Reactive Streams in the Web

Florian Stefan | eBay Classifieds Group | JUG Saxony 2017

Who am I?

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Contents

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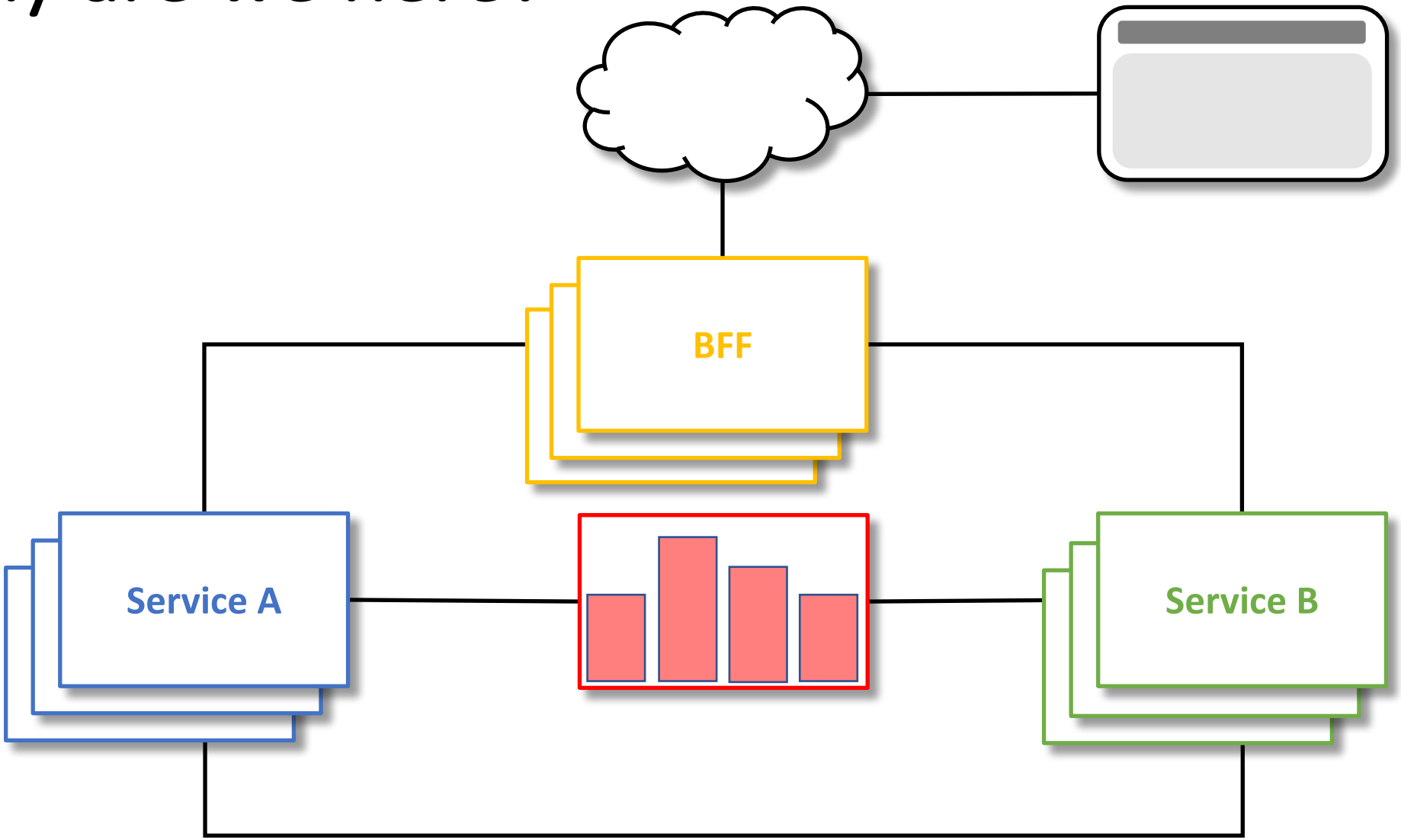
2) Reactive Streams with Reactor
3) Progressive HTML Rendering with Spring 5

It‘s about concepts rather than details!

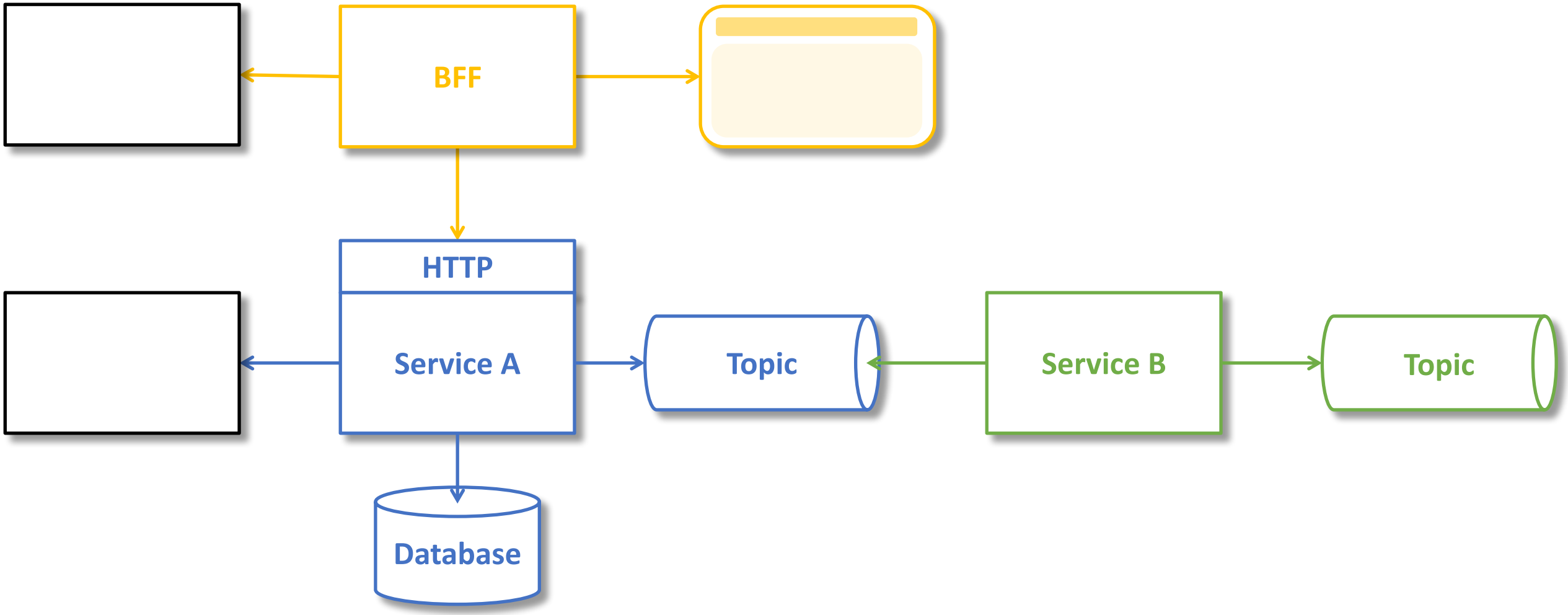
Why are we here?

It’s a distributed world!

Why are we here?



How are we doing this?



