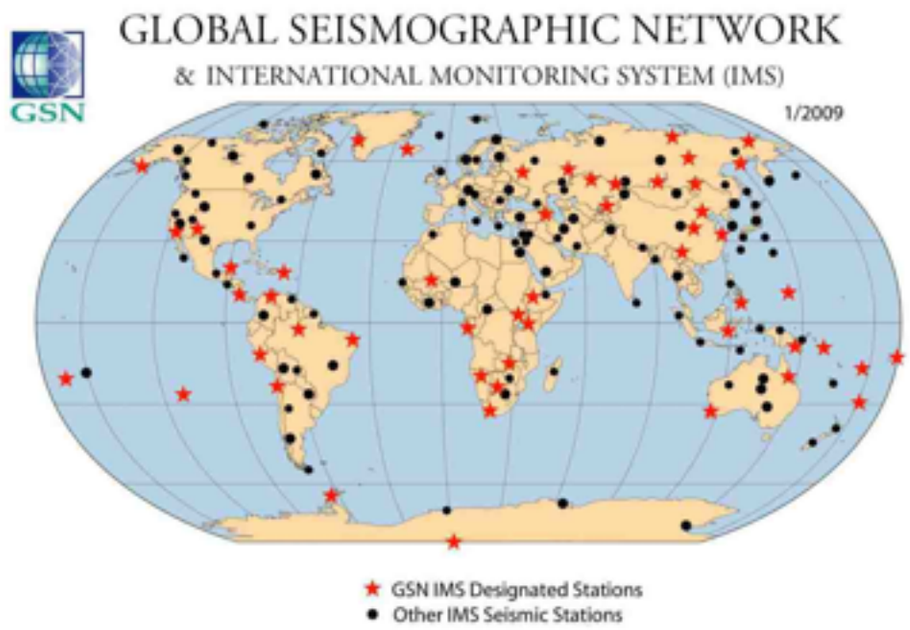
Trucks, Farm Equipment

- *Phone Home* to report movements determined using GPS.
  - Optimize routing.
  - Spy on drivers?
- Occasional network.

Typesafe

The data can be uploaded in batch. It's usually not required for real-time analytics.

Remote Sensors

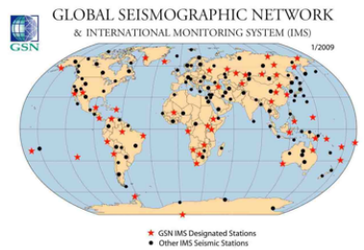


Typesafe

Used to monitor earthquakes and nuclear test ban compliance.
Another example is the growing network of Tsunami detectors.
Image: http://upload.wikimedia.org/wikipedia/commons/6/60/Modern-tractor.jpg

Remote Sensors

- *Human* to *Real Time*: trigger alert systems.
  - Earthquake warning systems.
  - Nuclear test pinpointing - test ban compliance.
- Reliable networks



Typesafe

The data can be uploaded in batch. It's usually not required for real-time analytics.

The Core Infrastructure

The case for a *Reactive* implementation.

