KotlinConf

Inter-Reactive Kotlin Applications

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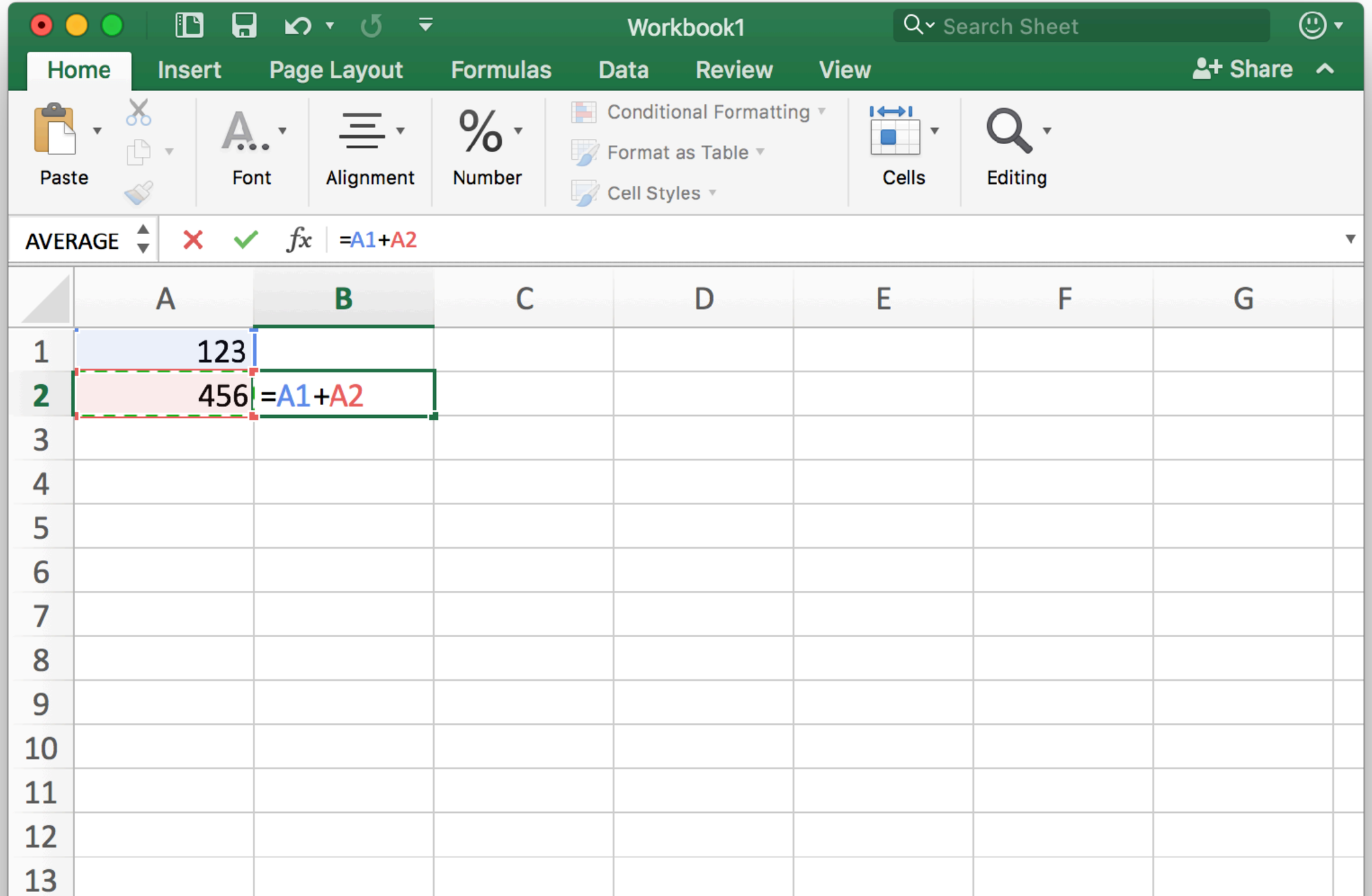
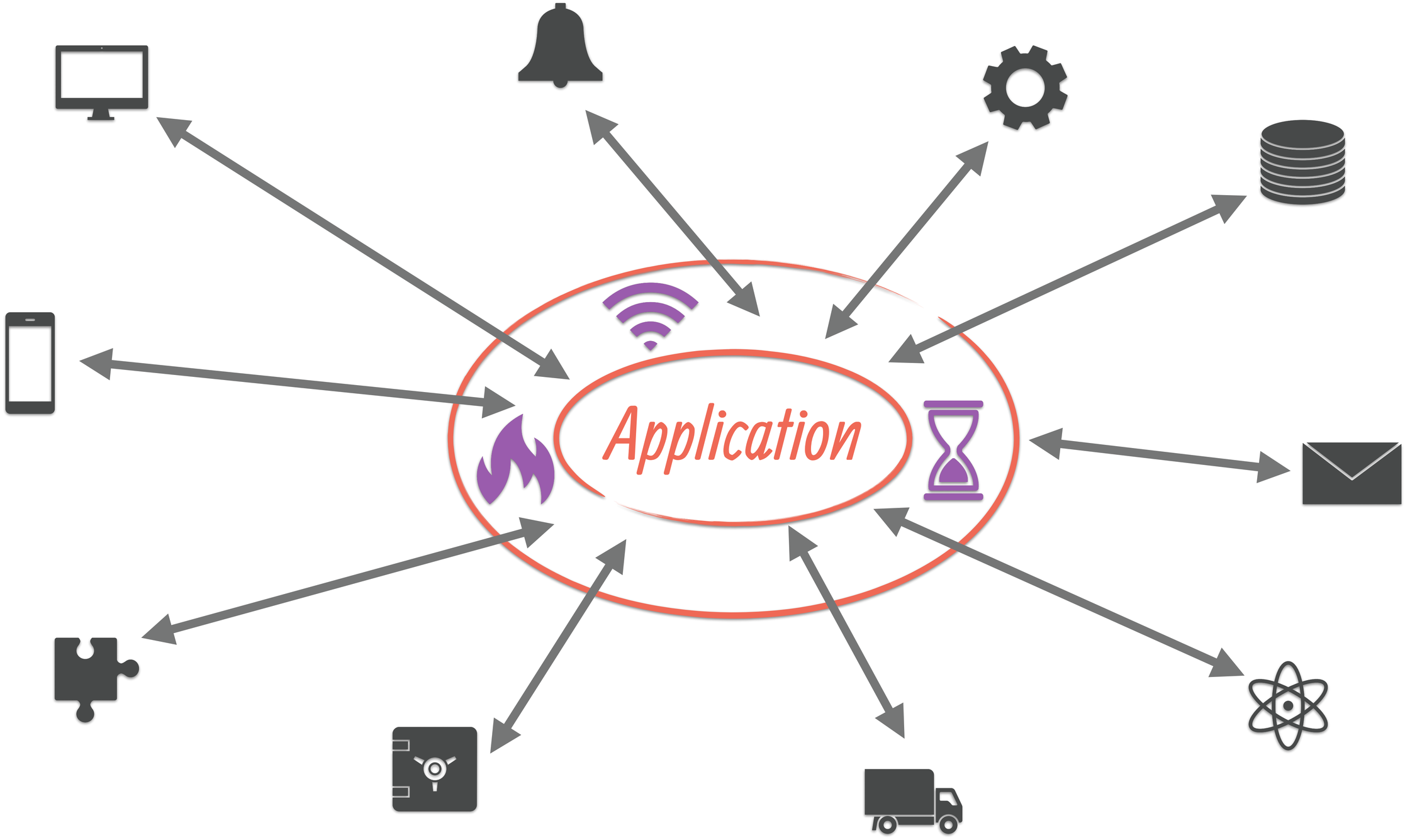
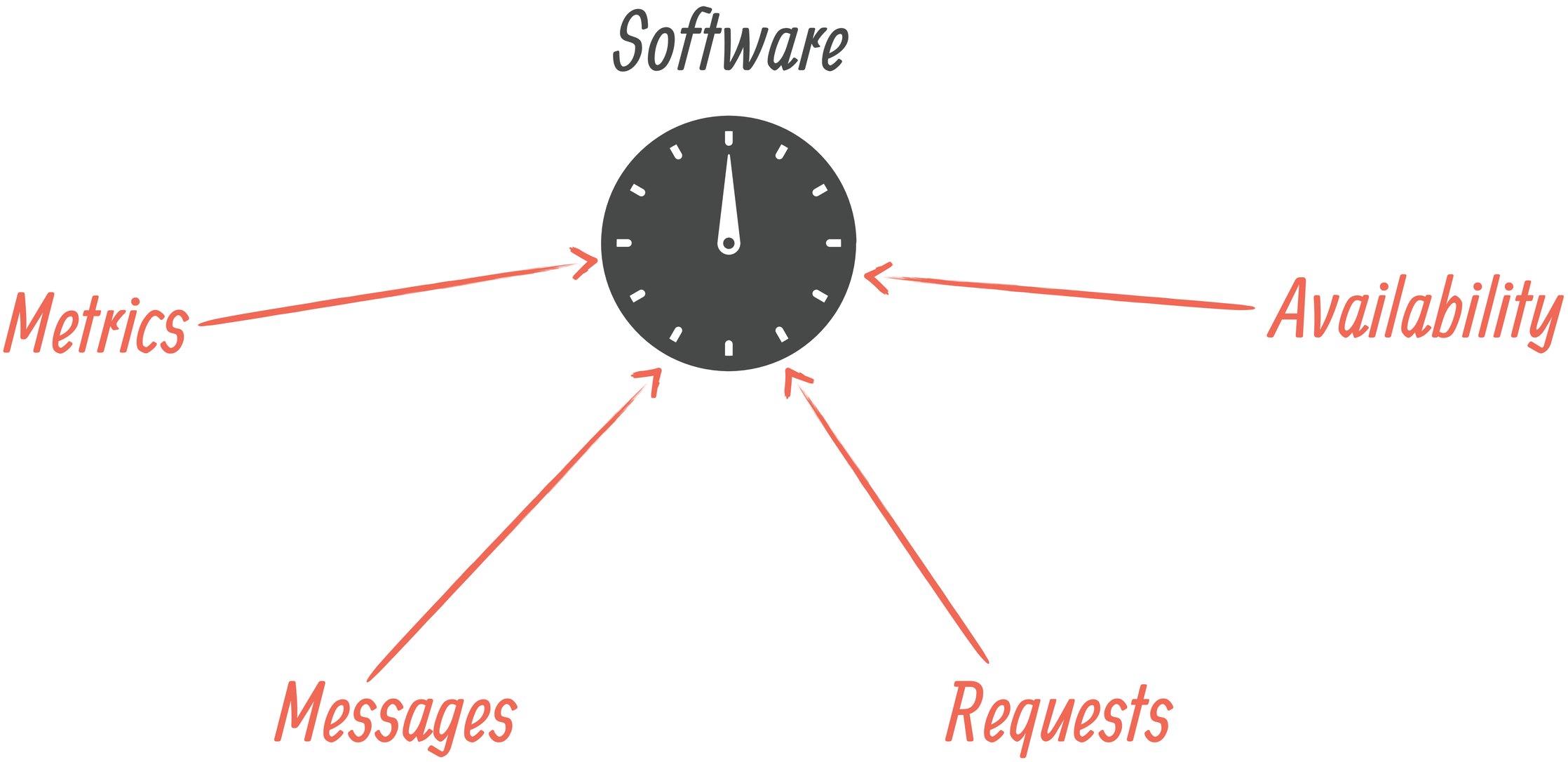
Outline