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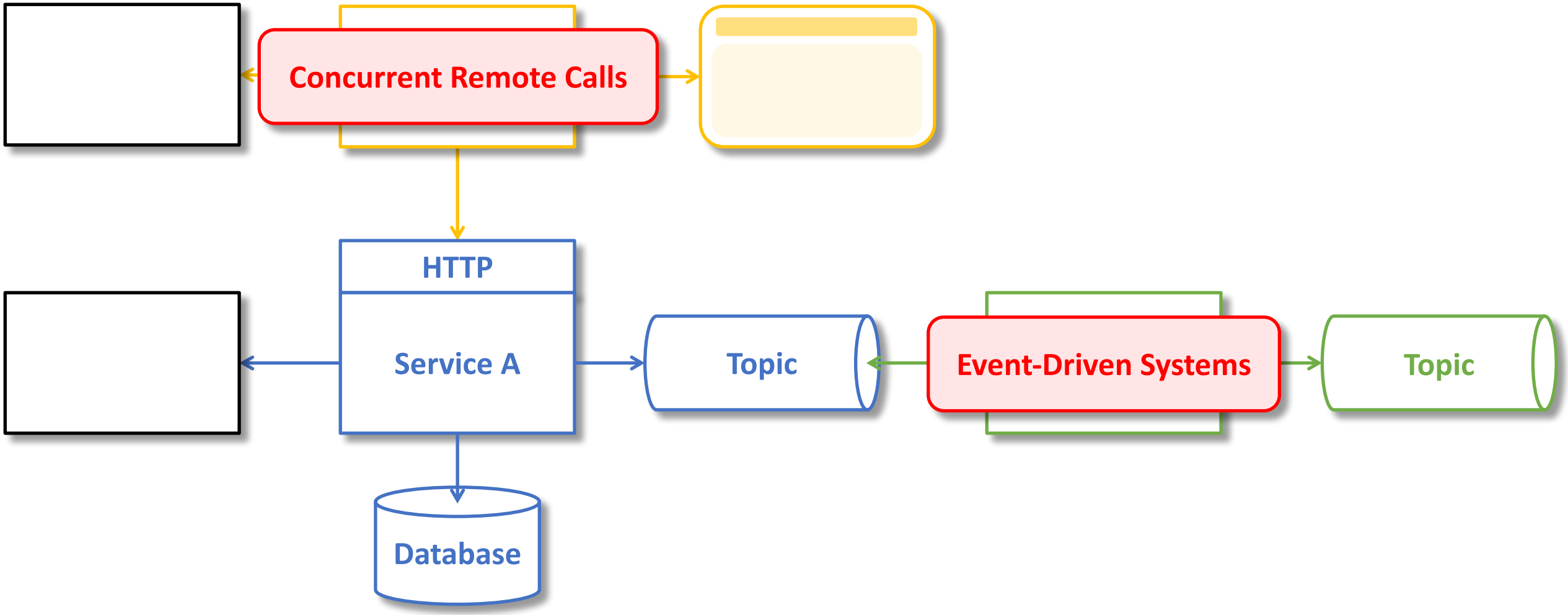
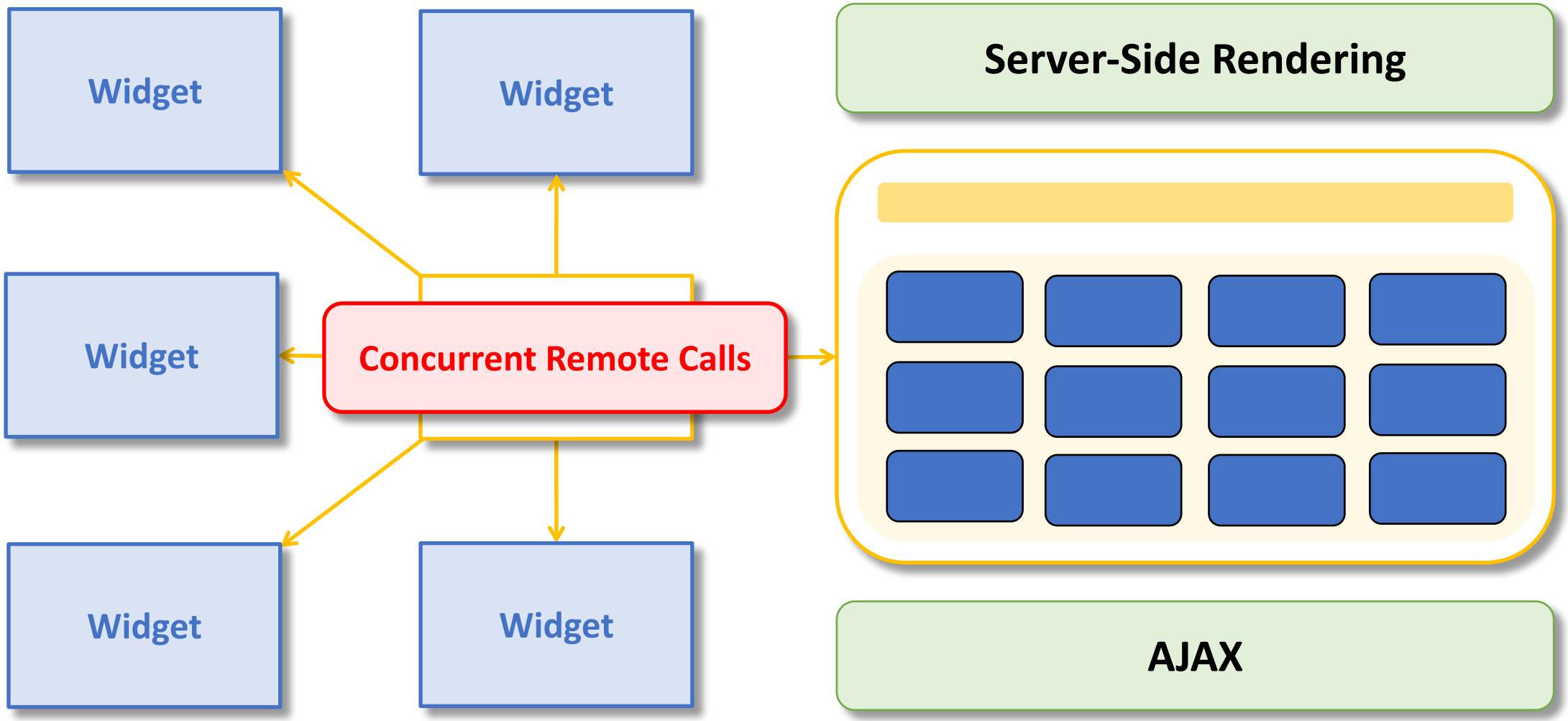