The Core Infrastructure

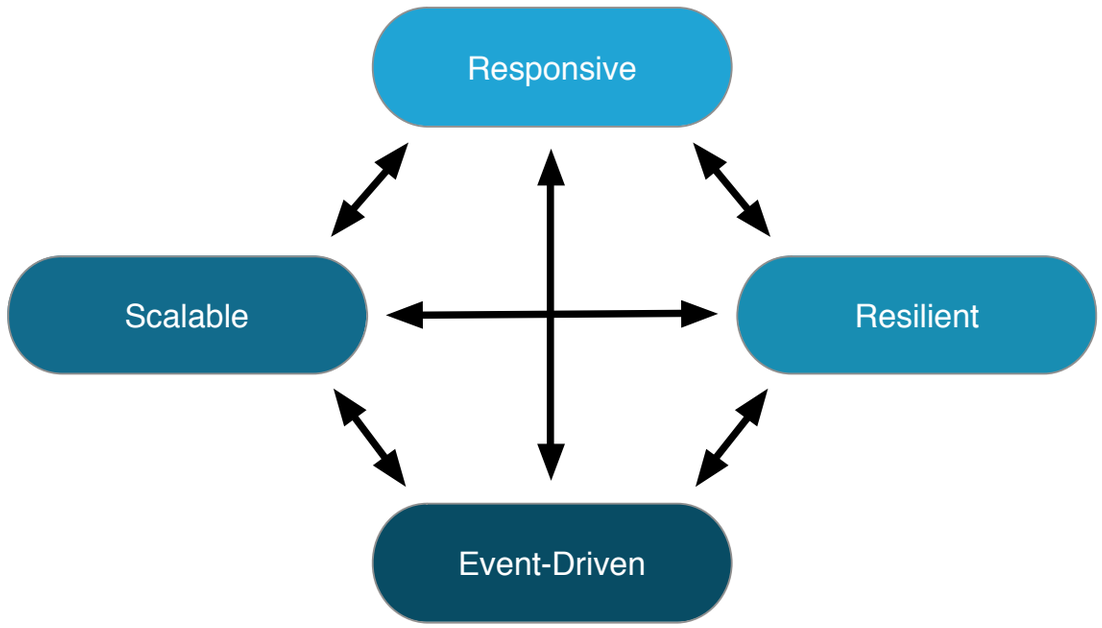
Reactive - the system responds to events quickly, rather than driving system activity

Reactive Manifesto

Typesafe

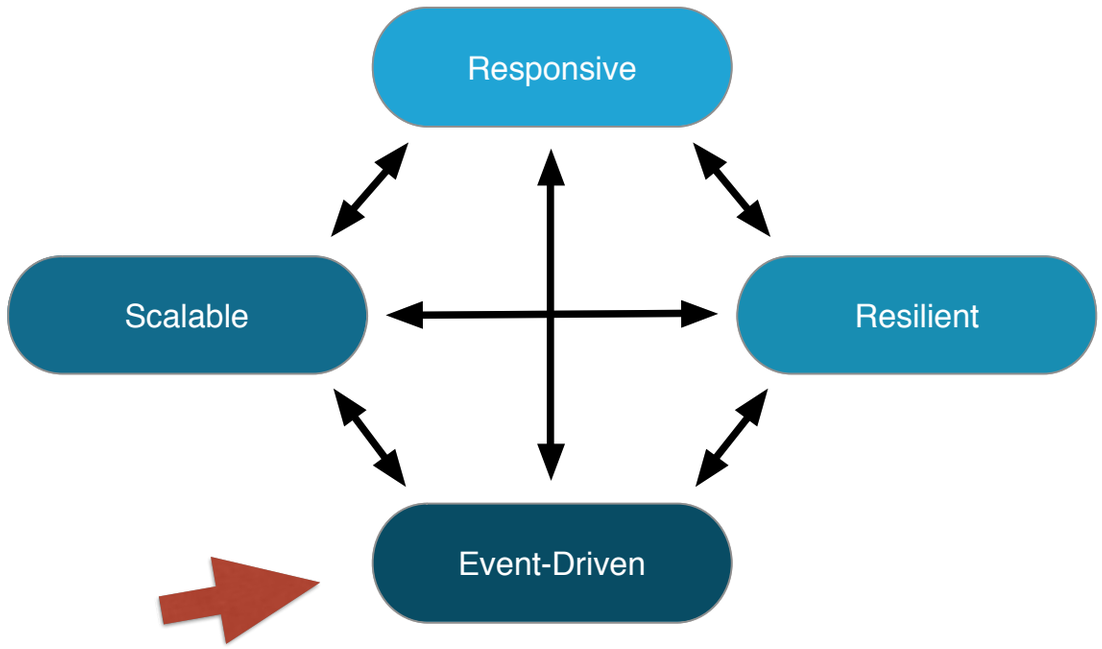
Why a Manifesto?