- ✓ Reactive applications
- ✓ Going event driven
- ✓ Going interactive with coroutines
- ✓ Streaming with channels
- ✓ Coroutines vs RxJava


Workbook1
Search Sheet
Home
Insert
Page Layout
Formulas
Data
Review
View
Share
Paste
Font
Alignment
Number
Conditional Formatting
Format as Table
Cell Styles
Cells
Editing
AVERAGE
=A1+A2
A
B
C
D
E
F
G
123
456
=A1+A2


Application


Software
Metrics
Availability
Messages
Requests

Reactive

"Responding to stimuli"

Manifesto, Actor, Messages
Resilience, Elasticity, Scalability,
Asynchronous, non-blocking

Reactive systems

Akka, **Vert.x**

Data flow
Back-pressure
Non-blocking

Reactive streams

Akka Streams, Rx v2,
Reactor, **Vert.x**

Data flow
Events, Observable
Spreadsheets

Reactive programming

Reactor, Reactive Spring,
RxJava, **Vert.x**

Eclipse Vert.x

Open source project started in 2012

Eclipse / Apache licensing

A toolkit for building reactive applications for the JVM

7K ★ on

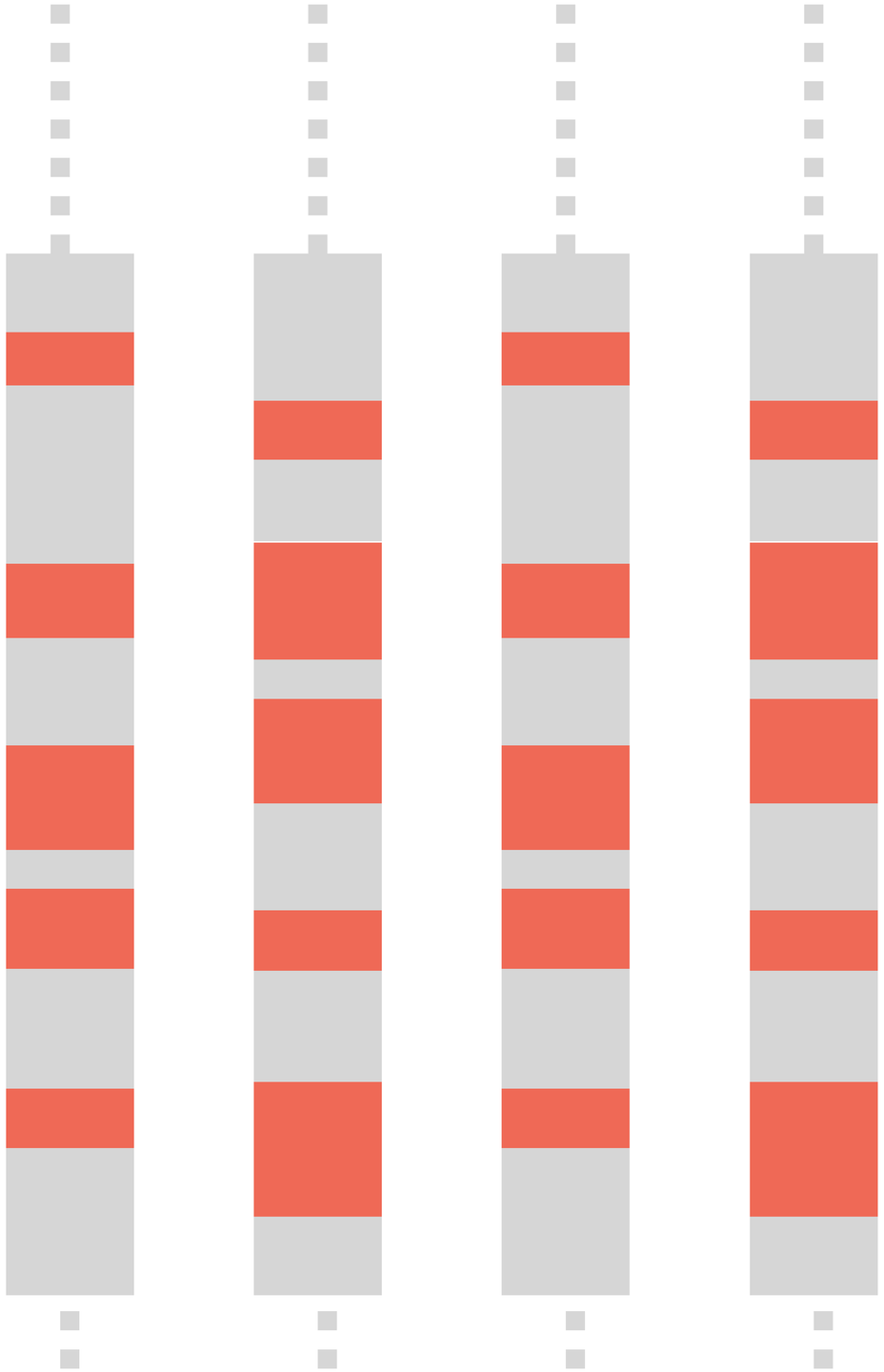
Built on top of Netty

https://vertx.io

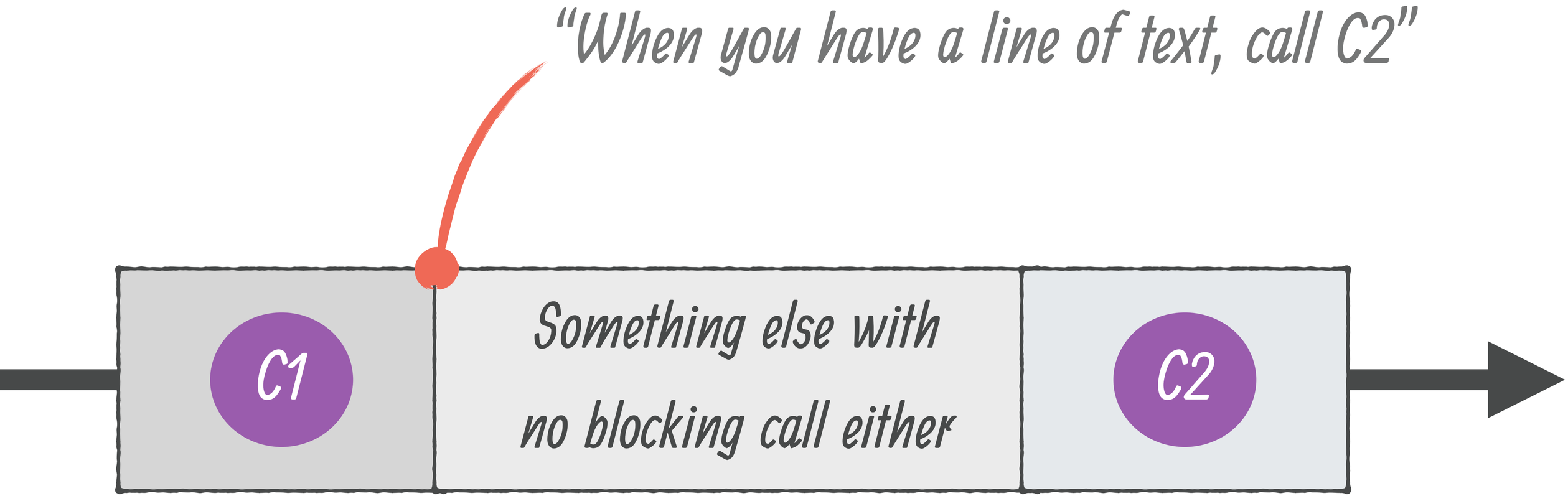
@vertx_project

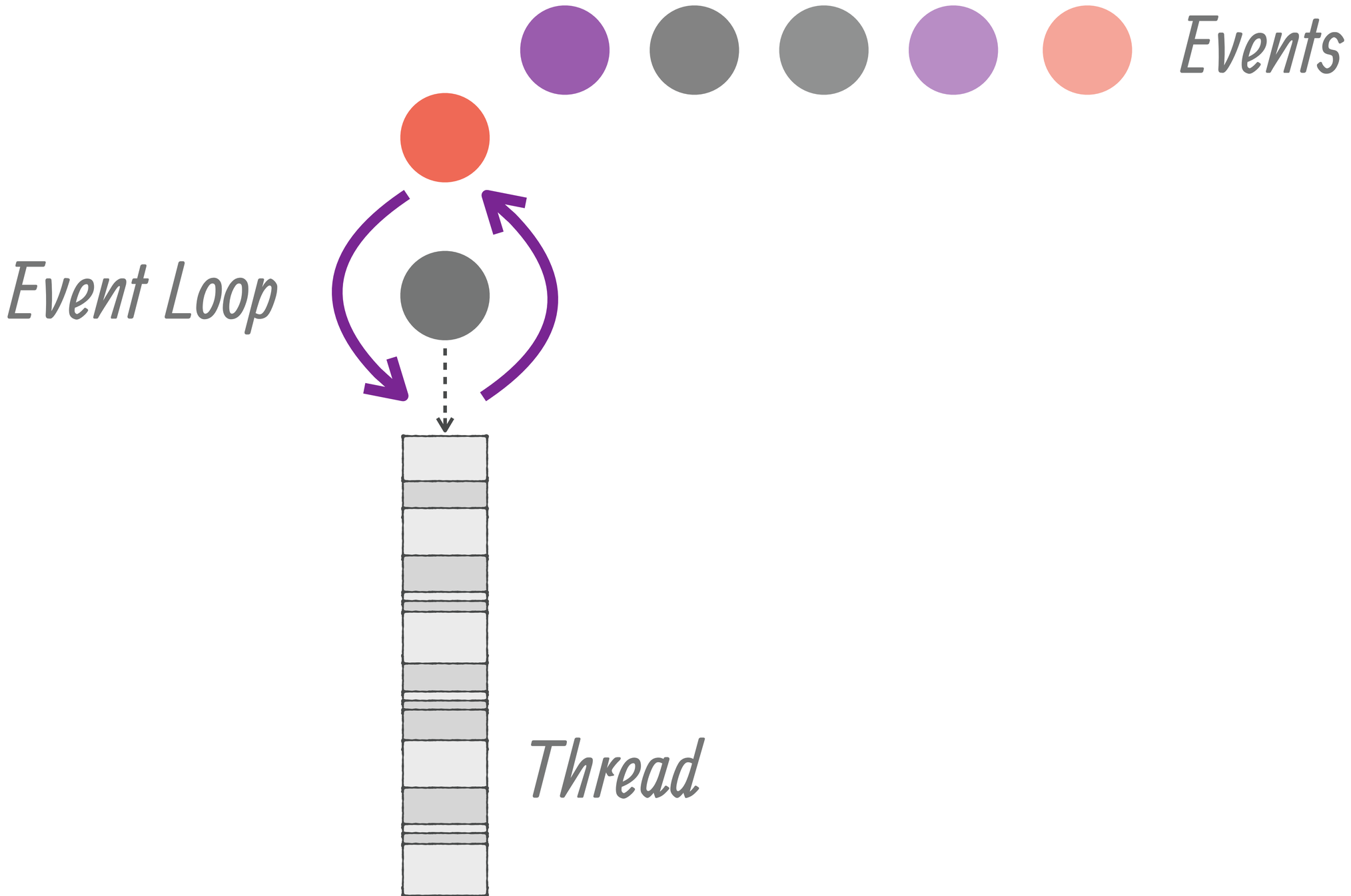
Going event driven

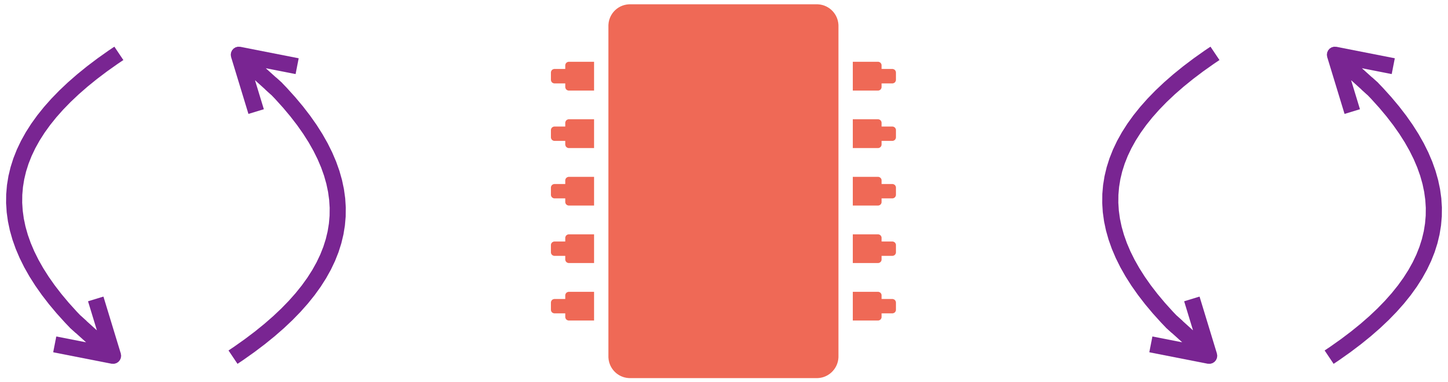
```
while (isRunning) {
  val line = bufferedReader.readLine()
  when (line) {
    "ECHO" → bufferedWriter.write(line)
    //  ...
    // Other cases ( ... )
    //  ...
    else → bufferedWriter.write("Unknown command")
  }
}
```



x 1000 =


"When you have a line of text, call C2"