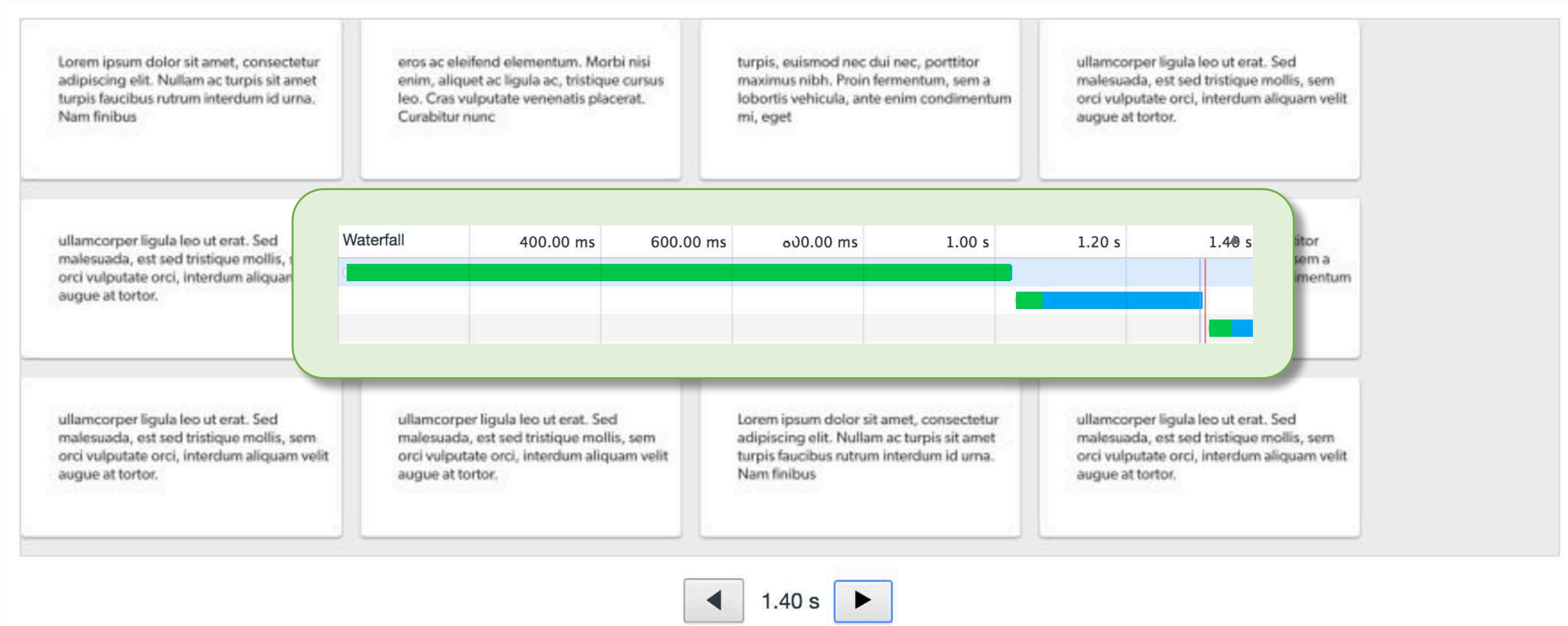
HTML Rendering



HTML Rendering

Server-Side Rendering

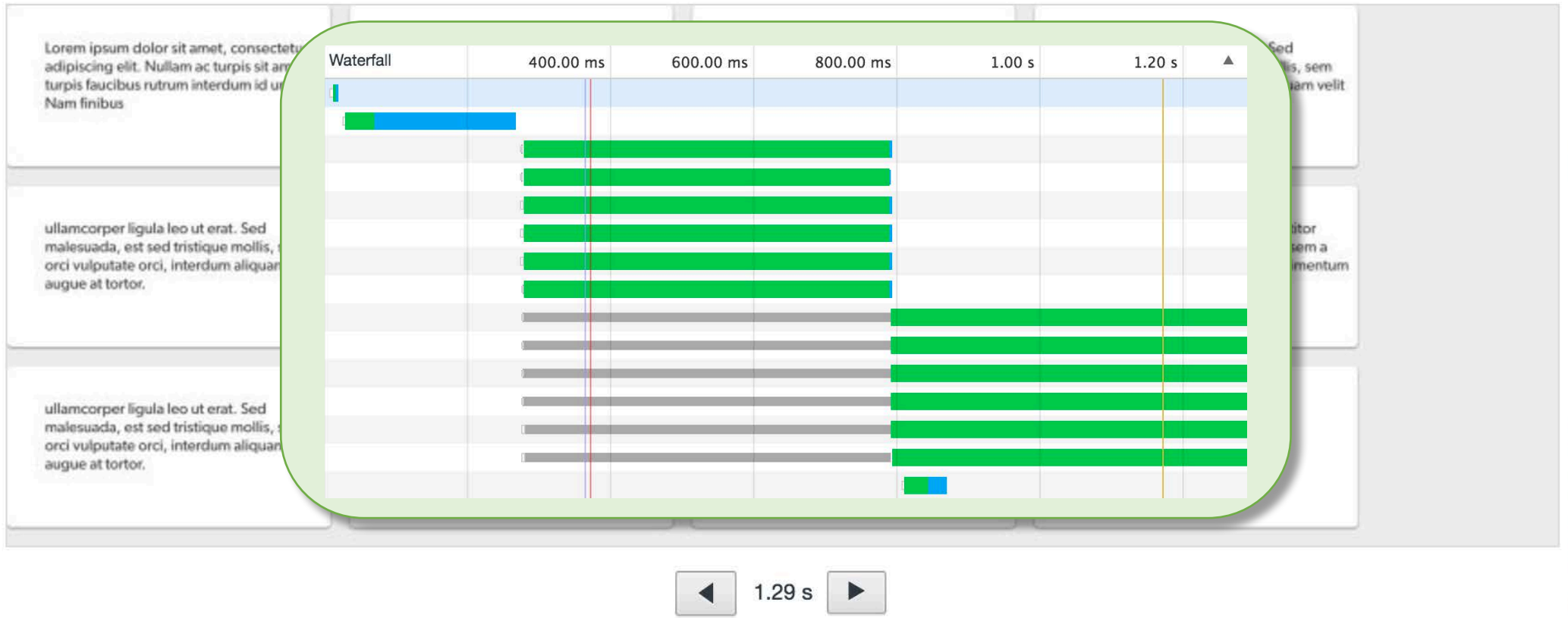
- Time To First Byte
- Prerendering / Caching



HTML Rendering

AJAX

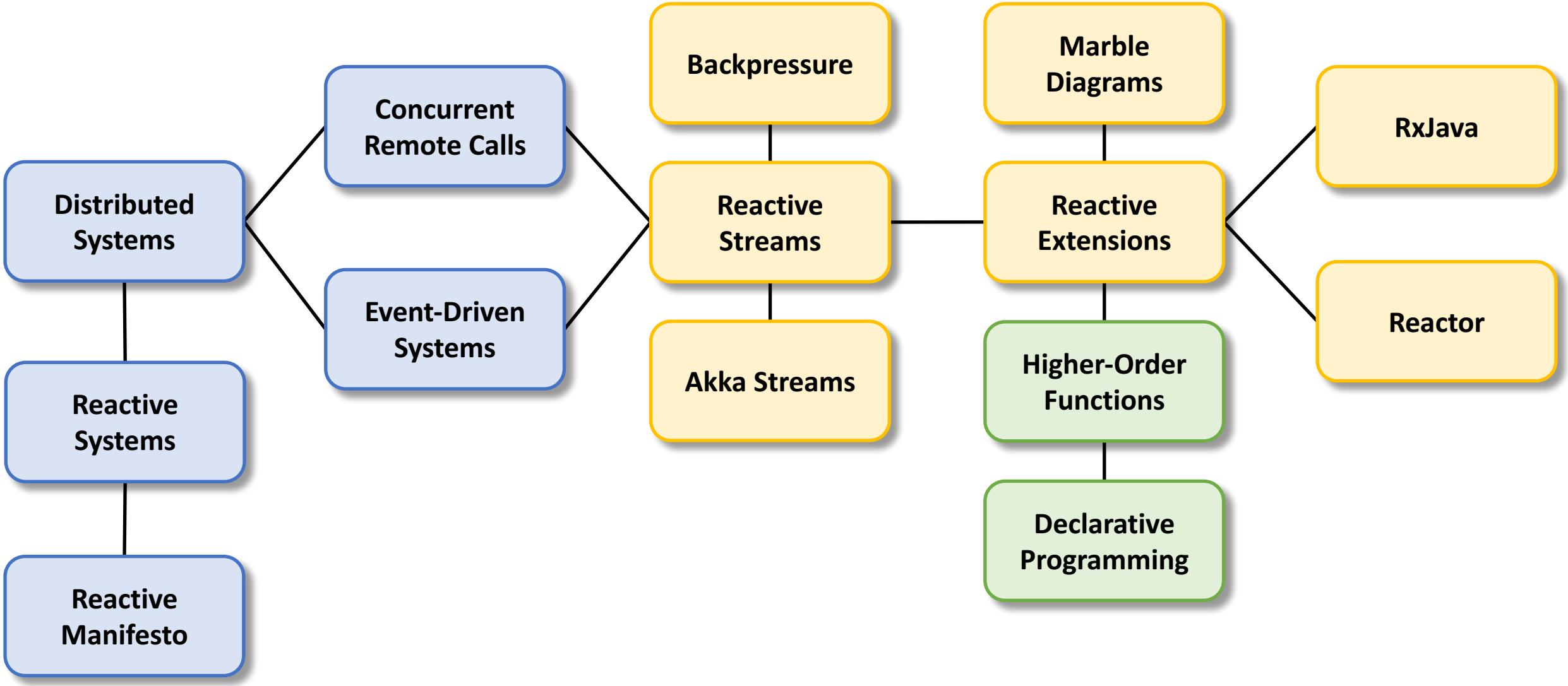
- Head-of-line blocking
- Multiplexing with HTTP/2



Can we do better?

How expensive will it be?

