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VERT.X

A TOOLKIT TO BUILD DISTRIBUTED
REACTIVE SYSTEMS

CLEMENT ESCOFFIER, JULIEN VIET

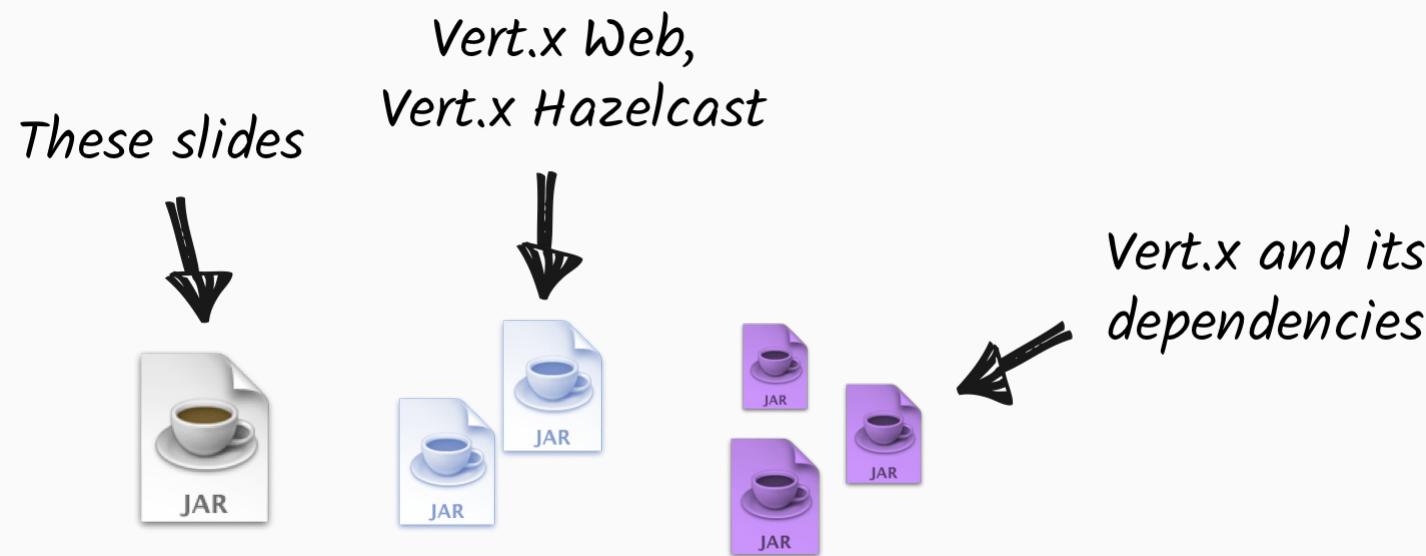
Vert.x Core Developers, Red Hat



**VERT.X IS A TOOLKIT TO BUILD
DISTRIBUTED AND REACTIVE
APPLICATIONS ON TOP OF THE JVM
USING AN ASYNCHRONOUS NON-
BLOCKING DEVELOPMENT MODEL.**

TOOLKIT

- Vert.x is a plain boring **jar**
- Vert.x components are plain boring jars
- Your application depends on this set of jars (classpath, *fat-jar*, ...)



DISTRIBUTED

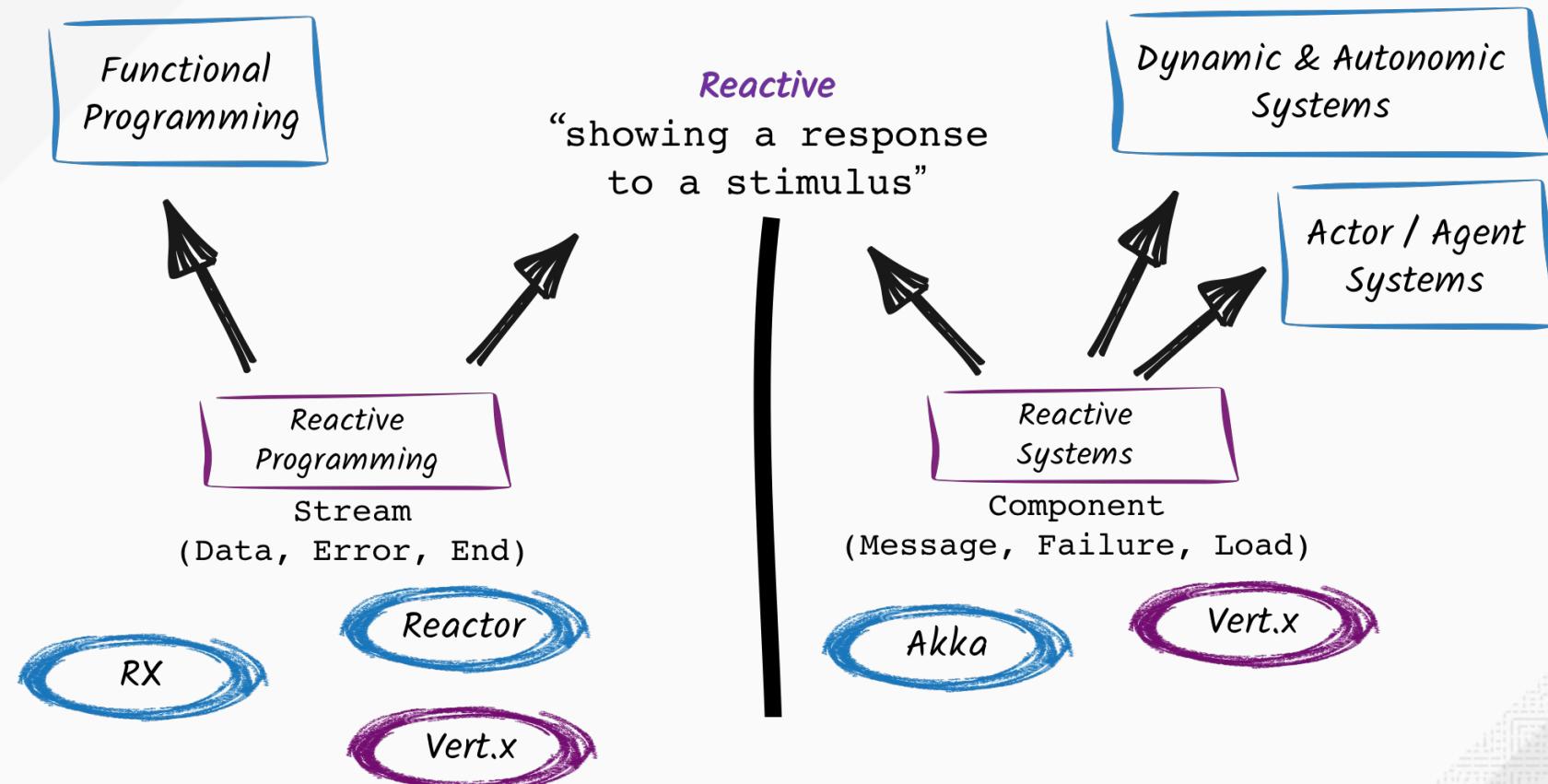
“ You know you have a distributed system when the crash of a computer you've never heard of stops you from getting any work done.” (Leslie Lamport)

REACTIVE SYSTEMS

- **Responsive** - they respond in an *acceptable* time
- **Elastic** - they scale up and down
- **Resilient** - they are designed to handle failures *gracefully*
- **Asynchronous** - they interact using async messages