C1
Something else with
no blocking call either
C2


Events
Event Loop
Thread



2 event-loops per CPU core by default

Movie rating application

```
router {
  get("/movie/:id") {
    ctx → getMovie(ctx)
  }
  post("/rate/:id") {
    ctx → rateMovie(ctx)
  }
  get("/rating/:id") {
    ctx → getRating(ctx)
  }
}
```

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  }
}
```

```
fun getMovie(ctx: RoutingContext) {

  val id = ctx.pathParam("id")
  val params = json { array(id) }
  client.queryWithParams("SELECT TITLE FROM MOVIE WHERE ID=?", params) {
    if (it.succeeded()) {
      val result = it.result()
      if (result.rows.size == 1) {
        ctx.response().end(json {
          obj("id" to id, "title" to result.rows[0]["TITLE"]).encode()
        })
      } else {
        ctx.response().setStatusCode(404).end()
      }
    } else {
      ctx.fail(it.cause())
    }
  }
}
```

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```
val movie = ctx.pathParam("id")
val rating = Integer.parseInt(ctx.queryParam("getRating")[0])
client.getConnection {
  if (it.succeeded()) {
    val connection = it.result()
    val queryParams = json { array(movie) }
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      if (it.succeeded()) {
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          val updateParams = json { array(rating, movie) }
          connection.updateWithParams("INSERT INTO RATING (VALUE, MOVIE_ID) VALUES ?, ?", updateParams) {