The Reactive Landscape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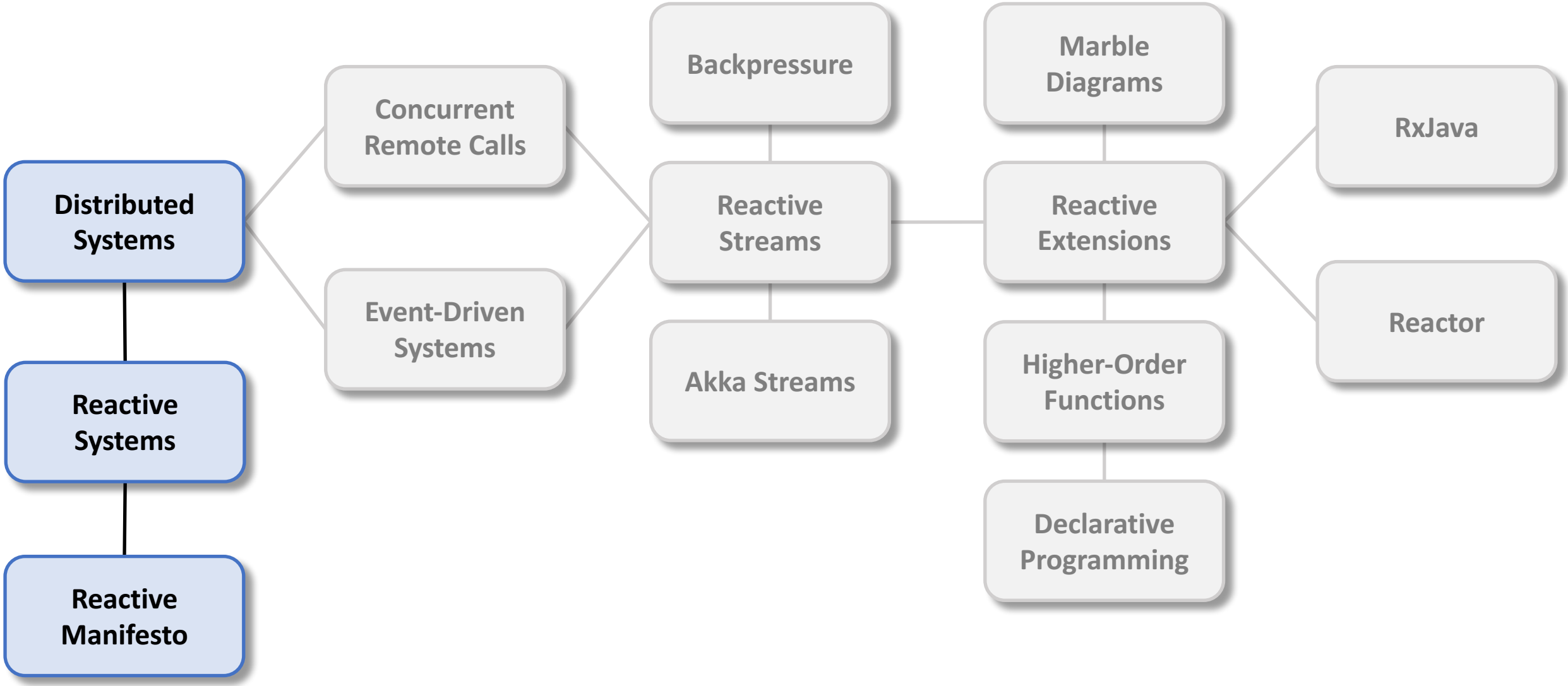
Marble Diagrams
Reactive Extensions
Higher-Order Functions
Declarative Programming
RxJava
Reactor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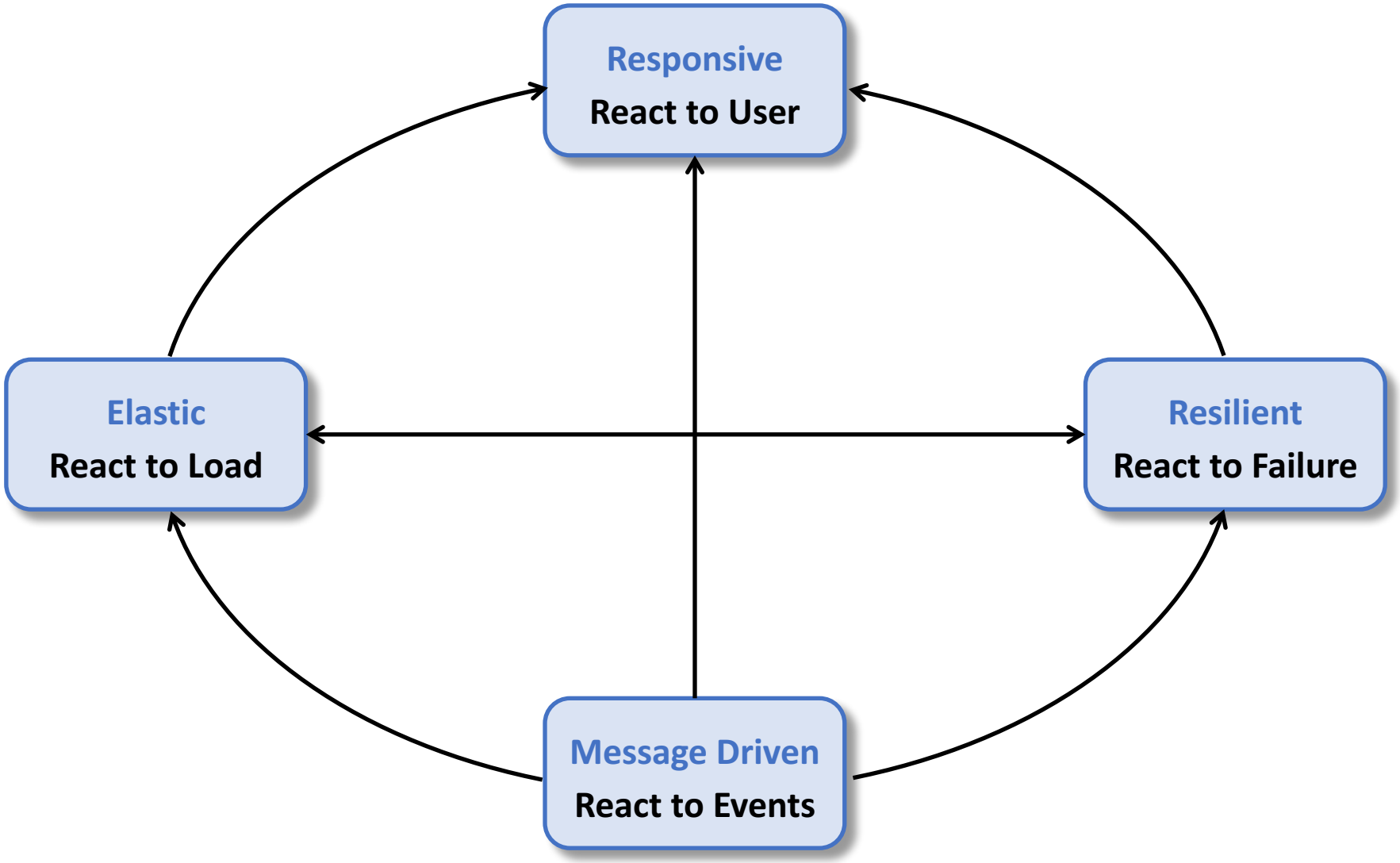
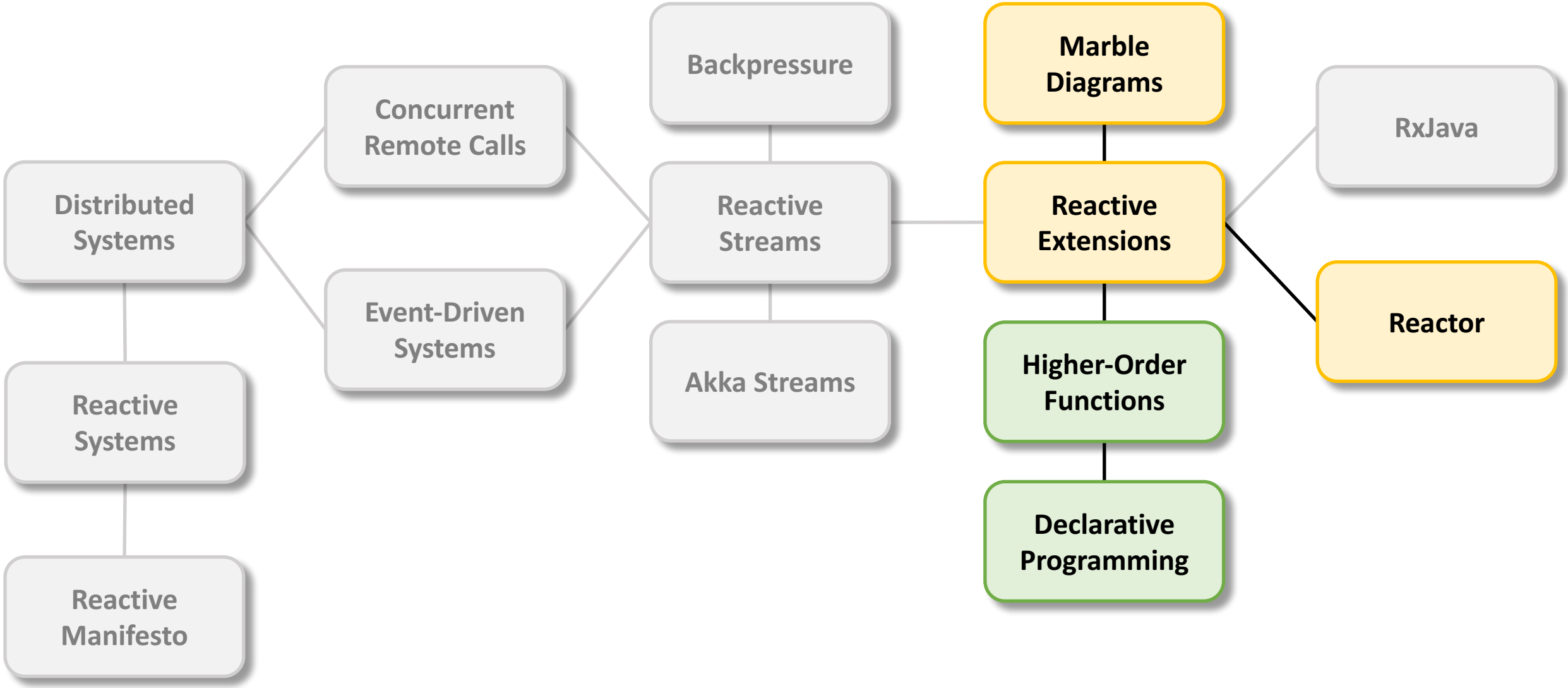
The Reactive Manifesto