- *Reactive* has been trending up:
  - Growing popularity of event-driven systems like Node.js, Erlang, Akka.
  - evangelism: Erik Meijer, Jonas Bonér, Martin Thompson…
- Define the “buzz word” preemptively…



reactivemanifesto.org

Typesafe



reactivemanifesto.org

Typesafe

Event Driven

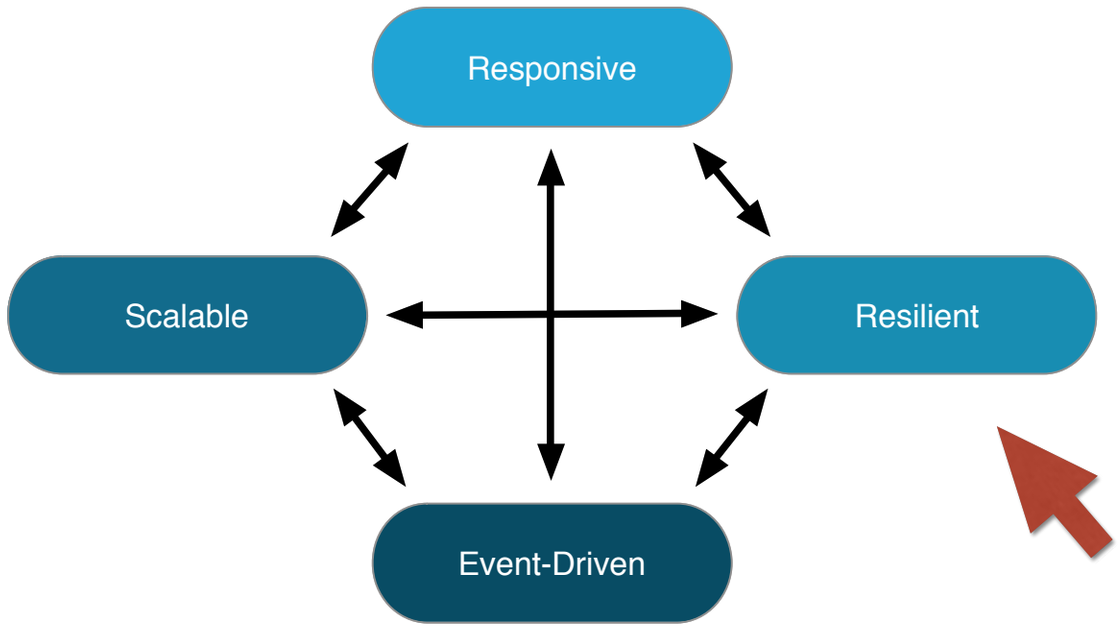
Reactive Applications scale up *and* down on demand

- *Asynchronous Programming*:
  - Transparently leverage all cores on each CPU.
  - Avoid resource contention; no blocking!
  - Add/remove servers dynamically.

Event Driven

Reactive Applications respond to changes in the world around them

- *Messages* are passed between services and subsystems.
- *Asynchronous* and *non-blocking* throughout.
- You define the *workflow*; the runtime decides how to *schedule* those tasks.