<http://www.reactivemanifesto.org/>

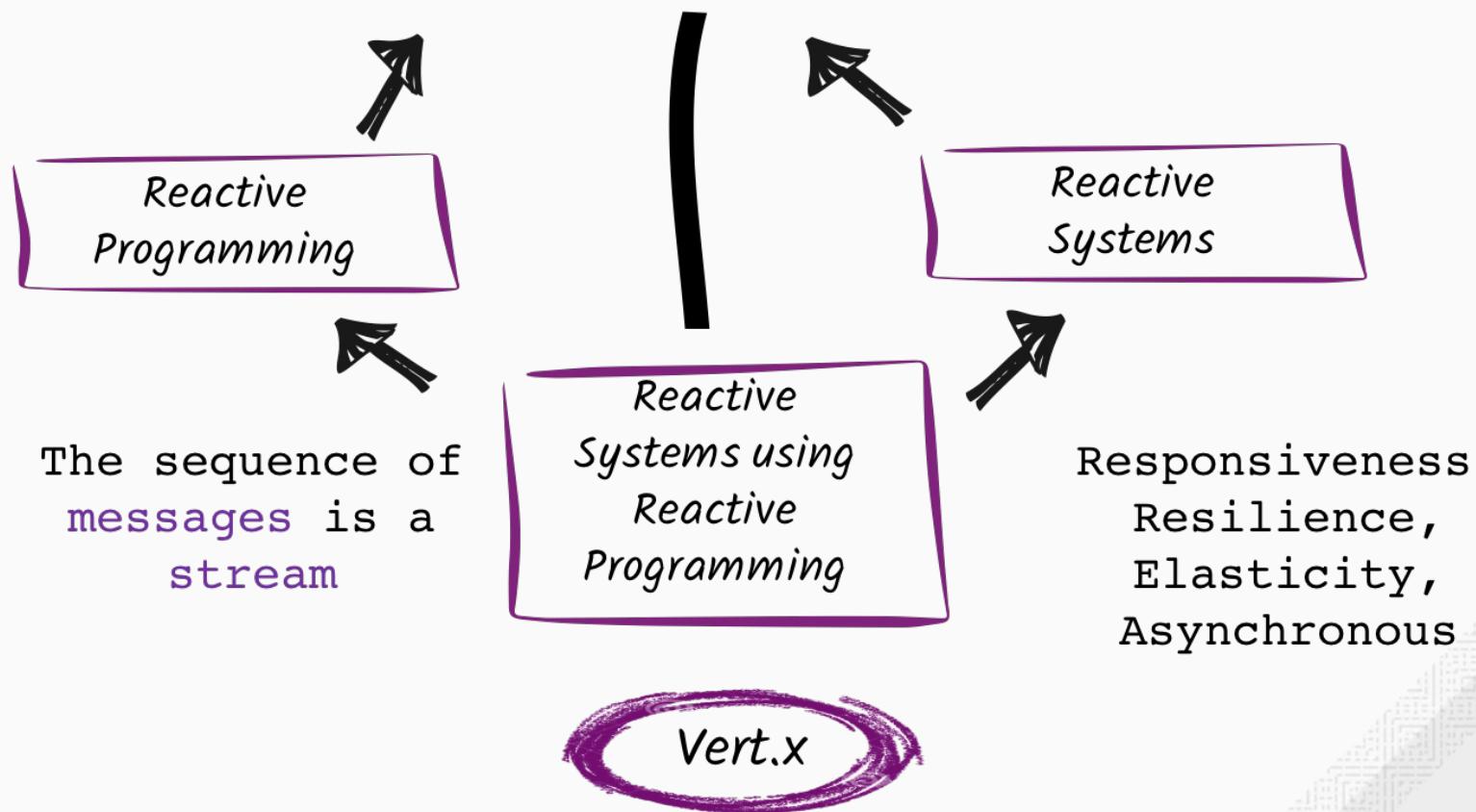
REACTIVE SYSTEMS != REACTIVE PROGRAMMING



REACTIVE SYSTEMS + REACTIVE PROGRAMMING

Reactive

“showing a response
to a stimulus”



POLYGLOT

Vert.x applications can be developed using

- Java
- Groovy
- Ruby (JRuby)
- JavaScript (Nashorn)
- Ceylon
- *Scala*
- *Kotlin*

MICROSERVICES

REBRANDING DISTRIBUTED APPLICATIONS

MICROSERVICES

“ The microservice **architectural style** is an approach to developing a single application as **a suite of small services**, each running in its own process and communicating with **lightweight mechanisms**, often an HTTP resource API. These services are built around business capabilities and **independently deployable** by fully automated deployment machinery. There is a **bare minimum of centralized management** of these services, which may be written in different programming languages and use different data storage technologies. (Martin Fowler)

A SUITE OF INDEPENDENT SERVICES:

Each service runs in its own process

- So they are **distributed applications**

Lightweight interactions - Loose-coupling

- **Not only HTTP**
- Messaging
- Streams
- (async) RPC

A SUITE OF INDEPENDENT SERVICES:

Independently developed, tested and deployed

- Automated process
- (Liskov) substitutability

It's all about **agility**

- Agility of the composition
- You can replace any microservice
- You can decide who uses who

SORRY... NO FREE LUNCH

Distributed applications are hard

- **fail** (fail-stop, byzantine fault)
- Discoverability issue
- Reliability issue
- Availability issue

How to keep *things* on track

- Monitoring
- Health
- Tracing
- ...

COMPLEXITY GROWTH



VERT.X

A toolkit to build distributed systems & microservices

VERT.X

Build **distributed** systems:

- Do not hide the **complexity**
- **Failure** as first-class citizen
- Provide the building blocks, not an all-in-one solution

Build **microservice** systems:

- Asynchronous
- Location transparency
- Resilience patterns
- Simple deployment & management

WHAT DOES VERT.X PROVIDE ?

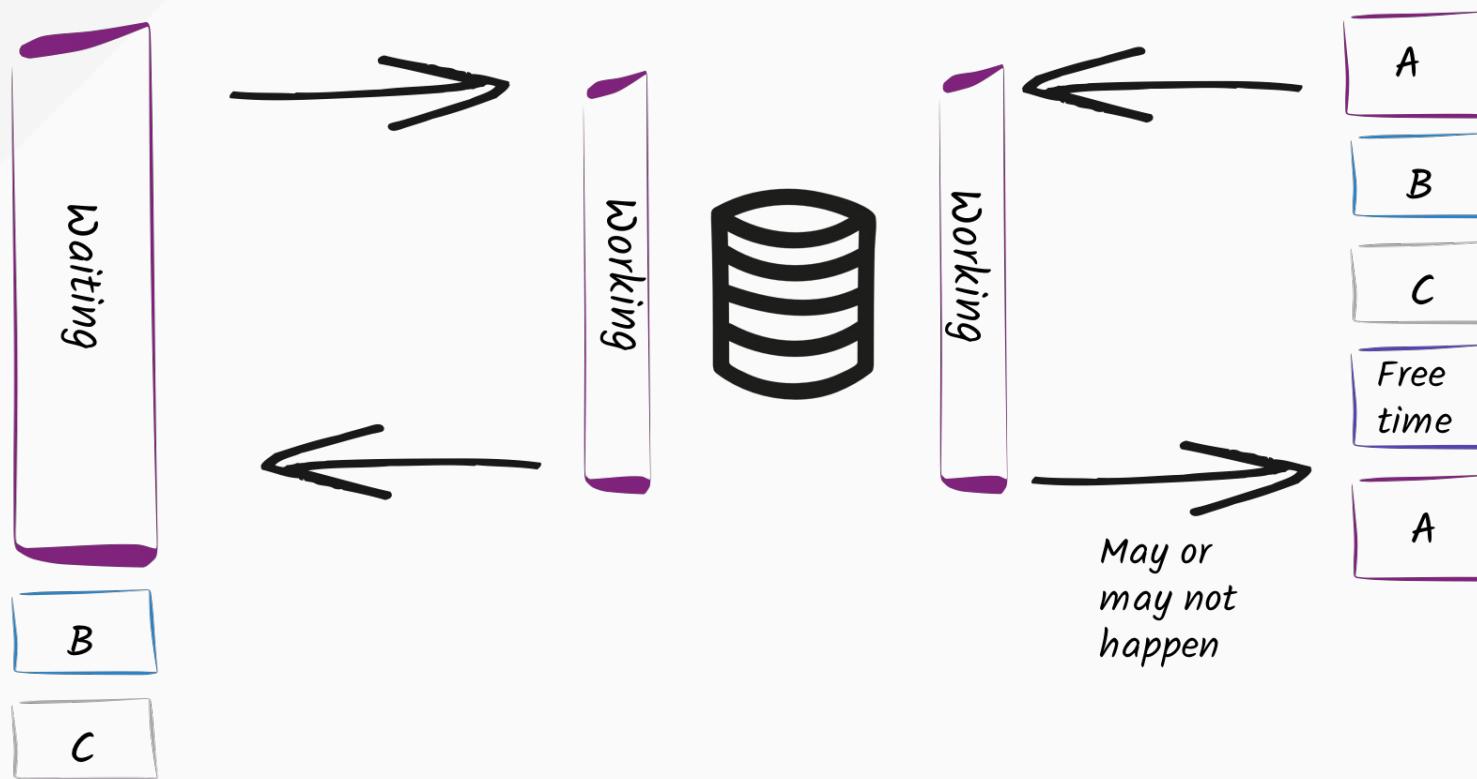
- TCP, UDP, HTTP 1 & 2 servers and clients
- (non-blocking) DNS client
- Clustering
- Event bus (messaging)
- Distributed data structures
- (built-in) Load-balancing
- (built-in) Fail-over
- Pluggable service discovery, circuit-breaker
- Metrics, Shell

REACTIVE

Build **reactive distributed** systems:

- **Responsive** - fast, is able to handle a large number of events / connections
- **Elastic** - scale up and down by just starting and stopping nodes, round-robin
- **Resilient** - failure as first-class citizen, fail-over
- **Asynchronous message-passing** - asynchronous and non-blocking development model

ASYNCHRONOUS & NON-BLOCKING



ASYNCHRONOUS & NON-BLOCKING

```
// Synchronous development model
X x = doSomething(a, b);

// Asynchronous development model - callback variant
doSomething(a, b, // Params
    ar -> {      // Last param is a Handler<AsyncResult<X>>
        // Result handler
    });
}

// Asynchronous development model - future variant
Future<X> future = doSomething(a, b);
future.setHandler(
    ar -> { /* Completion handler */});
```

REQUEST - REPLY INTERACTIONS

HTTP, TCP, RPC...