            if (it.succeeded()) {
              ctx.response().setStatusCode(201).end()
            } else {
              connection.close()
              ctx.fail(it.cause())
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      }
    }
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    ctx.fail(it.cause())
  }
}
```

Divide and conquer strategy

```
class RateMovie(val ctx:class RateMovie(
  val ctx: RoutingContext,
  val client: SQLClient,
  val movie: String,
  val rating: Int) {

  fun rate() {
    client.getConnection {
      if (it.succeeded()) {
        query(it.result())
      } else {
        ctx.fail(it.cause())
      }
    }
  }

  ...
}
```

```
fun query(connection: SQLConnection) {
  val params = json { array(movie) }
  connection.queryWithParams("SELECT TITLE FROM MOVIE WHERE ID=?", params) {
    if (it.succeeded()) {
      val result = it.result()
      if (result.rows.size == 1) {
        update(connection)
      } else {
        connection.close()
        ctx.response().setStatusCode(404).end()
      }
    } else {
      connection.close()
      ctx.fail(it.cause())
    }
  }
}
```

```
fun update(connection: SQLConnection) {
  val params = json { array(rating, movie) }
  connection.updateWithParams("INSERT INTO RATING (VALUE, MOVIE_ID)
VALUES ?, ?", params) {
    connection.close()
    if (it.succeeded()) {
      ctx.response().setStatusCode(201).end()
    } else {
      ctx.fail(it.cause())
    }
  }
}
```