Responsive
React to User
Elastic
React to Load
Resilient
React to Failure
Message Driven
React to Events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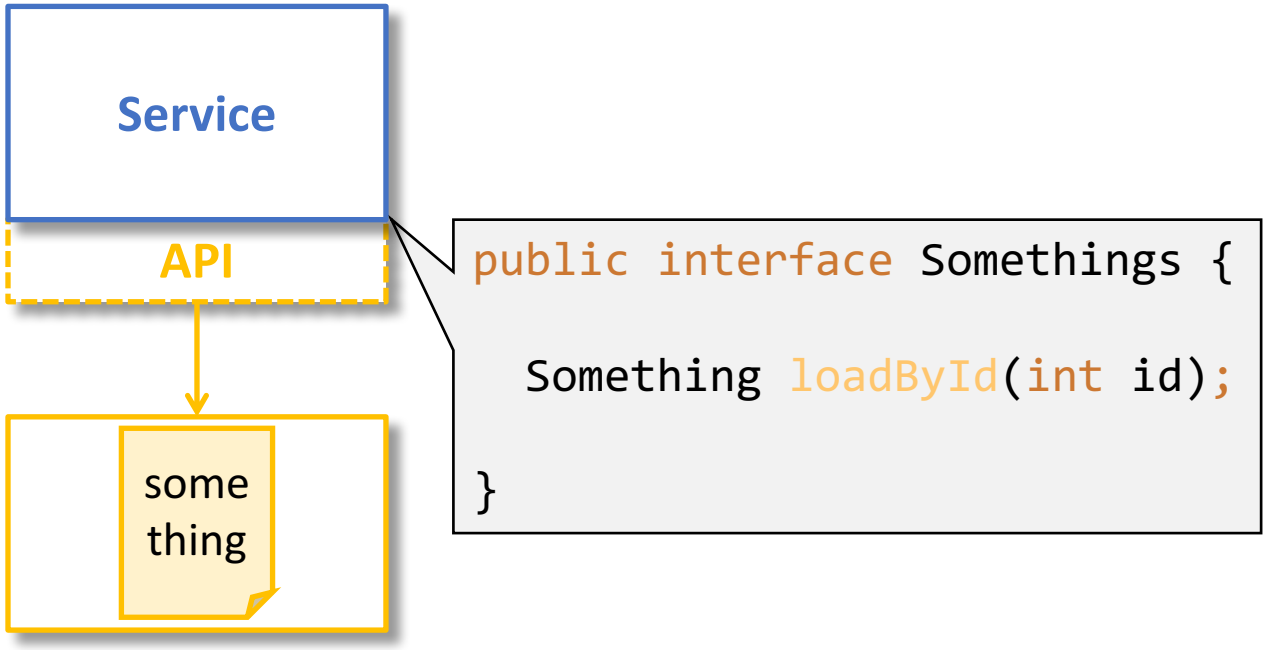
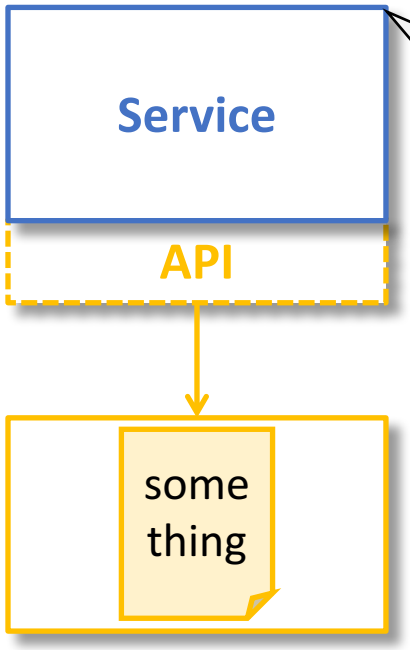
Reactive Manifesto

Reactive Extensions

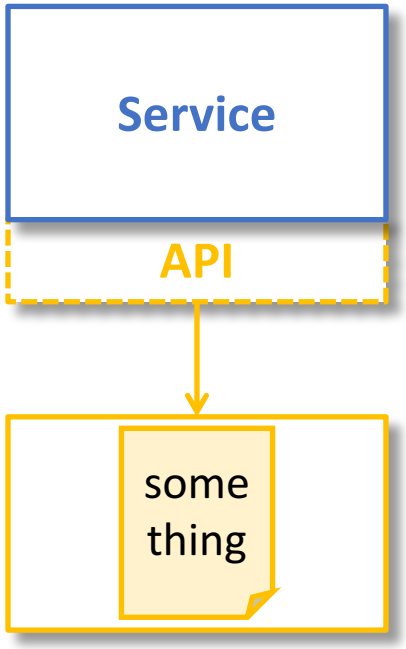


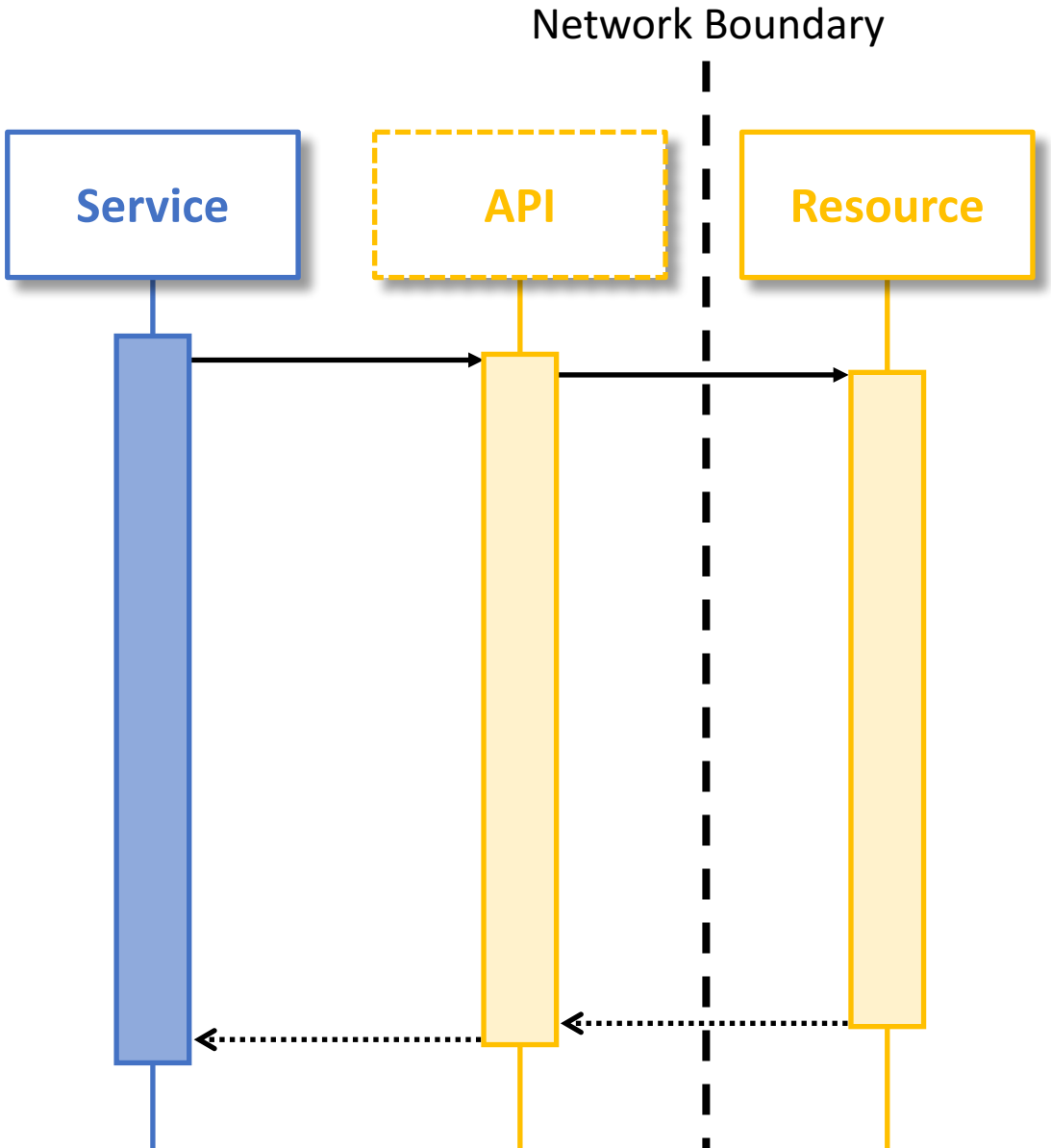
Reactive Extensions



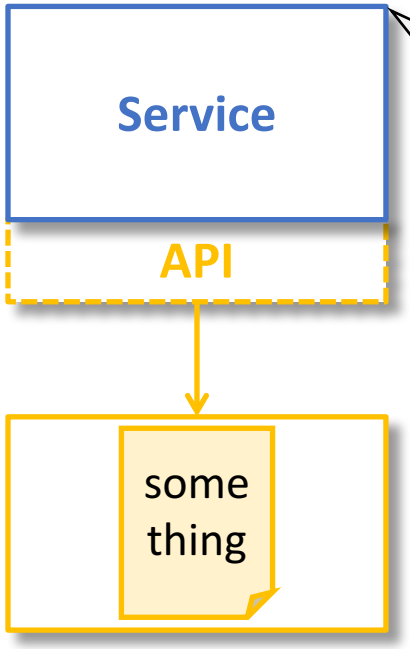

```
public Something loadById(int id) {
  return somethings.loadById(id);
}
```