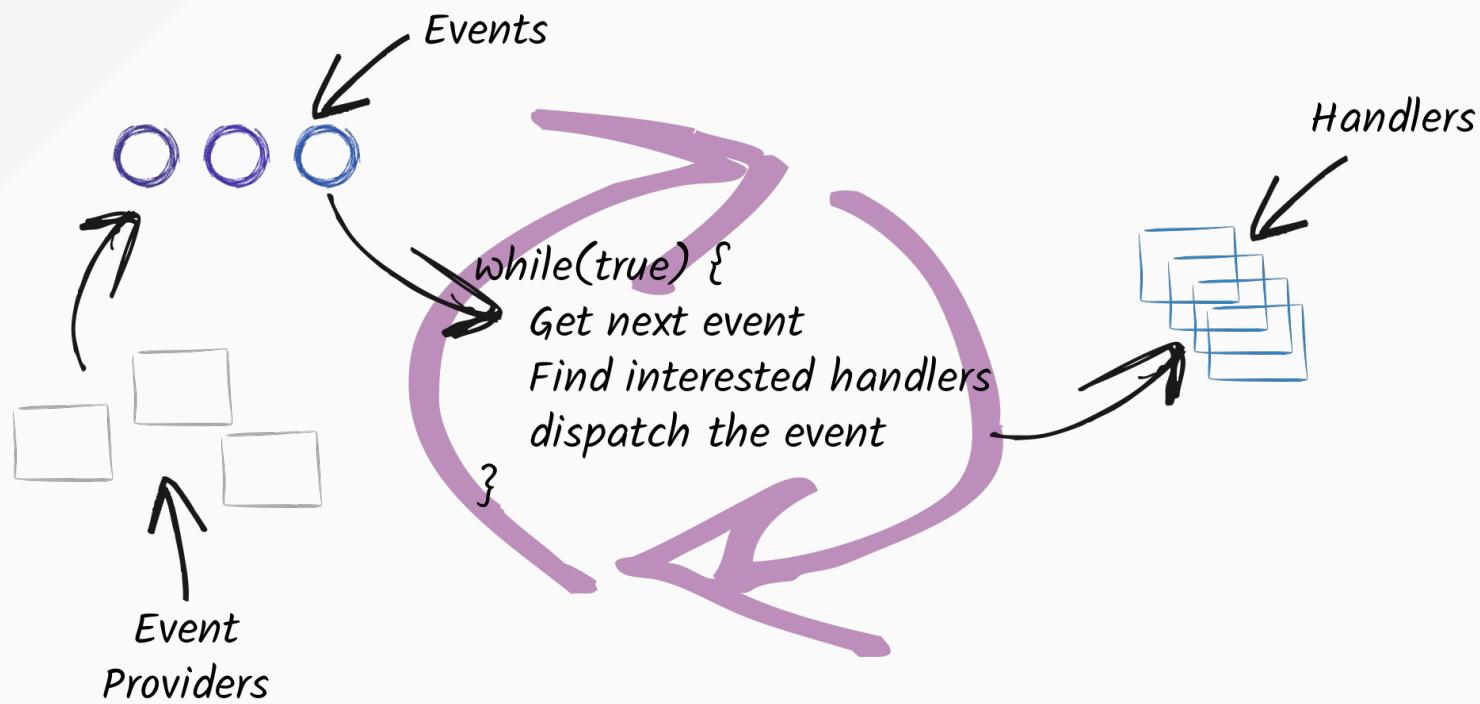
VERT.X HELLO WORLD

```
Vertx vertx = Vertx.vertx();
vertx.createHttpServer()
    .requestHandler(request -> {
        // Handler receiving requests
        request.response().end("World !");
    })
    .listen(8080, ar -> {
        // Handler receiving start sequence completion (AsyncResult)
        if (ar.succeeded()) {
            System.out.println("Server started on port "
                + ar.result().actualPort());
        } else {
            ar.cause().printStackTrace();
        }
    });
});
```

VERT.X HELLO WORLD

Invoke

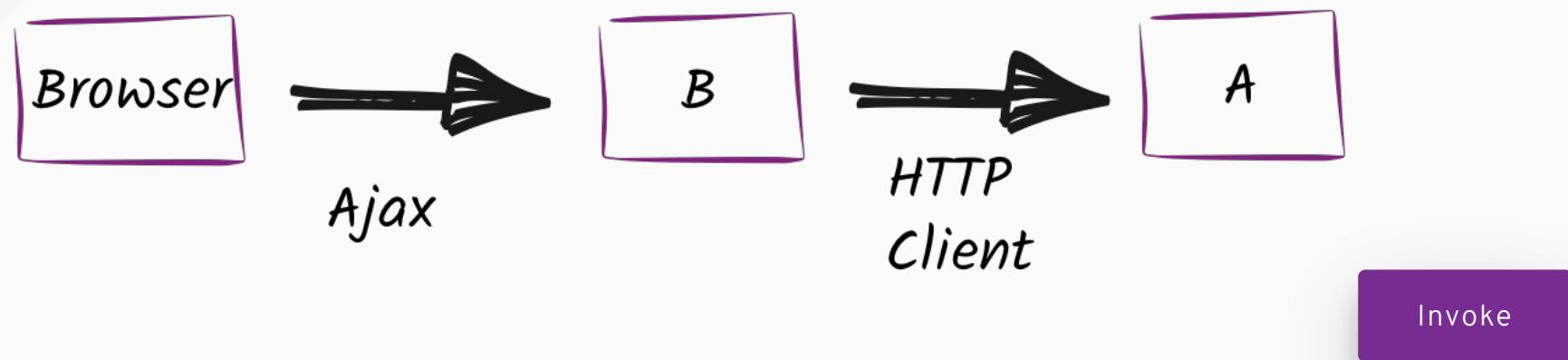
EVENT LOOPS



VERT.X ASYNC HTTP CLIENT

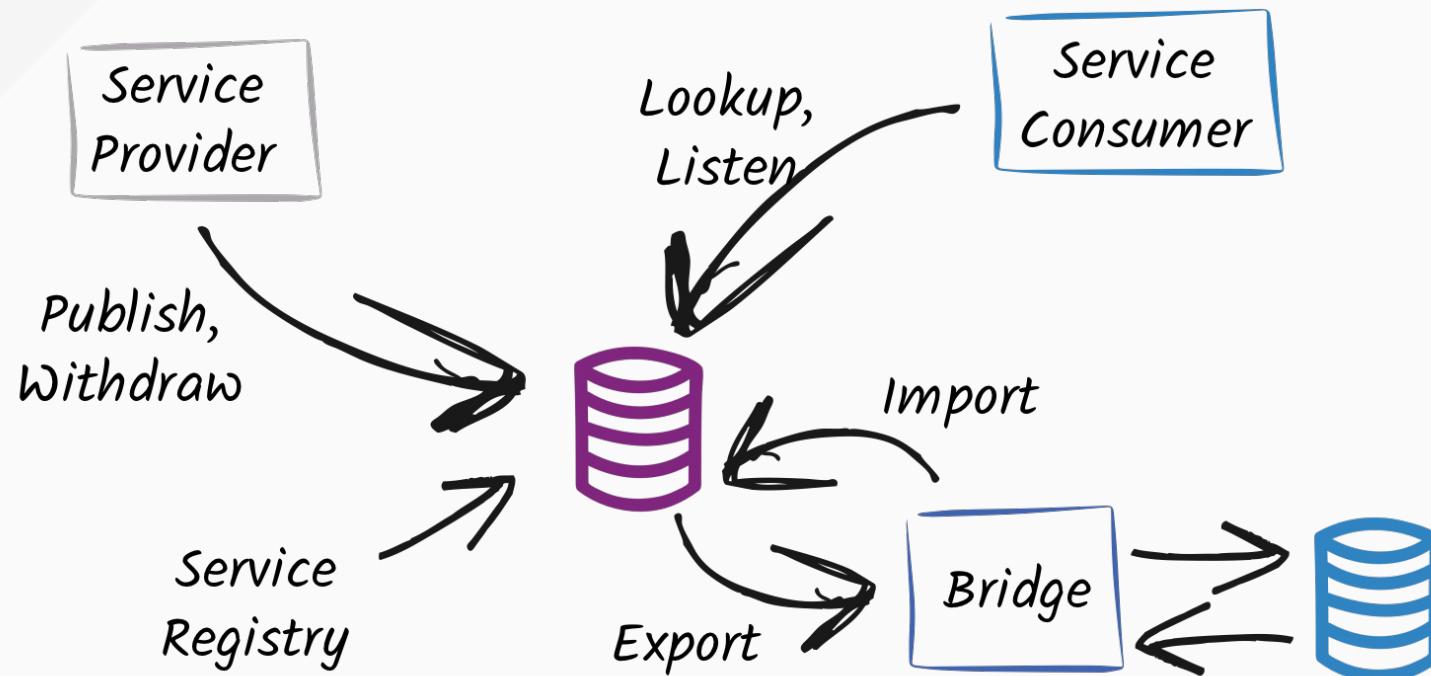
```
HttpClient client = vertx.createHttpClient(  
    new HttpClientOptions()  
        .setDefaultHost("localhost")  
        .setDefaultPort(8081));  
  
client.getNow("/", response -> {  
    // Handler receiving the response  
  
    // Get the content  
    response.bodyHandler(buffer -> {  
        // Handler to read the content  
    });  
});
```

CHAINED HTTP REQUESTS



SERVICE DISCOVERY

Locate the services, environment-agnostic



SERVICE DISCOVERY

```
HttpEndpoint.getClient(discovery,  
    new JsonObject().put("name", "vertx-http-server"),  
    result -> {  
        if (result.failed()) {  
            rc.response().end("D'oh no matching service");  
            return;  
        }  
        HttpClient client = result.result();  
        client.getNow("/", response -> {  
            response.bodyHandler(buffer -> {  
                rc.response().end("Hello " + buffer.toString());  
            });  
        });  
    });
```