Going interactive with coroutines

Kotlin Coroutines

Toolkit approach

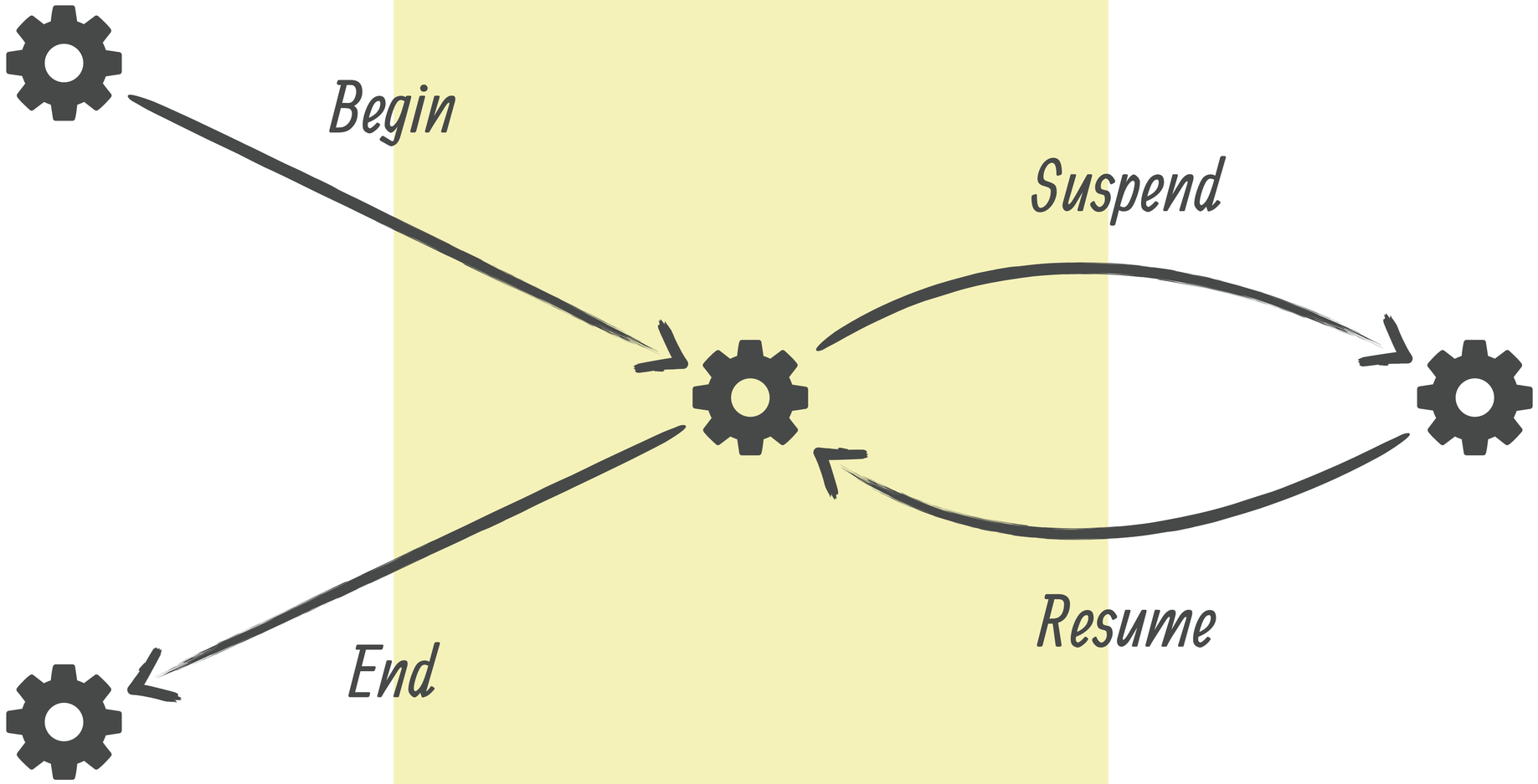
Suspending lambdas and functions

Sequential flow

Coroutines can be composed

Language control flow

Coroutine life cycle



Coroutines for Vert.x

Coroutines are confined on Vert.x event loop thread

`awaitResult<T>` for asynchronous methods

channel support

integrates with coroutine ecosystem

```
launch(vertx.dispatcher()) {

  try {

    val result1 = awaitResult<String> { handler →
      handler.handle(Future.succeededFuture("OK"))
    }
    println("Result 1 $result1")

    val result2 = awaitResult<String> { handler →
      handler.handle(Future.failedFuture("Ouch"))
    }
    println("Result 2 $result1")

  } catch (e: Exception) {
    println("Ouch ${e.message}")
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```

(demo)

"Going interactive with coroutines"

Streaming with channels

Streaming with channels

Kotlin provides channels

- ReceiveChannel
- SendChannel

Vert.x provides streams

- ReadStream
- WriteStream


send(●)
receive()

ReadStream

```
vertx.createHttpServer().requestHandler { request →

  val readStream: ReadStream<Buffer> = request

  readStream.handler { buffer →
    // Handle each buffer
  }

  readStream.exceptionHandler { err →
    request.response().setStatusCode(500).end("${err.message}")
  }

  readStream.endHandler {
    request.response().end("OK")
  }

}.listen(8080)
```

ReceiveChannel

```
vertx.createHttpServer().requestHandler { request →

  val readStream: ReadStream<Buffer> = request
  val receiveChannel: ReceiveChannel<Buffer> = readStream.toChannel(vertx)

  launch(vertx.dispatcher()) {
    try {
      for (buffer in receiveChannel) {
        // Handle each buffer
      }
      request.response().end("OK")
    } catch (e: Exception) {
      request.response().setStatusCode(500).end("${e.message}")
    }
  }

}.listen(8080)
```

WriteStream

```
val writeStream: WriteStream<Buffer> = request.response()

val item = Buffer.buffer("the-item")

fun sendItemAndClose() {
  writeStream.write(item)
  request.response().end()
}

if (!writeStream.writeQueueFull()) {
  sendItemAndClose()
} else {
  writeStream.drainHandler {
    sendItemAndClose()
  }
}
```

SendChannel

```
val writeStream: WriteStream<Buffer> = request.response()
val sendChannel = writeStream.toChannel(vertx)