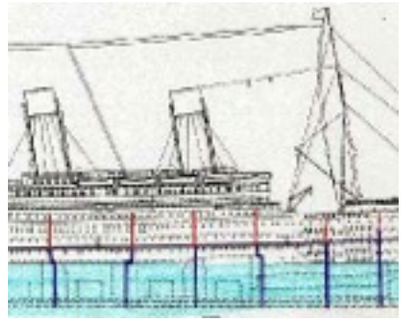
reactivemanifesto.org

Typesafe

Resilient

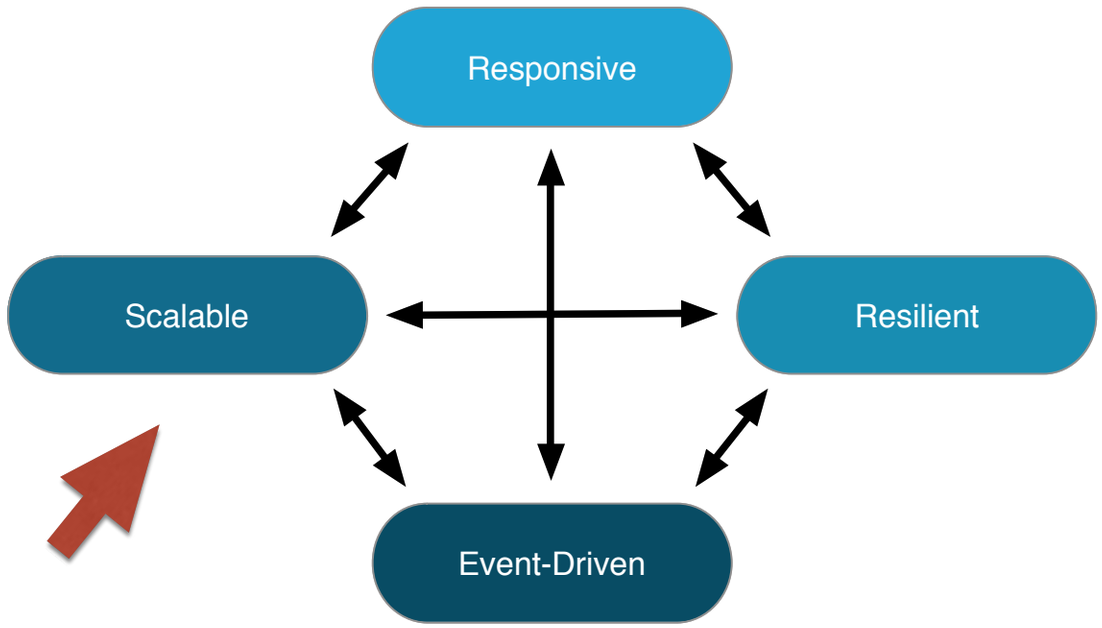
Reactive Applications are architected to handle failure at all levels

- *Bulkheads*: contain “damage”.
  - Within one process.
  - Within one server.
  - Within one datacenter.
  - …



Typesafe

Bulkheads are built into ships, for example, to contain leaks to a small section without compromising the whole ship. Firefalls perform a similar function.
Image: http://axion.physics.ubc.ca/titanic/03_bulkhead.jpg



reactivemanifesto.org

Typesafe

Scalable

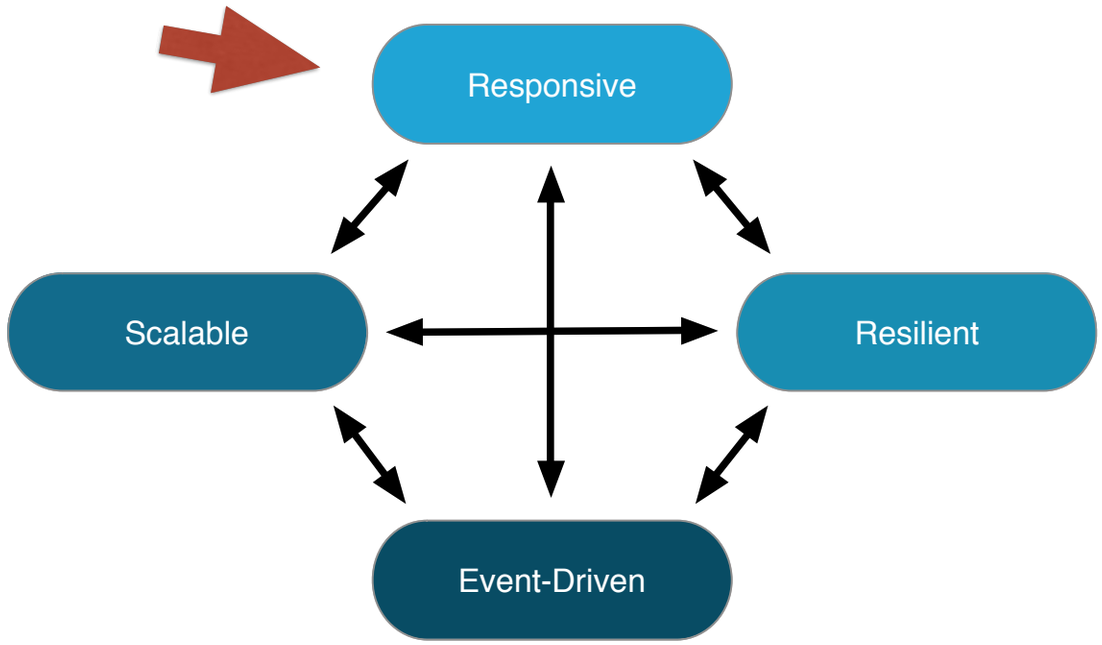
Reactive Applications scale up *and* down on demand