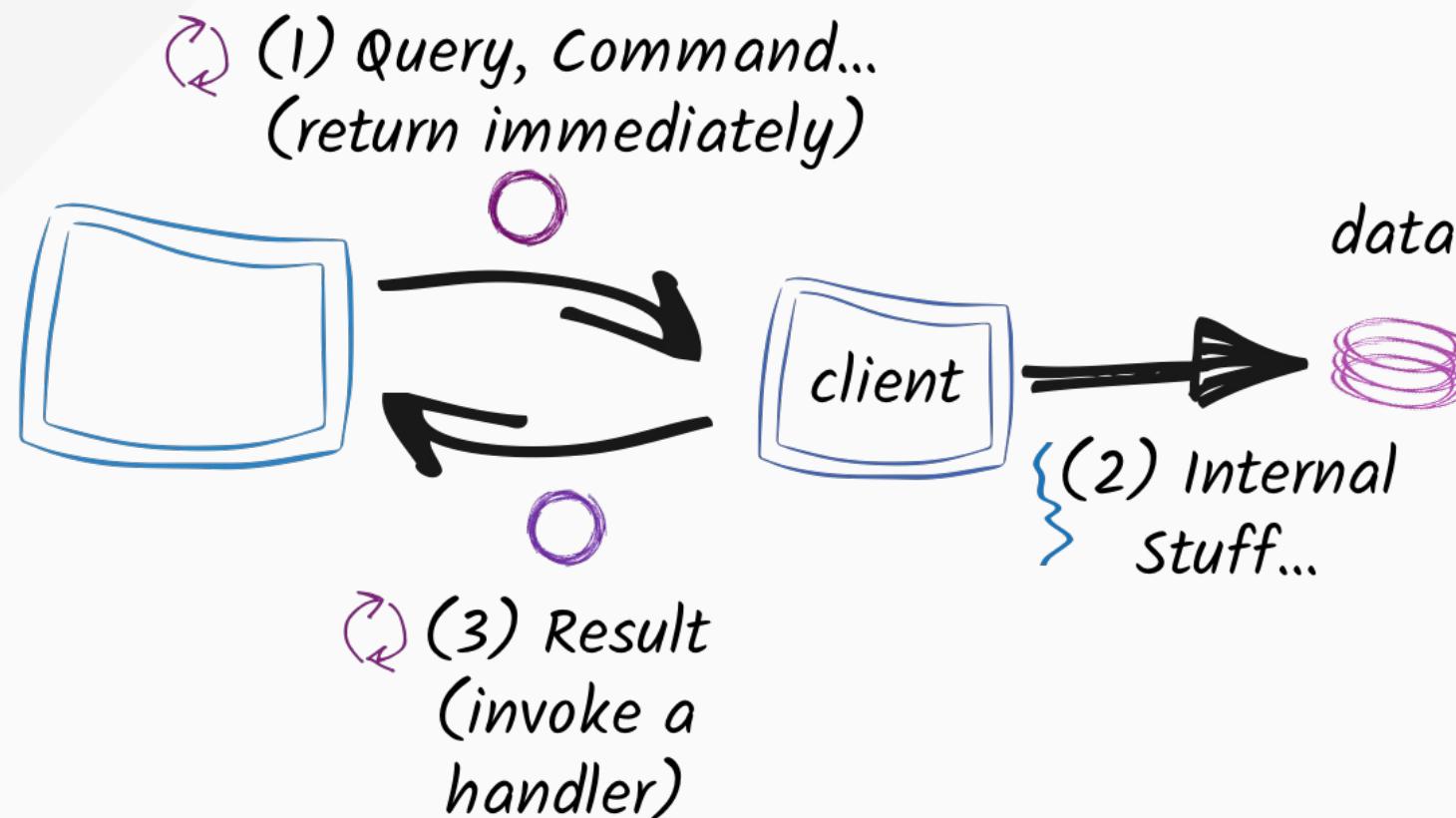
INTERACTING WITH BLOCKING SYSTEMS



```
vertx.executeBlocking(  
    future -> {  
        // Executed using a worker thread  
    },  
    asyncResult -> {  
        // Executed in the event loop thread  
        if (asyncResult.failed()) {  
            // ...  
        } else {  
            // ...  
        }  
    }  
);
```



INTERACTING WITH BLOCKING SYSTEMS



MESSAGING

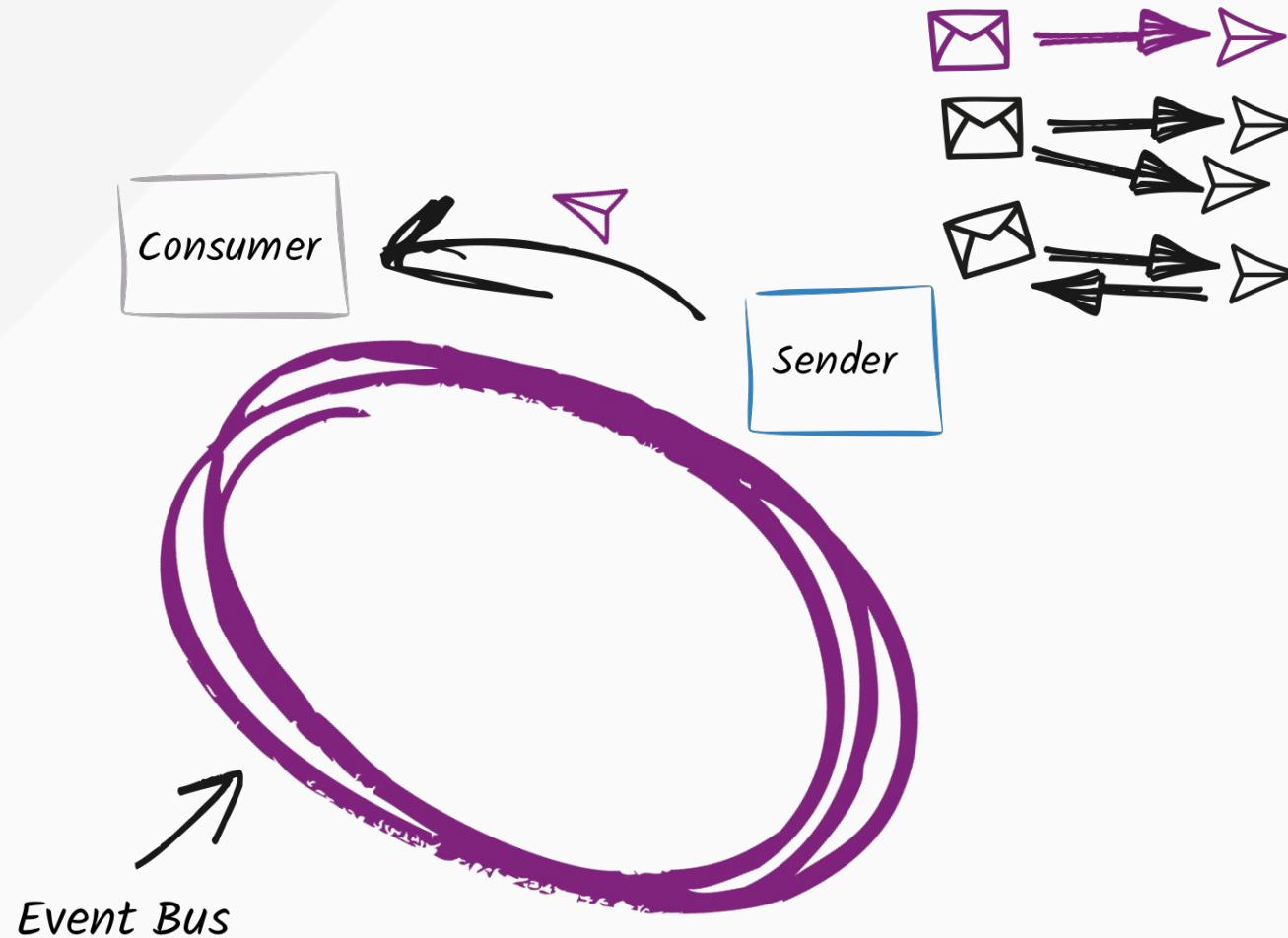
The eventbus - the spine of Vert.x applications...

THE EVENT BUS

The event bus is the **nervous system** of vert.x:

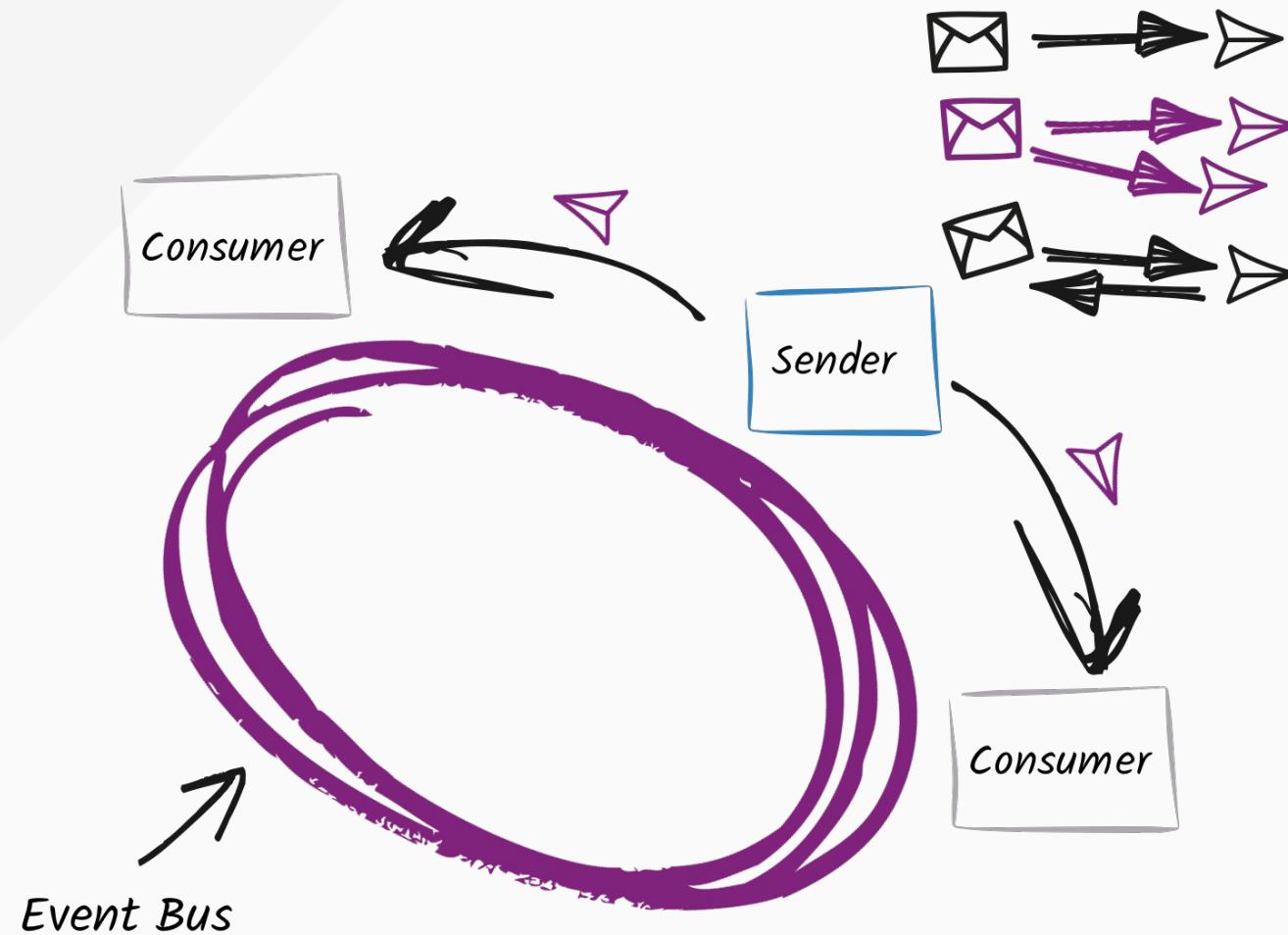
- Allows different components to communicate regardless
 - the implementation language and their location
 - whether they run on vert.x or not (using bridges)
- **Address:** Messages are sent to an address
- **Handler:** Messages are received by Handlers.