Reactive Extensions



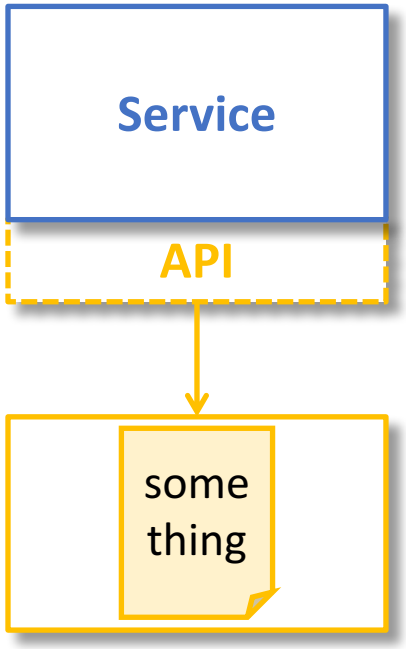


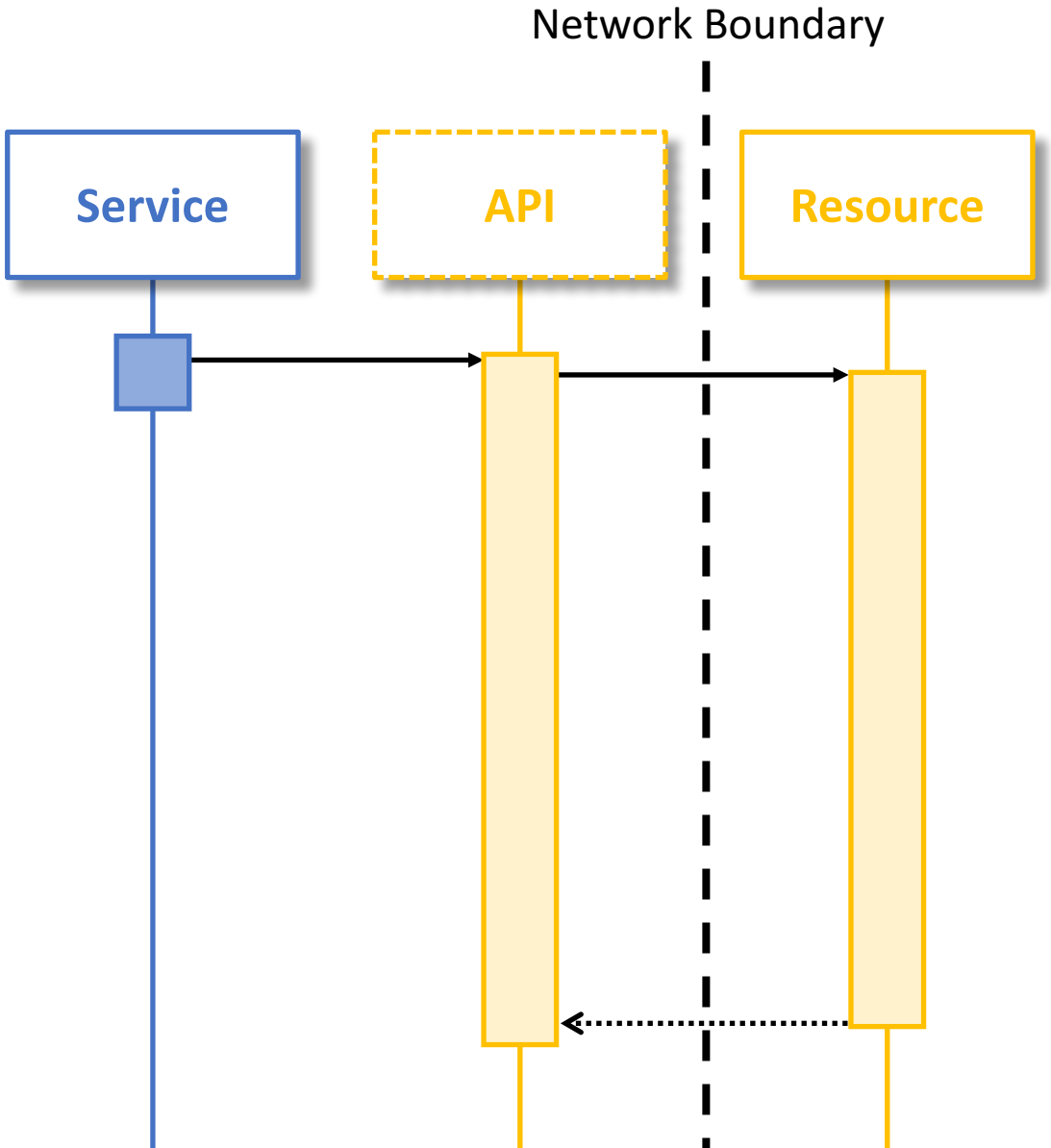
Reactive Extensions




```
public CompletableFuture<Something> loadById(int id) {
  return supplyAsync(() -> somethings.loadById(id), executor);
}
```

Reactive Extensions





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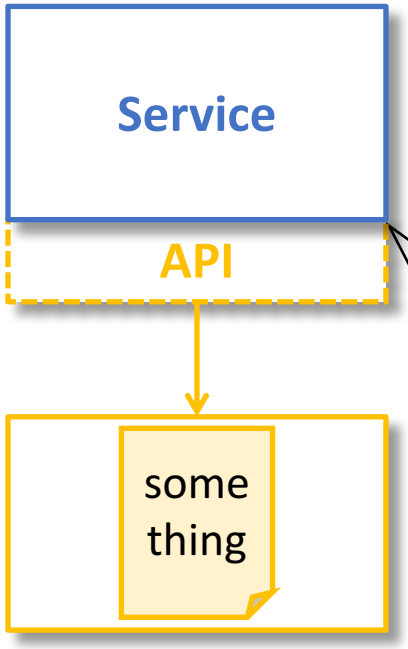
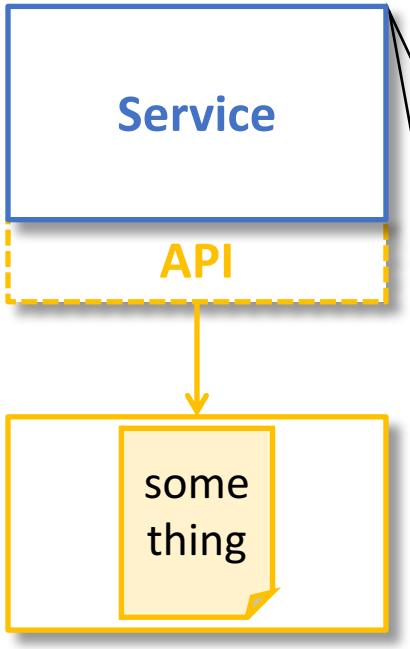



```
public interface Somethings {

  void loadById(int id, BiConsumer<Exception, Something> callback);

}
```

Reactive Extensions

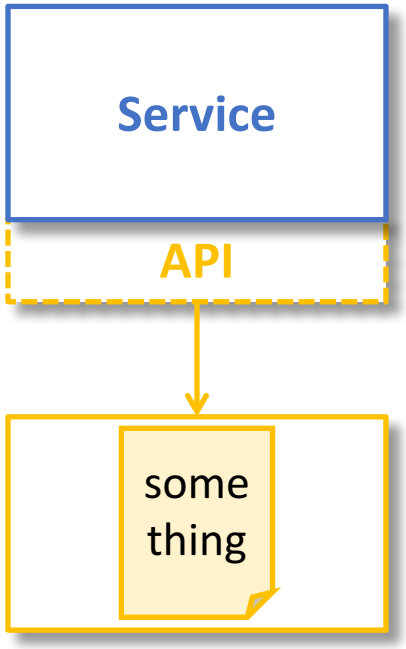


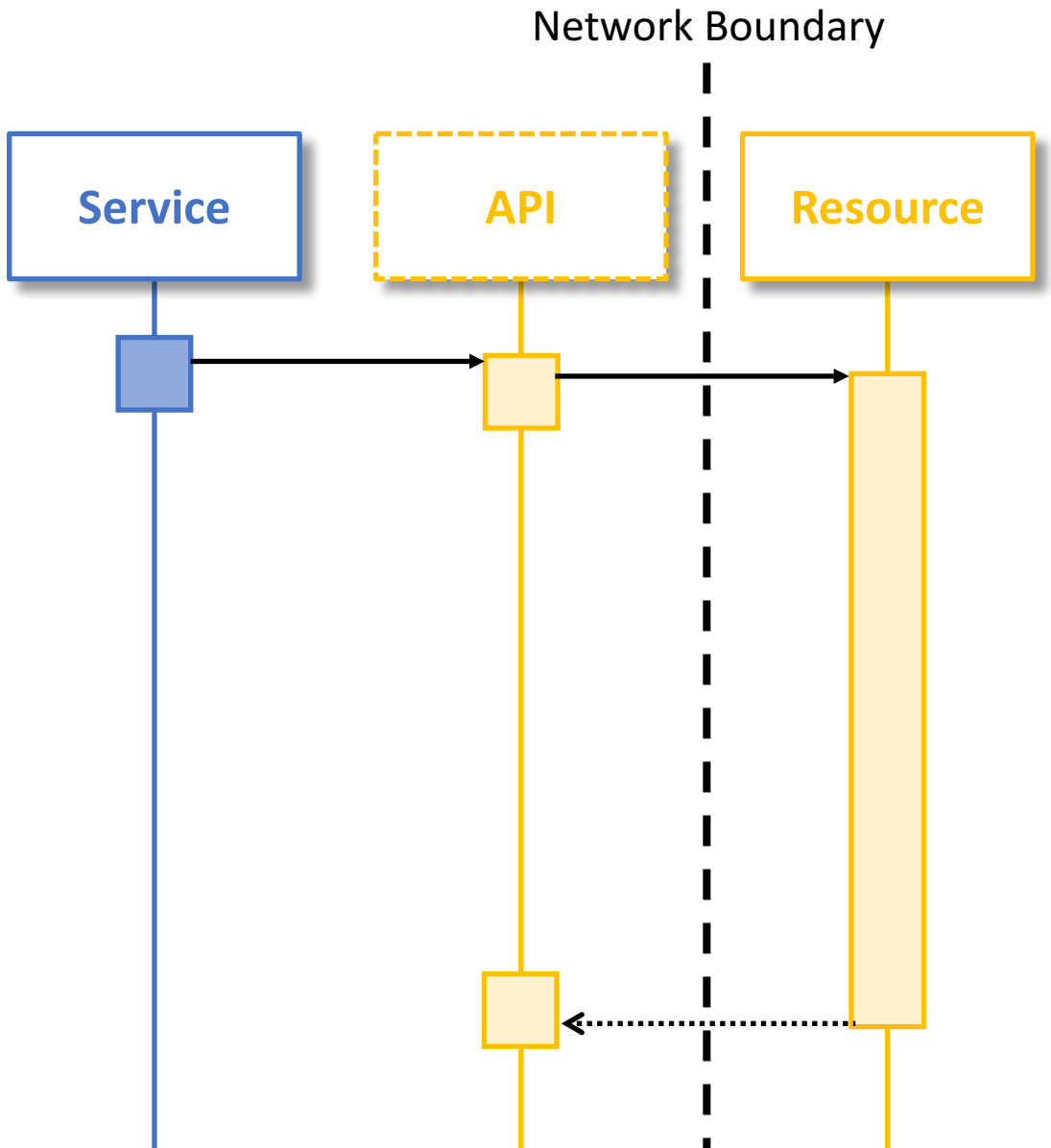

```
public CompletableFuture<Something> loadById(int id) {
  CompletableFuture<Something> eventualSomething =
    new CompletableFuture<>();

  somethings.loadById(id, (error, something) -> {
    if (error != null) {
      eventualSomething.completeExceptionally(error);
    } else {
      eventualSomething.complete(something);
    }
  });

  return eventualSomething;
}
```