- *Asynchronous Programming*:
  - Leverage all cores on a CPU.
  - Avoid resource contention.
  - Add/remove servers dynamically.

Scalable

Reactive Applications scale up *and* down on demand

- *Horizontal Scaling*:
  - Add servers, clusters.
  - ~Linear performance, load gain?



reactivemanifesto.org

Typesafe

Responsive

Reactive Applications are always available & provide low-latency responsiveness

- No *SPOFs*:
- No *bottlenecks*.
- Tuned for *performance*.
- Minimized *latency*.

Typesafe

Latency sources include garbage collection pauses, resource contention, network partitions, and bottlenecks.

So, a Reactive Application:

- Is *reactive* from top to bottom.
- *Decouples* event generation and processing.
- *Minimizes* the weakest link in the chain to match *Amdahl's Law*.

For More…

- See this *Martin Thompson Interview*:
  - infoq.com/interviews/reactive-system-design-martin-thompson

Typesafe Stack

- Actors are asynchronous and communicate via message passing
- Supervision and clustering in support of fault tolerance

- Purely asynchronous and non-blocking web frameworks
- No container required, no inherent bottlenecks in session management

- Asynchronous and immutable programming constructs
- Composable abstractions enabling simpler concurrency and parallelism

Typesafe Stack

- Actors are asynchronous and communicate via message passing
- Supervision and clustering in support of fault tolerance

- Purely asynchronous and non-blocking web frameworks
- Supervision and clustering in support of fault tolerance