POINT TO POINT



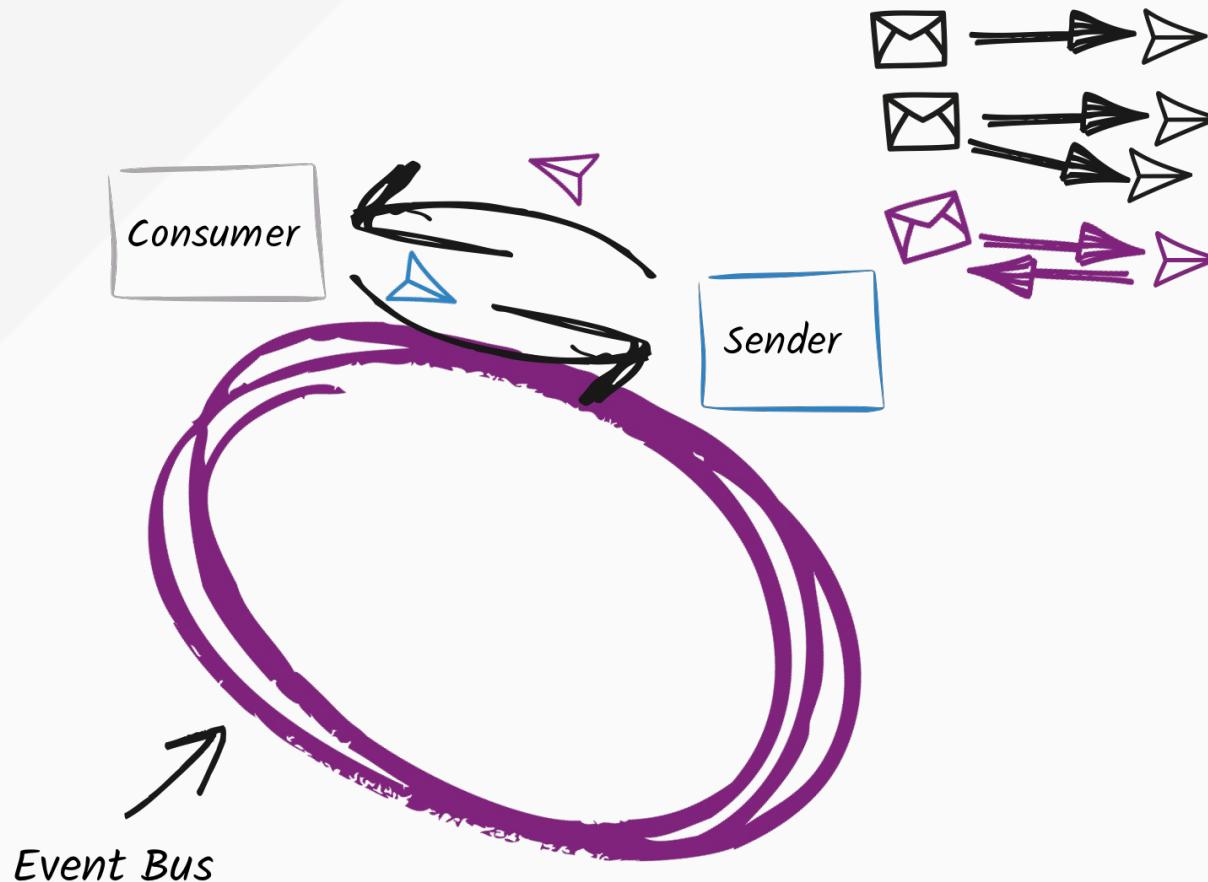
```
vertx.eventBus().send("address", "message");
vertx.eventBus().consumer("address", message -> {});
```

PUBLISH / SUBSCRIBE



```
vertx.eventBus().publish("address", "message");
vertx.eventBus().consumer("address", message -> {});
```

REQUEST / RESPONSE



```
vertx.eventBus().send("address", "message", reply -> {});  
vertx.eventBus().consumer("address",  
    message -> { message.reply("response"); });
```

FROM LOCAL TO CLUSTERED

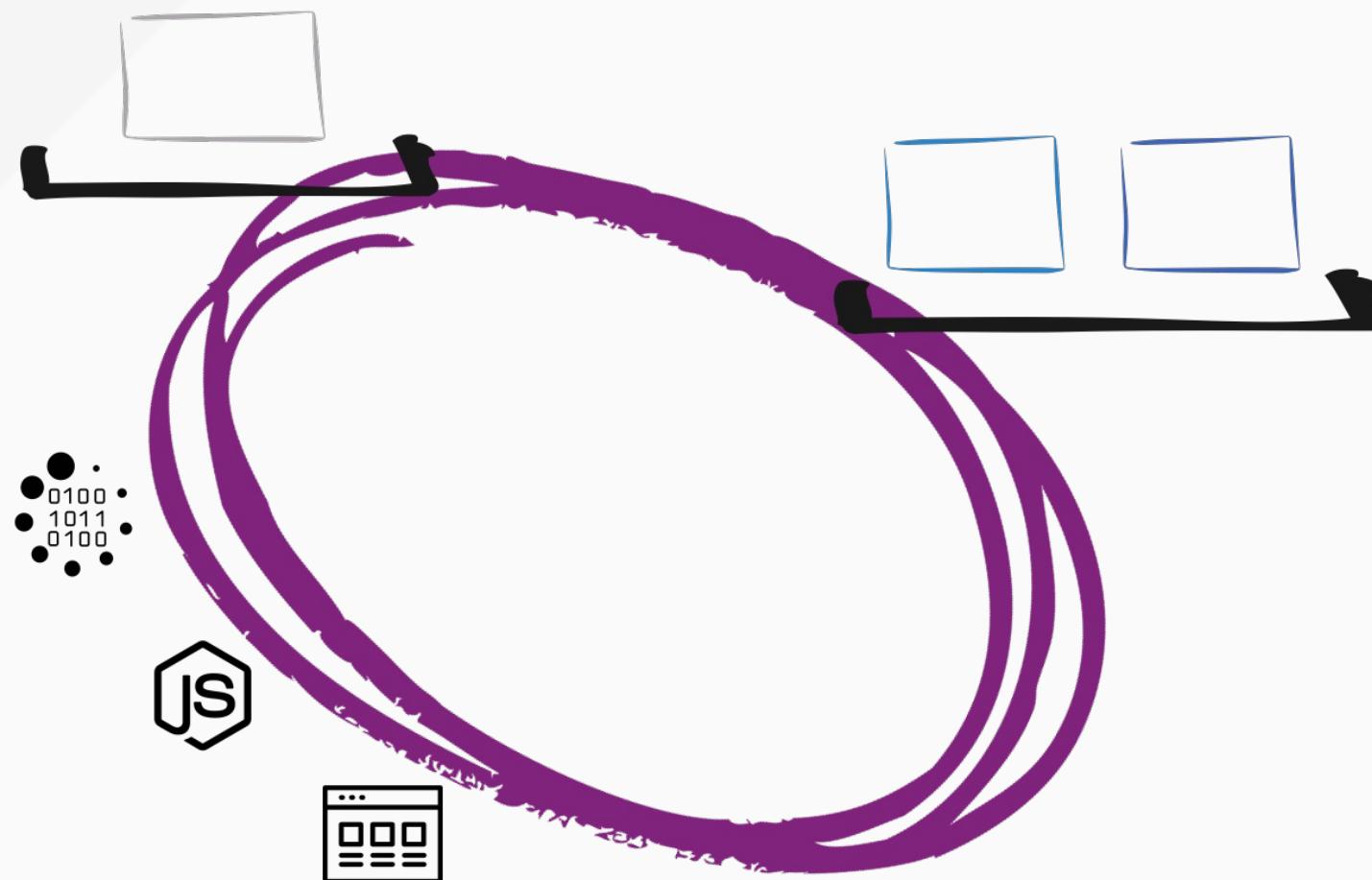
Vert.x instances form a **cluster**

```
Vertx.clusteredVertx(new VertxOptions(), result -> {
    if (result.failed()) {
        System.err.println("Cannot create a clustered vert.x : "
            + result.cause());
    } else {
        Vertx vertx = result.result();
        // ...
    }
});
```