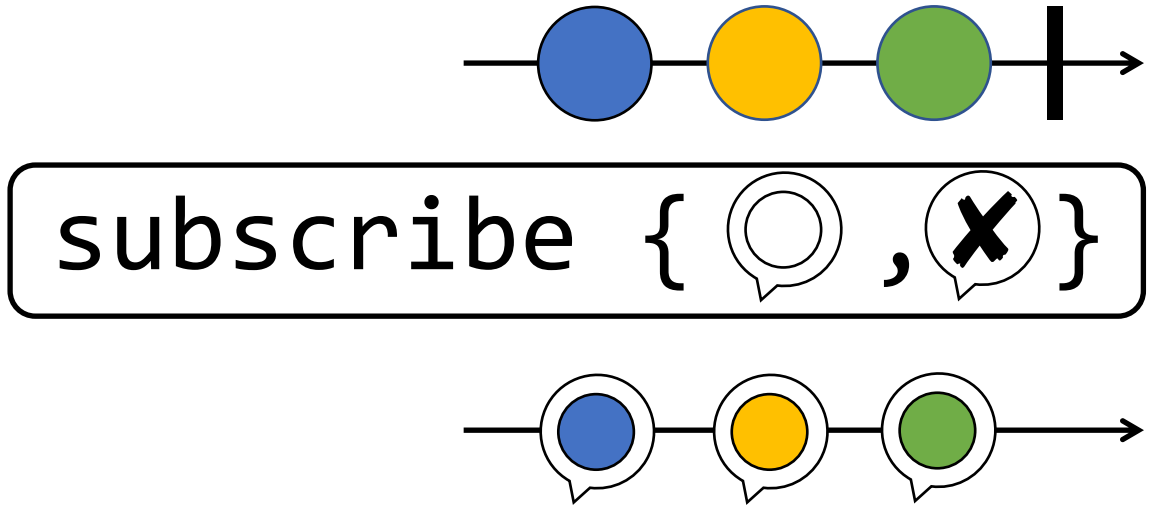
Reactive Extensions





Reactive Extensions

CompletableFuture<T>	Mono<T>	Flux<T>
represents an already scheduled task	represents a building plan (caller has to subscribe)	represents a building plan (caller has to subscribe)
completes only once	emits at most one value	emits many values



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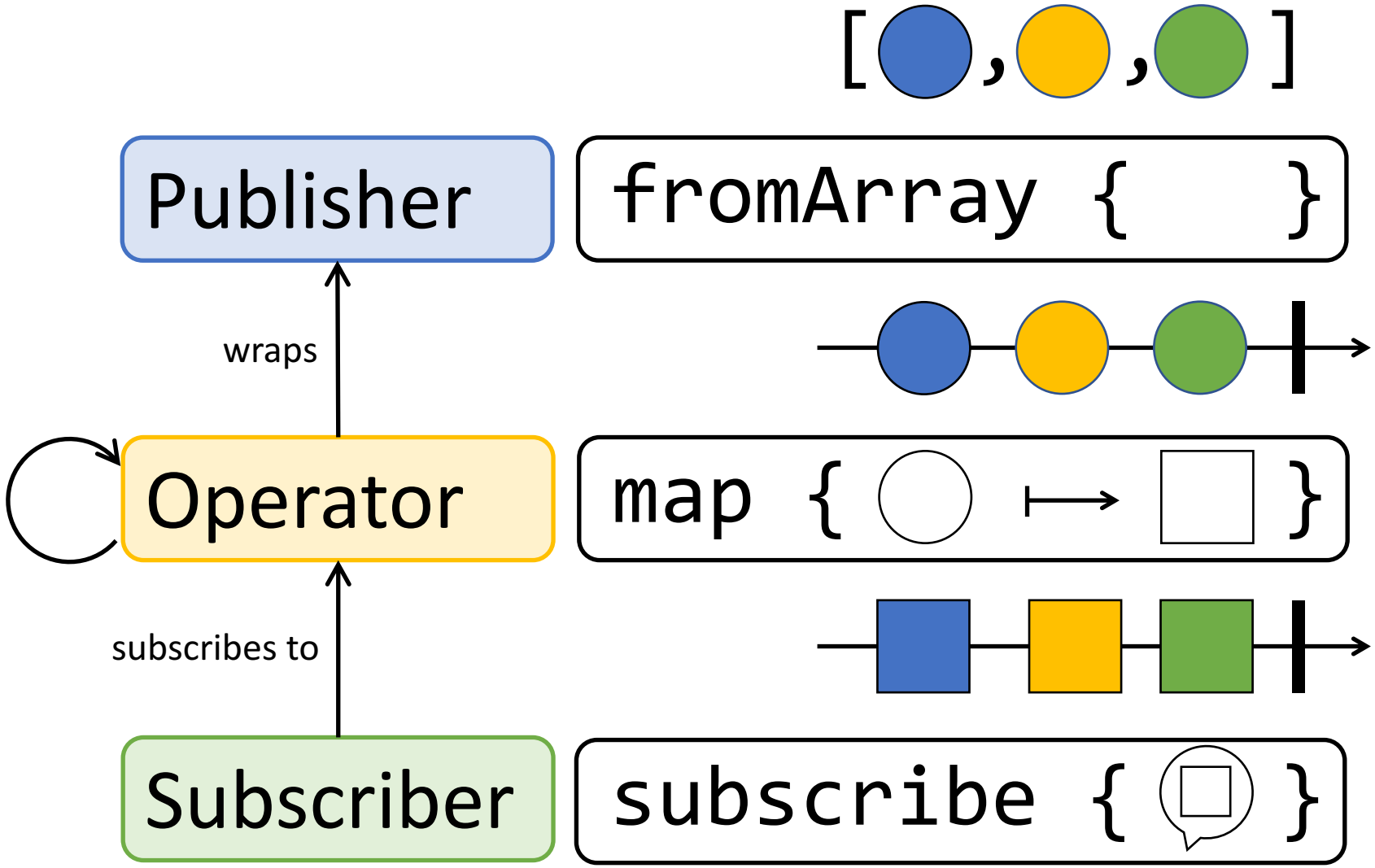
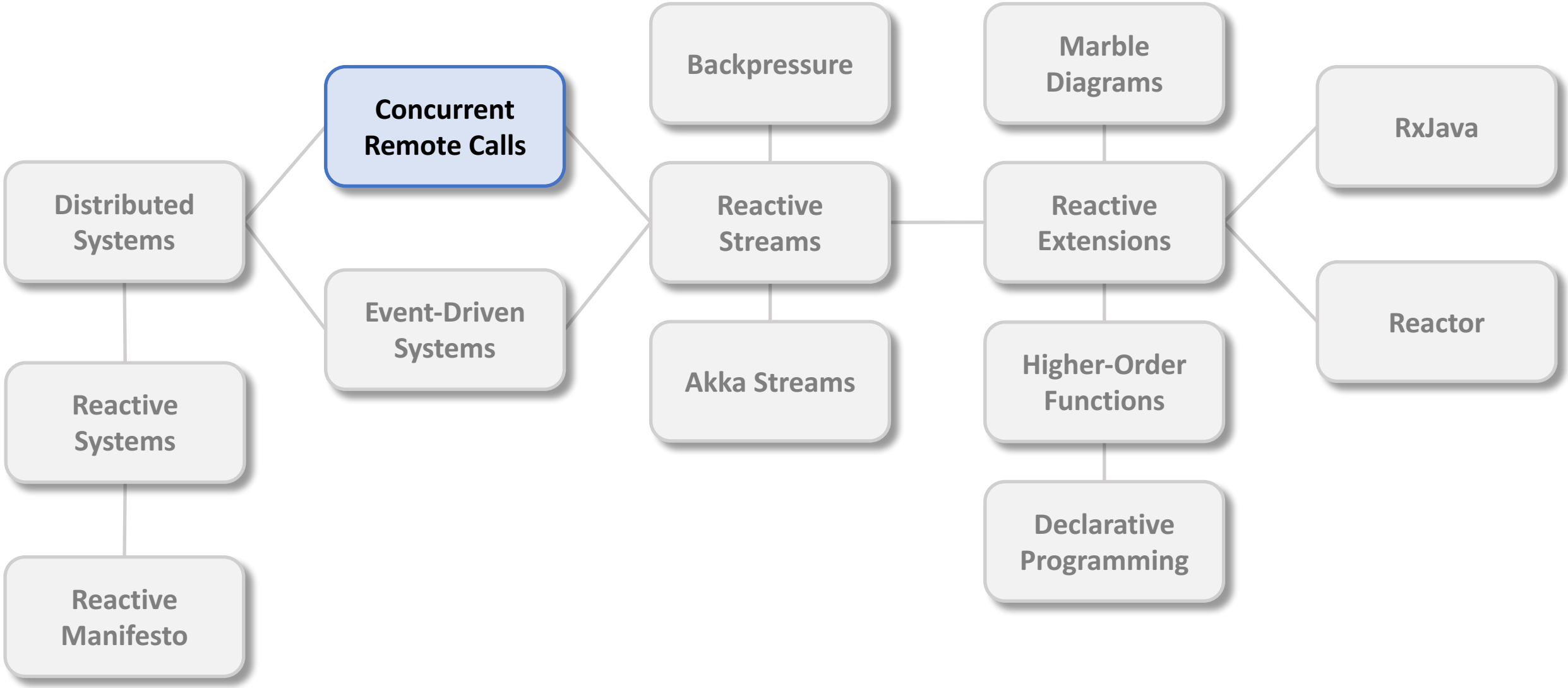