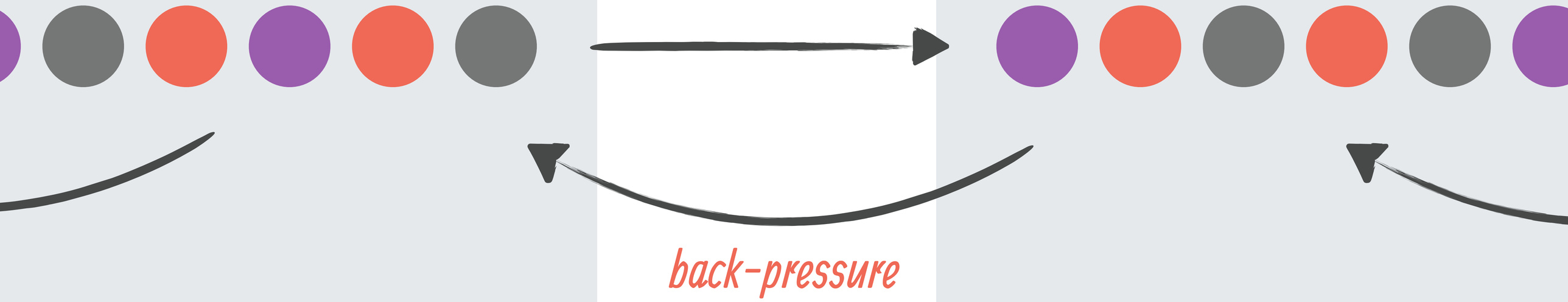
launch(vertx.dispatcher()) {

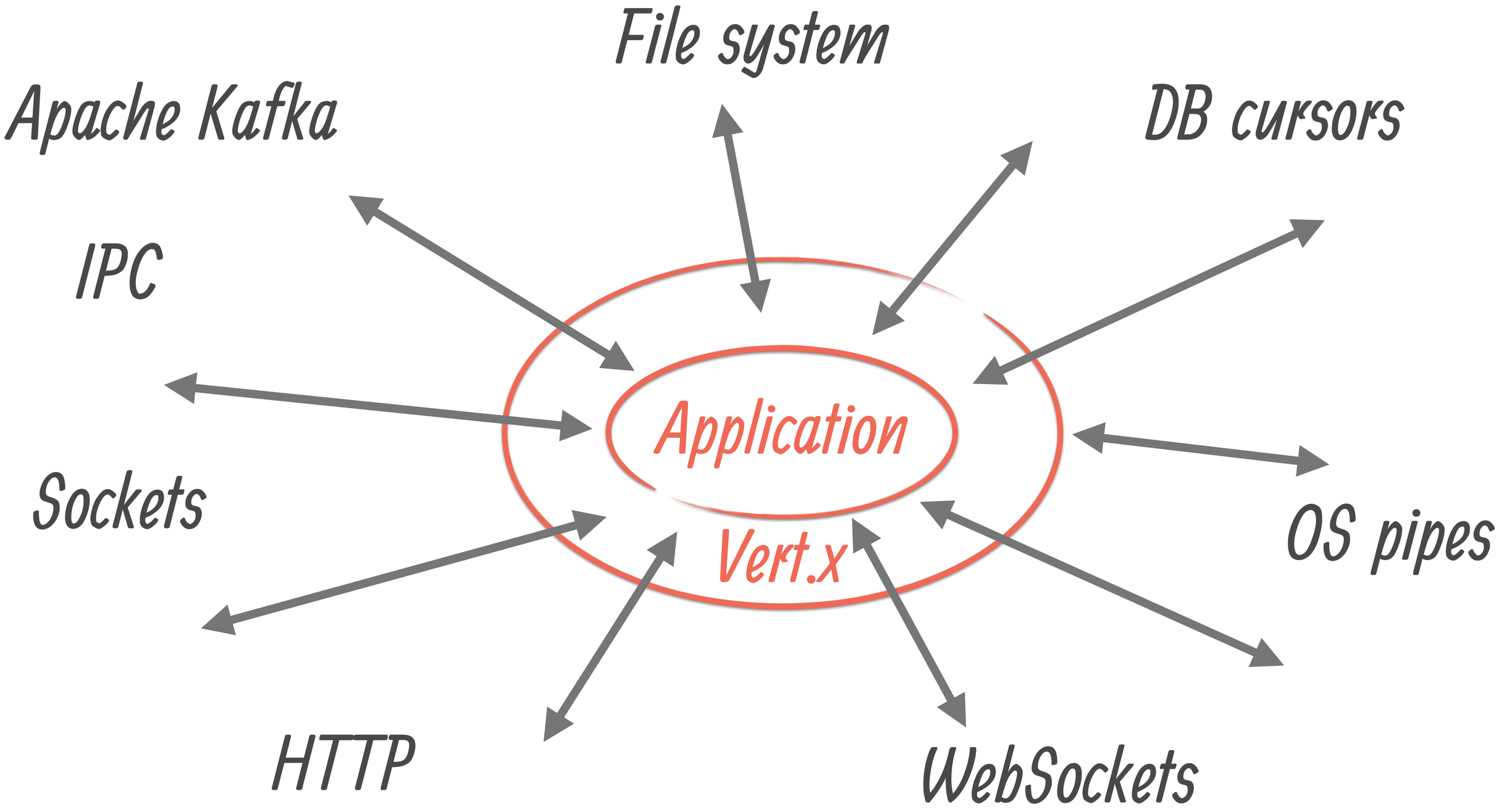
  sendChannel.send(Buffer.buffer("the-item"))

  request.response().end()
}
```

when full

when drained


back-pressure


File system
Apache Kafka
DB cursors
IPC
Application
Sockets
OS pipes
Vert.x
HTTP
WebSockets

Preemptive back-pressure