The event bus is distributed on all the cluster members

DISTRIBUTED EVENT BUS

Almost anything can send and receive messages

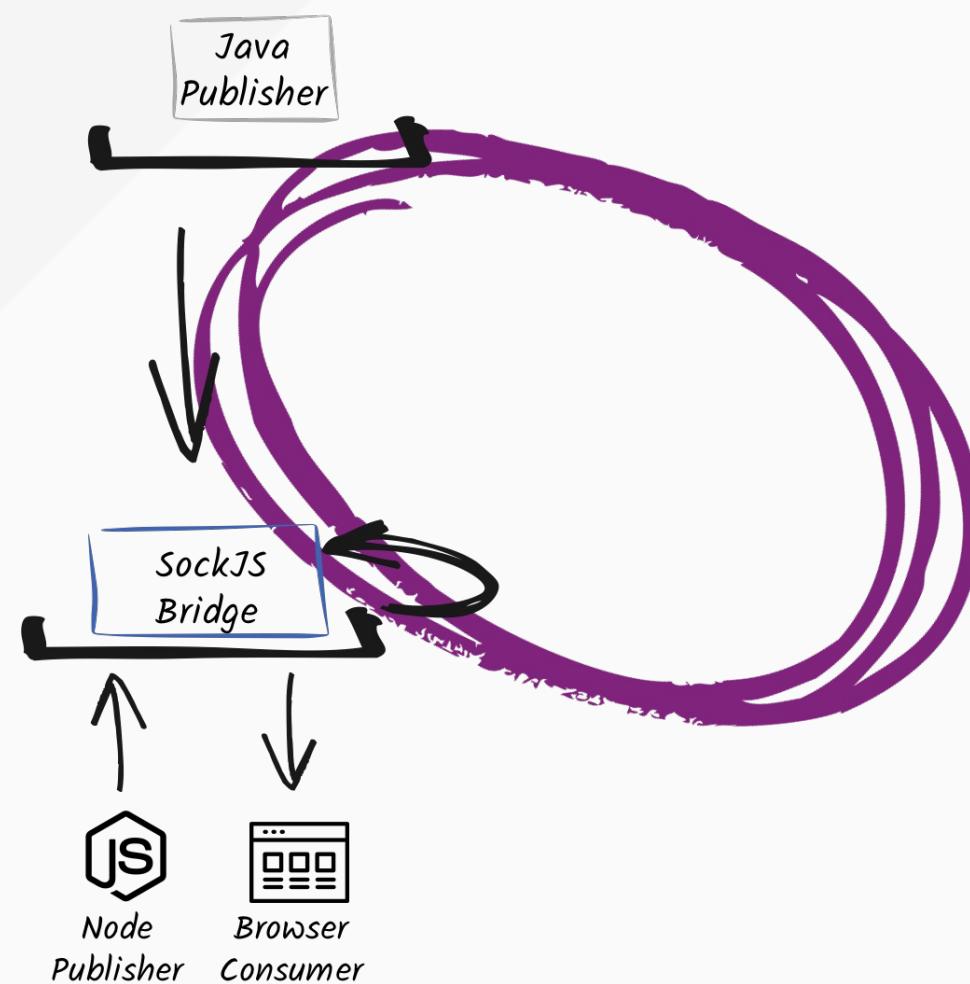


DISTRIBUTED EVENT BUS

Let's have a java (Vert.x) app, and a node app sending data just here:



DISTRIBUTED EVENT BUS



EVENTBUS CLIENTS AND BRIDGES

Bridges

- SockJS: browser, node.js
- TCP: languages / systems able to open a TCP socket
- Stomp
- AMQP
- Apache Camel

Clients:

- Go, C#, C, Python, Swift...

RELIABILITY PATTERNS

Don't be fool, be prepared to fail

RELIABILITY

It's not about being bug-free or bullet proof,
we are **humans**.

It's about being prepared to **fail**,
and handling these **failures**.

MANAGING FAILURES

Distributed communication may fail

AsyncResult lets us manage these failures:

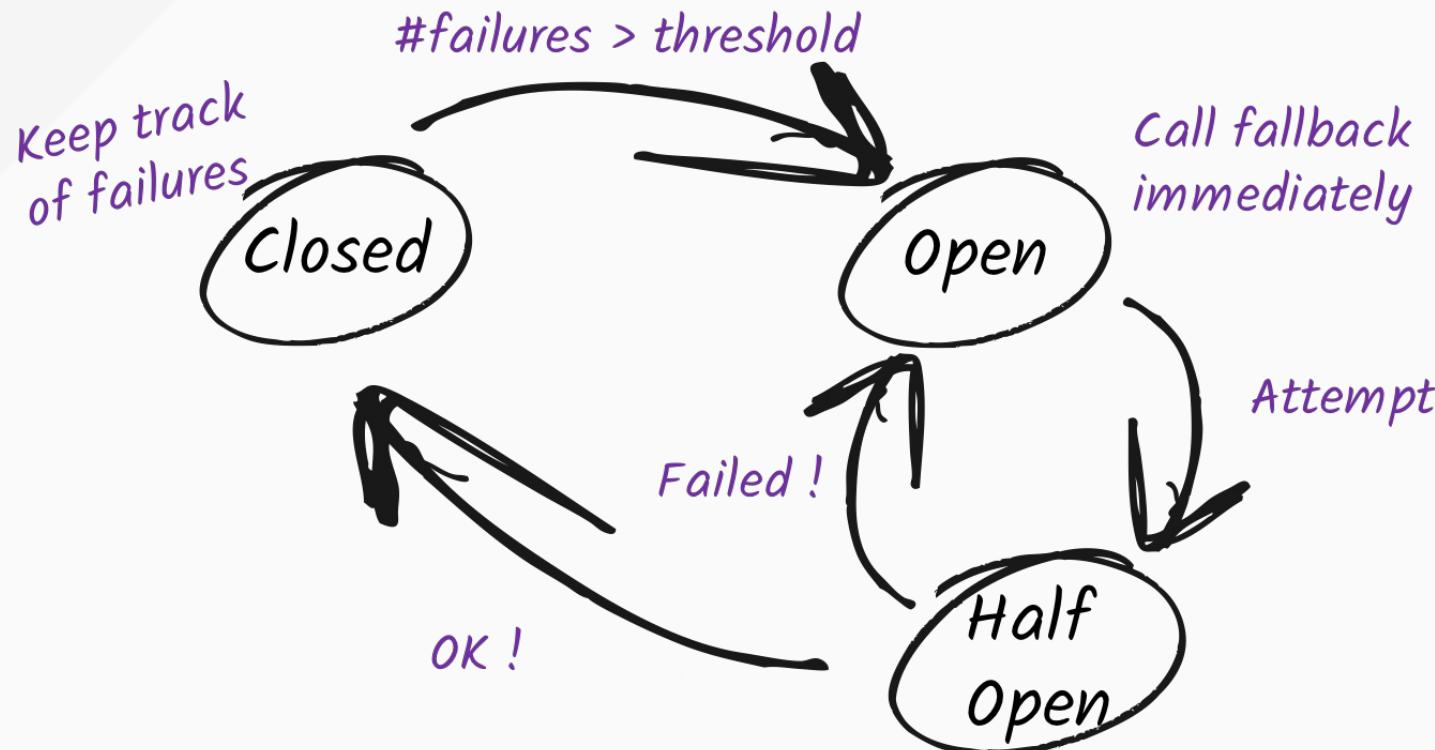
```
doSomethingAsync(param1, param2,  
    ar -> {  
        if (ar.failed()) {  
            System.out.println("D'oh, it has failed !");  
        } else {  
            System.out.println("Everything fine ! ");  
        }  
    });
```

MANAGING FAILURES

Adding timeouts

```
vertx.eventbus().send(..., ...,
    new DeliveryOptions().setSendTimeout(1000),
    reply -> {
        if (reply.failed()) {
            System.out.println("D'oh, he did not reply to me !");
        } else {
            System.out.println("Got a mail " + reply.result().body());
        }
    });
});
```

CIRCUIT BREAKER

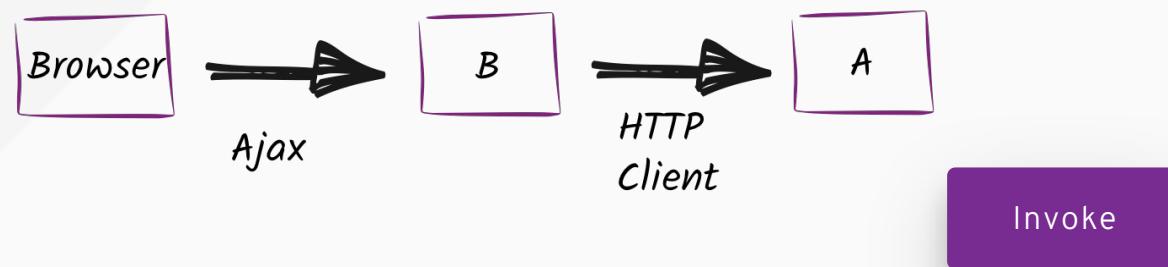


CIRCUIT BREAKER

```
cb.executeWithFallback(future -> {
    // Async operation
    client.get("/", response -> {
        response.bodyHandler(buffer -> {
            future.complete("Hello " + buffer.toString());
        });
    })
    .exceptionHandler(future::fail)
    .end();
},

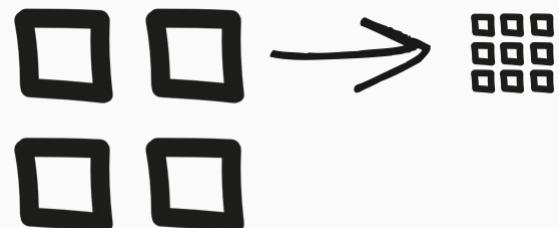
// Fallback
t -> "Sorry... " + t.getMessage() + " (" + cb.state() + ")"
)
// Handler called when the operation has completed
.setHandler(content -> /* ... */);
```