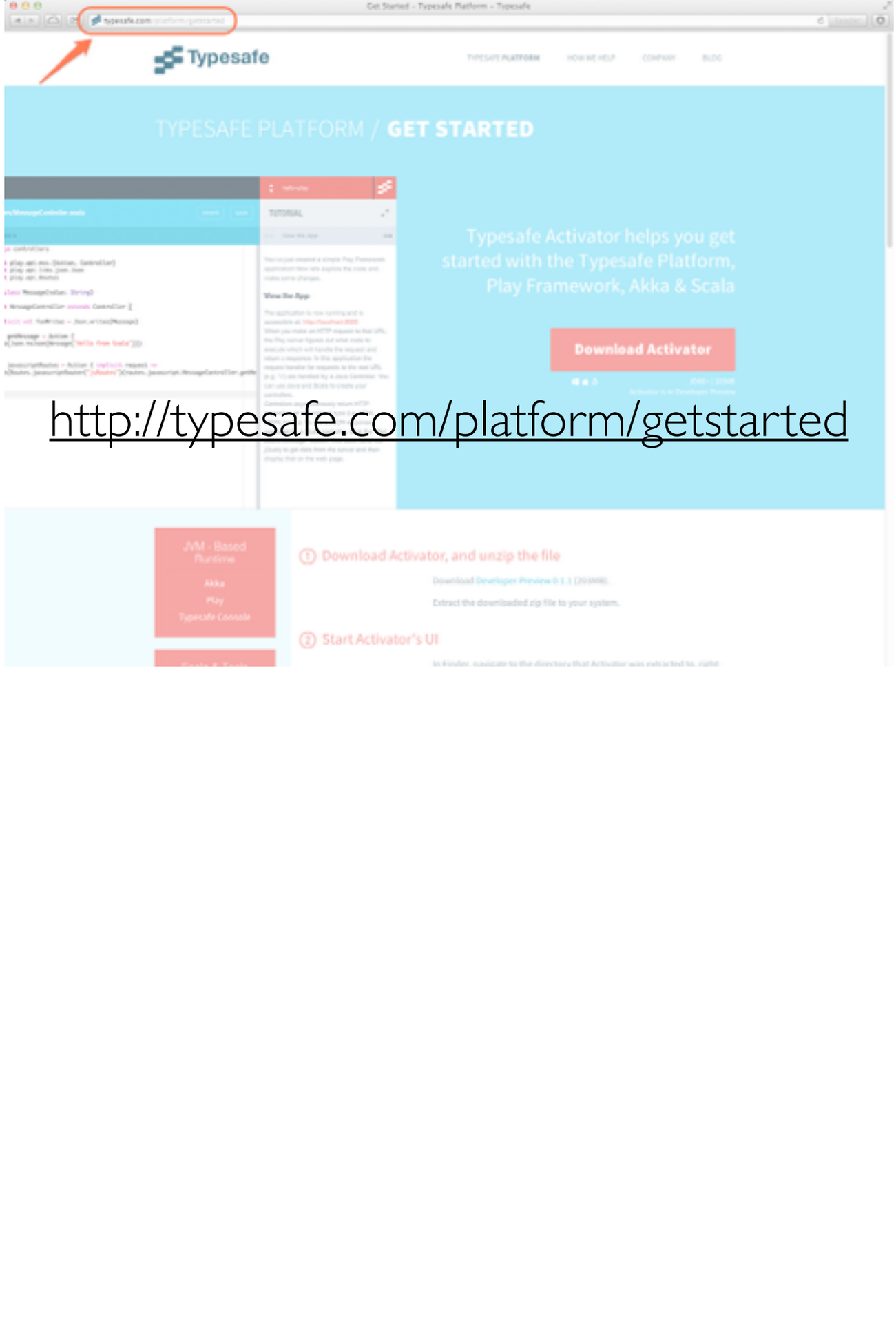
- Asynchronous and immutable programming constructs
- Composable abstractions enabling simpler concurrency and parallelism

Typesafe Stack

- Actors are asynchronous and communicate via message passing
- Supervision and clustering in support of fault tolerance

- Purely asynchronous and non-blocking web frameworks
- No container required, no inherent bottlenecks in session management

- Asynchronous and immutable programming constructs
- Composable abstractions enabling simpler concurrency and parallelism



http://typesafe.com/platform/getstarted

Reactive Coursera Course

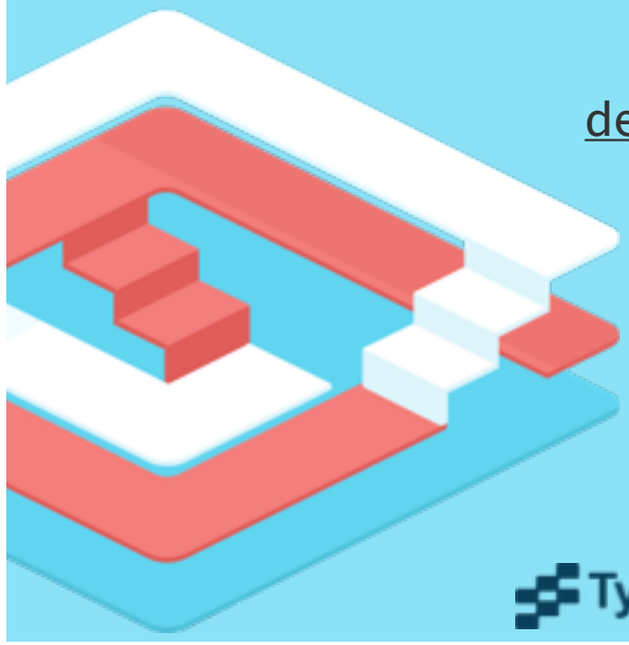
Principles of Reactive Programming

coursera.org/course/reactive

Started November 4th,
7 weeks long

Typesafe

Thank You!
Questions?



dean.wampler@typesafe.com

@deanwampler

Typesafe