```
try {
  while (true) {
    val amount = input.read(buffer)
    if (amount == -1) {
      break
    }
    output.write(buffer, 0, amount)
  }
} finally {
  output.close()
}
```

when buffer is full

block the thread

Cooperative back-pressure

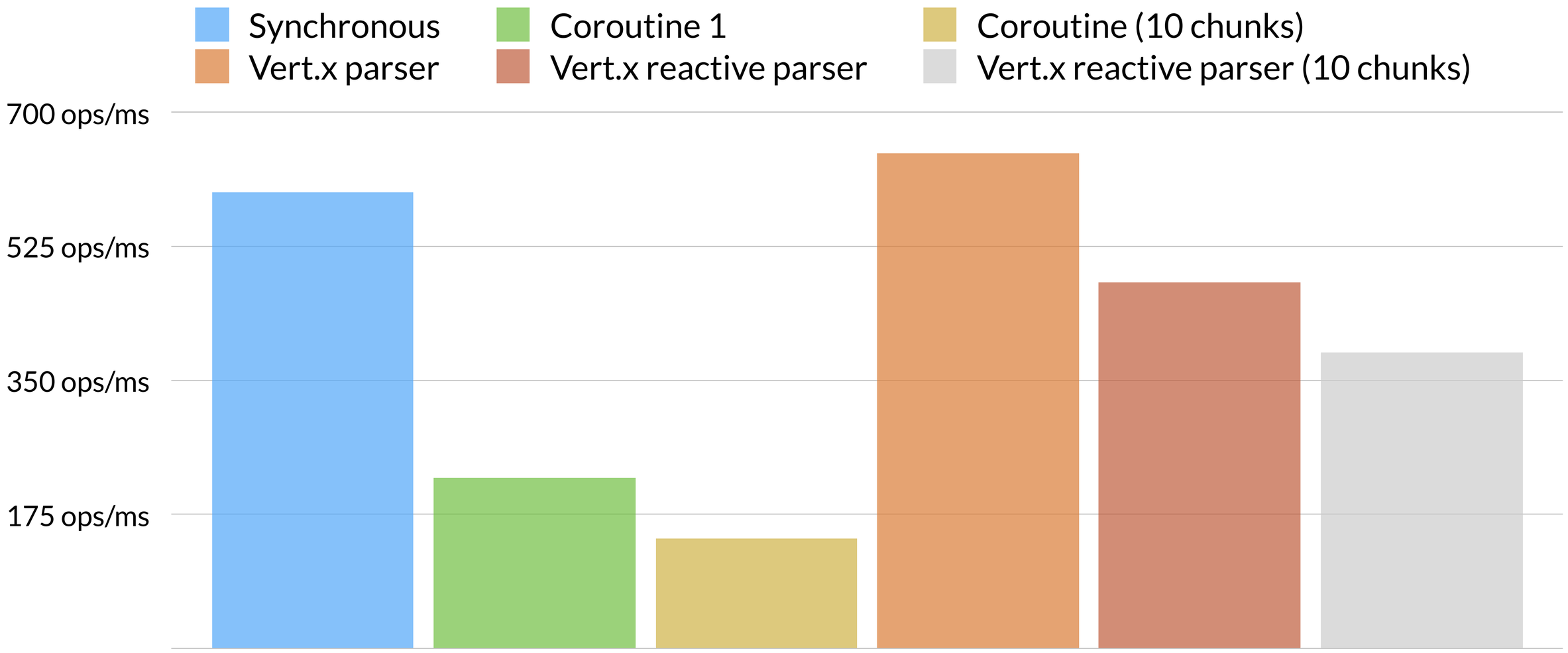
```
launch(vertx.dispatcher()) {
  try {
    while (true) {
      val buffer = input.receiveOrNull()
      if (buffer == null) {
        break;
      }
      output.send(buffer);
    }
  } finally {
    output.close()
  }
}
```

when buffer is full

suspends the coroutine

Example - JSON parser

- Most parsers requires full buffering
  - Process JSON as soon as possible
  - Reduce the footprint
- Handle large JSON documents
- JSON streaming


Synchronous
Coroutine 1
Coroutine (10 chunks)
Vert.x parser
Vert.x reactive parser
Vert.x reactive parser (10 chunks)
700 ops/ms
525 ops/ms
350 ops/ms
175 ops/ms

Coroutines vs RxJava

Rxified application

```
router {
  get("/movie/:id") {
    ctx → getMovie(ctx)
  }
  post("/rate/:id") {
    ctx → rateMovie(ctx)
  }
  get("/rating/:id") {
    ctx → getRating(ctx)
  }
}
```

```
val movie = ctx.pathParam("id")
val rating = ctx.queryParam("getRating")[0]
val query = "SELECT TITLE FROM MOVIE WHERE ID=?"
val queryParams = json { array(movie) }
val update = "INSERT INTO RATING (VALUE, MOVIE_ID) VALUES ?, ?"
val updateParams = json { array(rating, movie) }

val single = client.rxGetConnection().flatMap {
  connection →
  connection
    .rxQueryWithParams(query, queryParams)
    .flatMap {
      result →
      if (result.results.size == 1) {
        connection.rxUpdateWithParams(update, updateParams)
      } else {
        Single.error<UpdateResult>(NotFoundException())
      }
    }
    .doAfterTerminate { connection.close() }
}
```

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}
```

```
val consumer = createKafkaConsumer(vertx, map, String::class, JsonObject::class)
val stream = consumer.toObservable()

stream
  .map({ record -> record.value().getInteger("temperature") })
  .buffer(1, TimeUnit.SECONDS)
  .map({ list -> list.sum() })
  .subscribe({ temperature -> println("Current temperature is " + temperature) })
```

Coroutines and RxJava

Both are complementary

Combine them with

- kotlinx-coroutines-rx1
- kotlinx-coroutines-rx2

TL;DR

TL;DR

- ✓ Coroutines are great for workflows and correlated events
- ✓ Vert.x provides an unified end-to-end reactive model + ecosystem
- ✓ Make your Reactive applications Interactive in Kotlin

vertx.io

Kotlin Slack #vertx

GitHub repo

https://goo.gl/19BJiH

Guide to async programming with Vert.x

https://goo.gl/AcWW3A

Building Reactive Microservices in Java

https://goo.gl/ep6yB9