CIRCUIT BREAKER



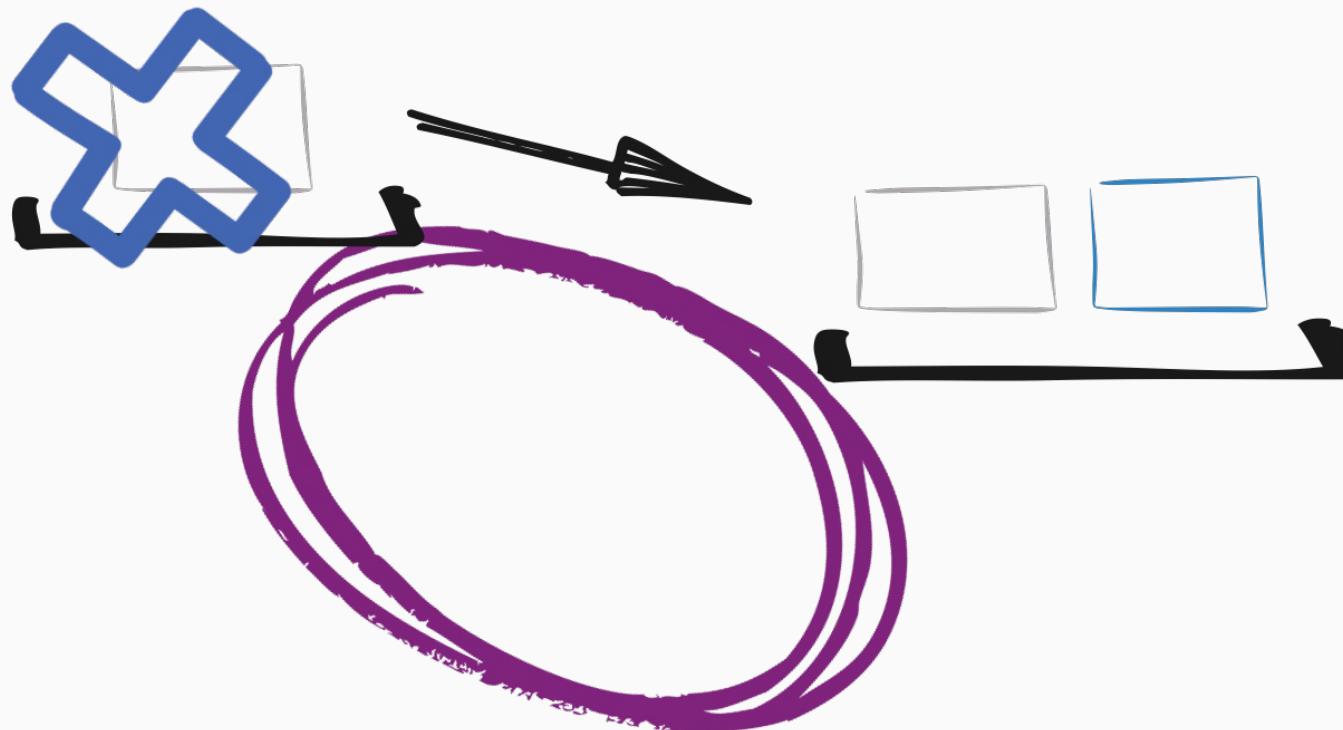
VERTICLE FAIL-OVER

- Verticles are chunk of code that get deployed and run by Vert.x
- Verticles can deploy other verticles
- Verticles can be written in Java, Groovy, JavaScript, Ruby, Ceylon...



VERTICLE FAIL-OVER

In **High-Availability** mode, verticles deployed on a node that **crashes** are redeployed on a sane node of the cluster.



VERTICLE FAIL-OVER

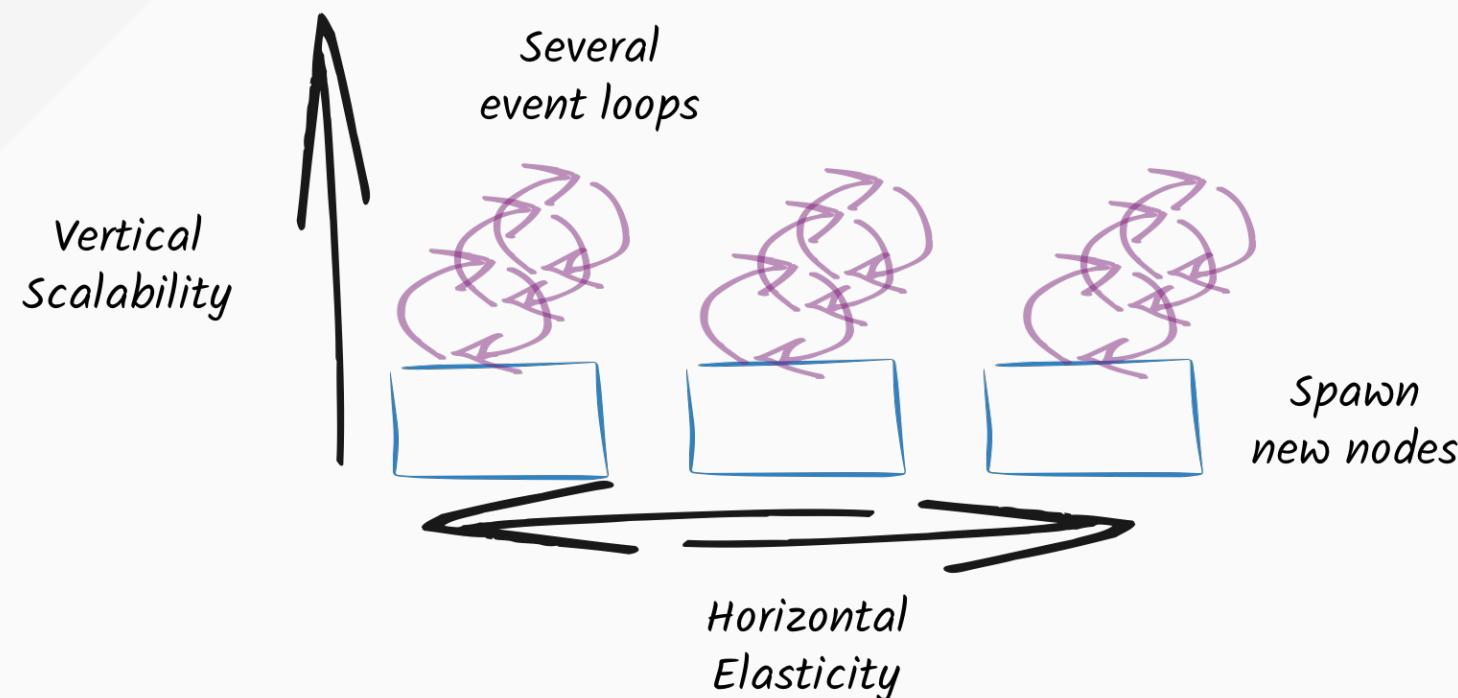
Invoke



ELASTICITY PATTERNS

Be prepared to be famous

ELASTICITY PATTERNS

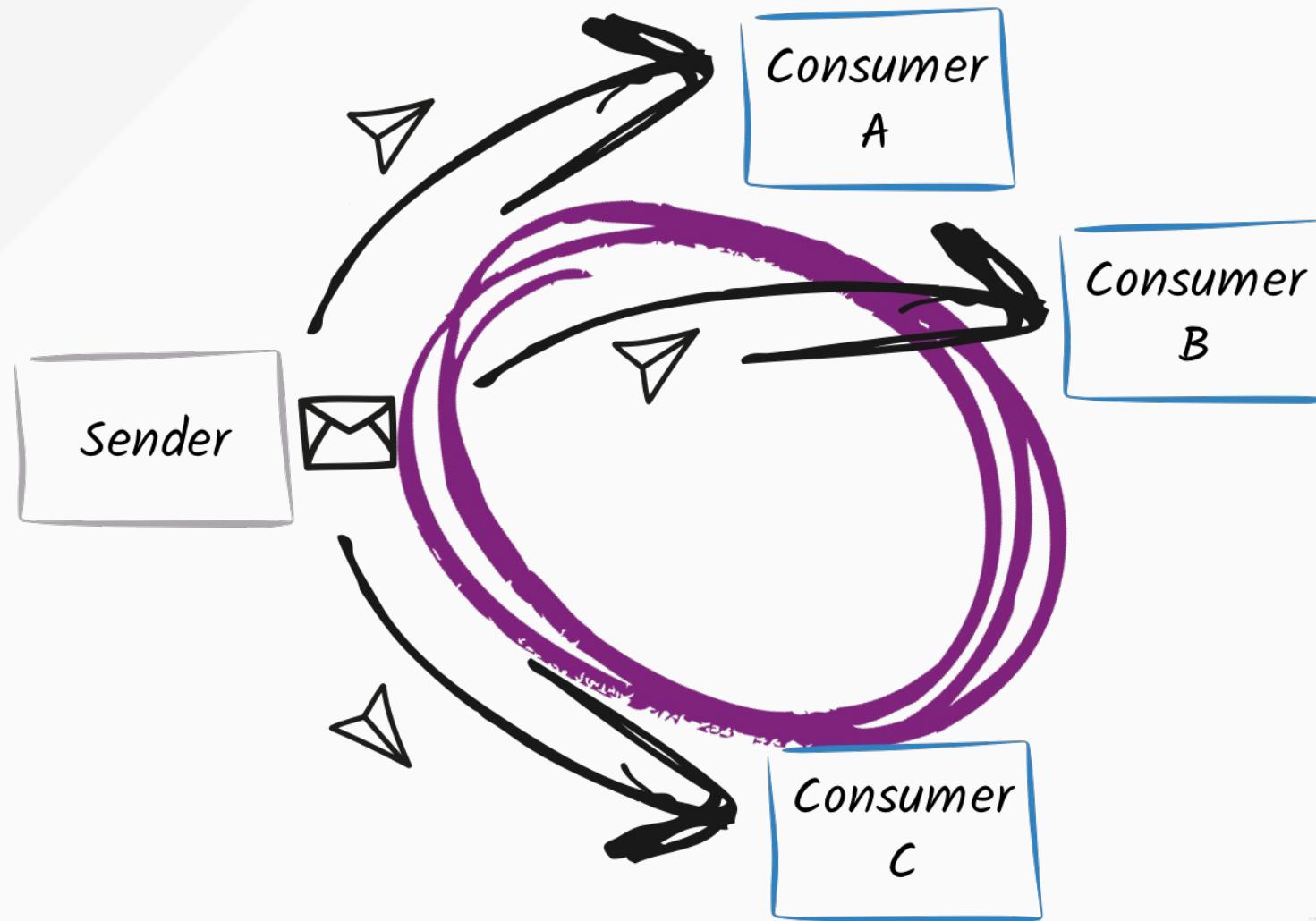


BALANCING THE LOAD

When several consumers listen to the same address, Vert.x dispatches the sent messages using a **round robin**.

So, to improve the scalability, just spawn a new node!

BALANCING THE LOAD

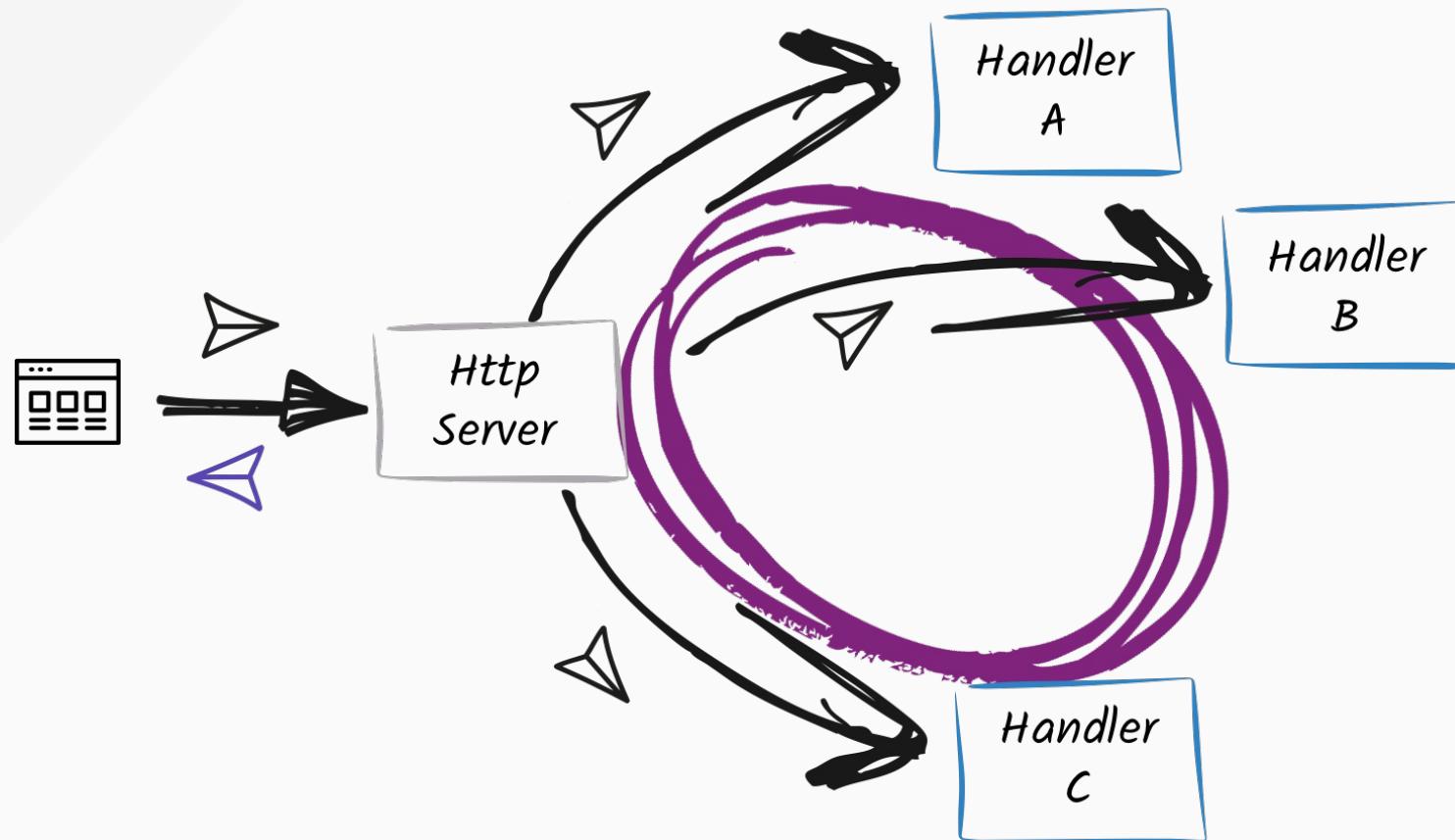


BALANCING THE LOAD

Invoke



SCALING HTTP

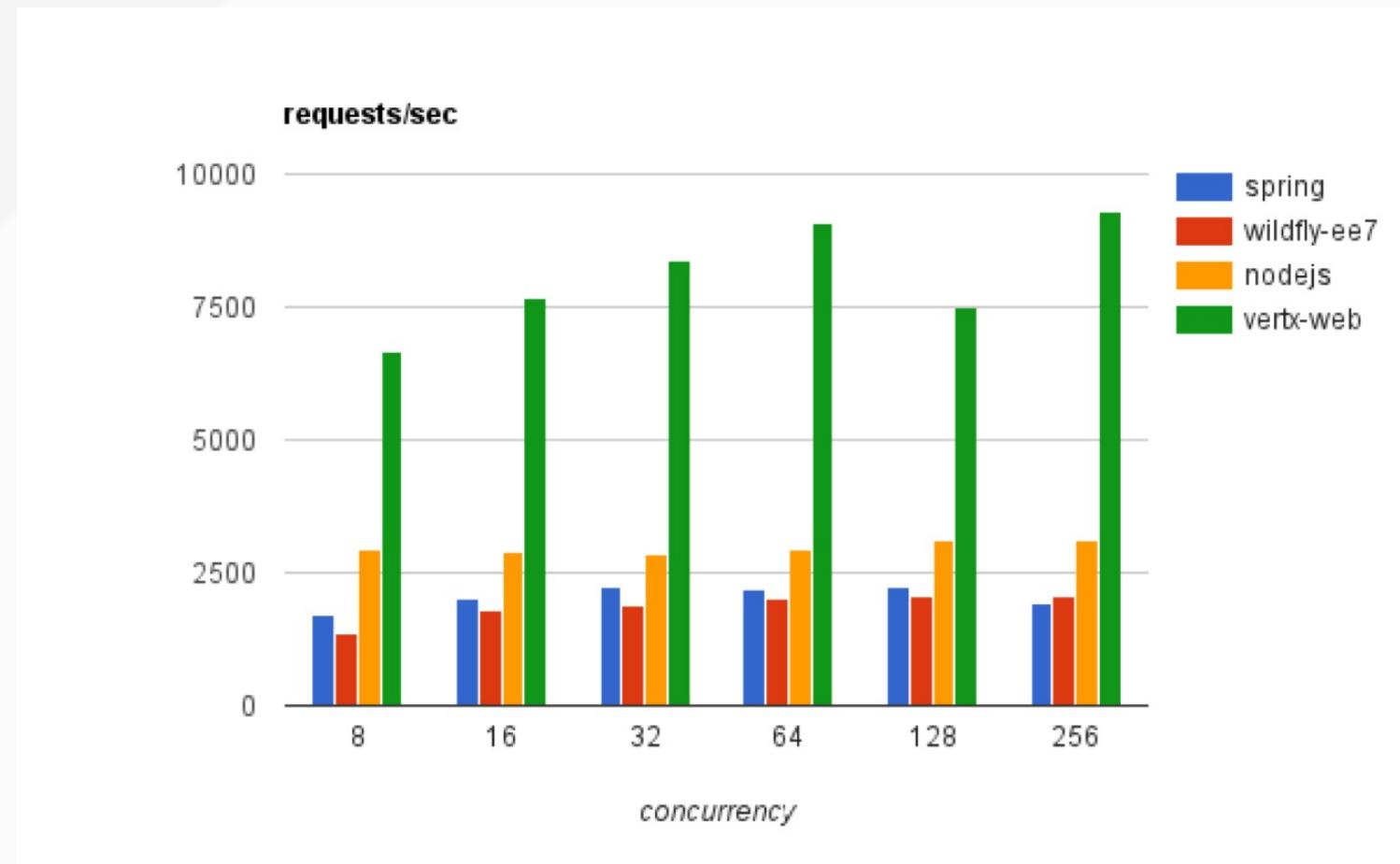


WHAT ABOUT PERFORMANCES ?

Because we do it well, and we do it fast

TECHEMPOWER - FORTUNE

Request -> JDBC (query) -> Template engine -> Response



THIS IS NOT THE END();

But the first step on the Vert.x path



redhat®

THANK YOU!



@clementplop

@julienviet

@vertx_project