Reactive Extensions

```
Circle[] circles = { Circle.of(BLUE), ... };

Flux.fromArray(circles)

    .map(circle -> Square.of(circle.getColor()))

    .log()

    .subscribe(...);
```

```
[main] INFO - | onSubscribe()
[main] INFO - | ?
[main] INFO - | onNext(Square(BLUE))
[main] INFO - | onNext(Square(YELLOW))
[main] INFO - | onNext(Square(GREEN))
[main] INFO - | onComplete()
```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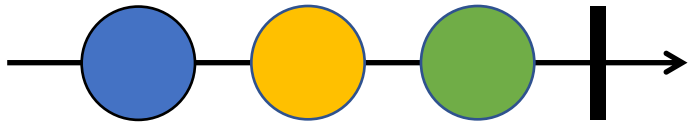
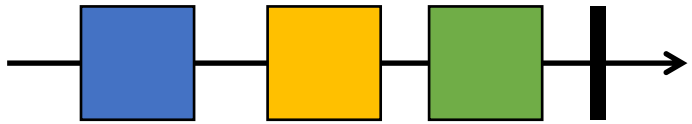
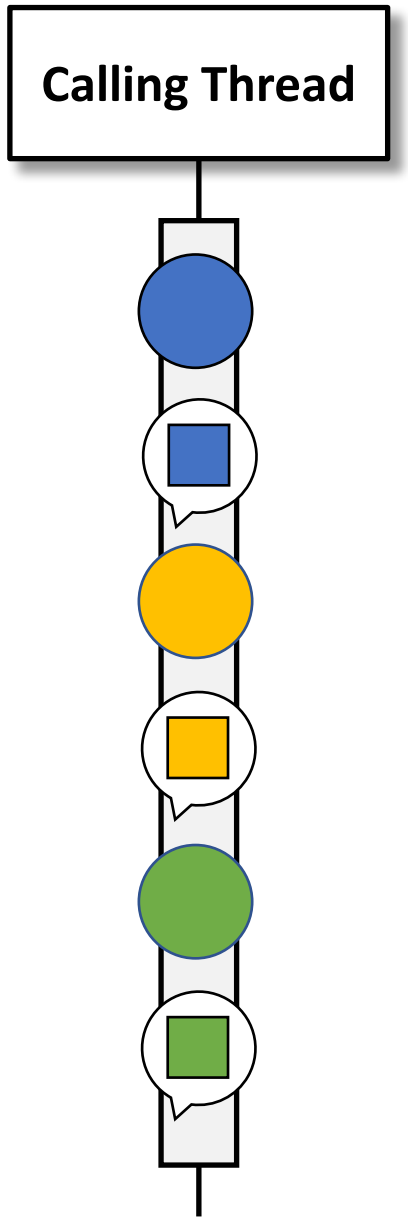
Concurrency



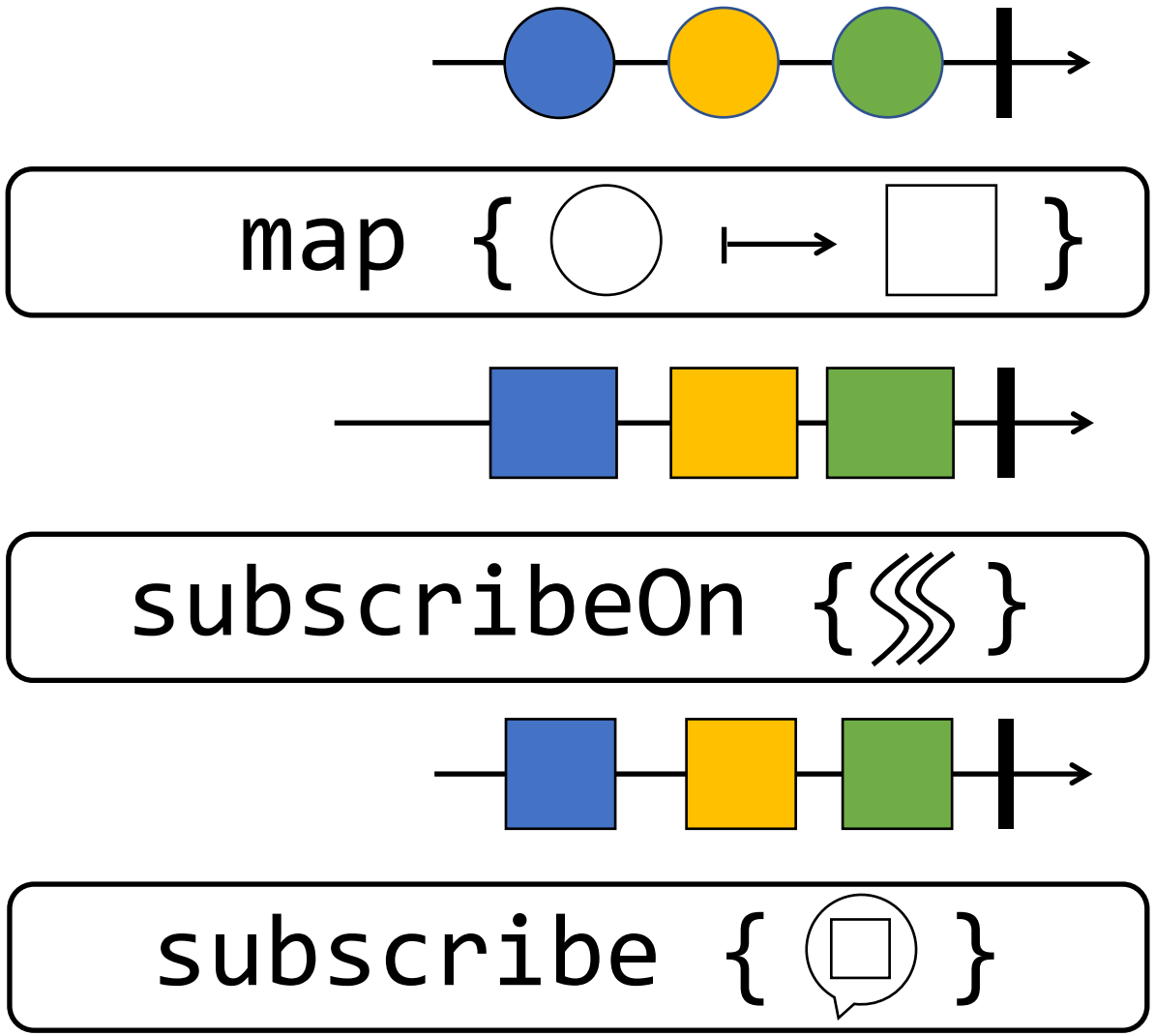
```
map { ○ ⟼ □ }
```

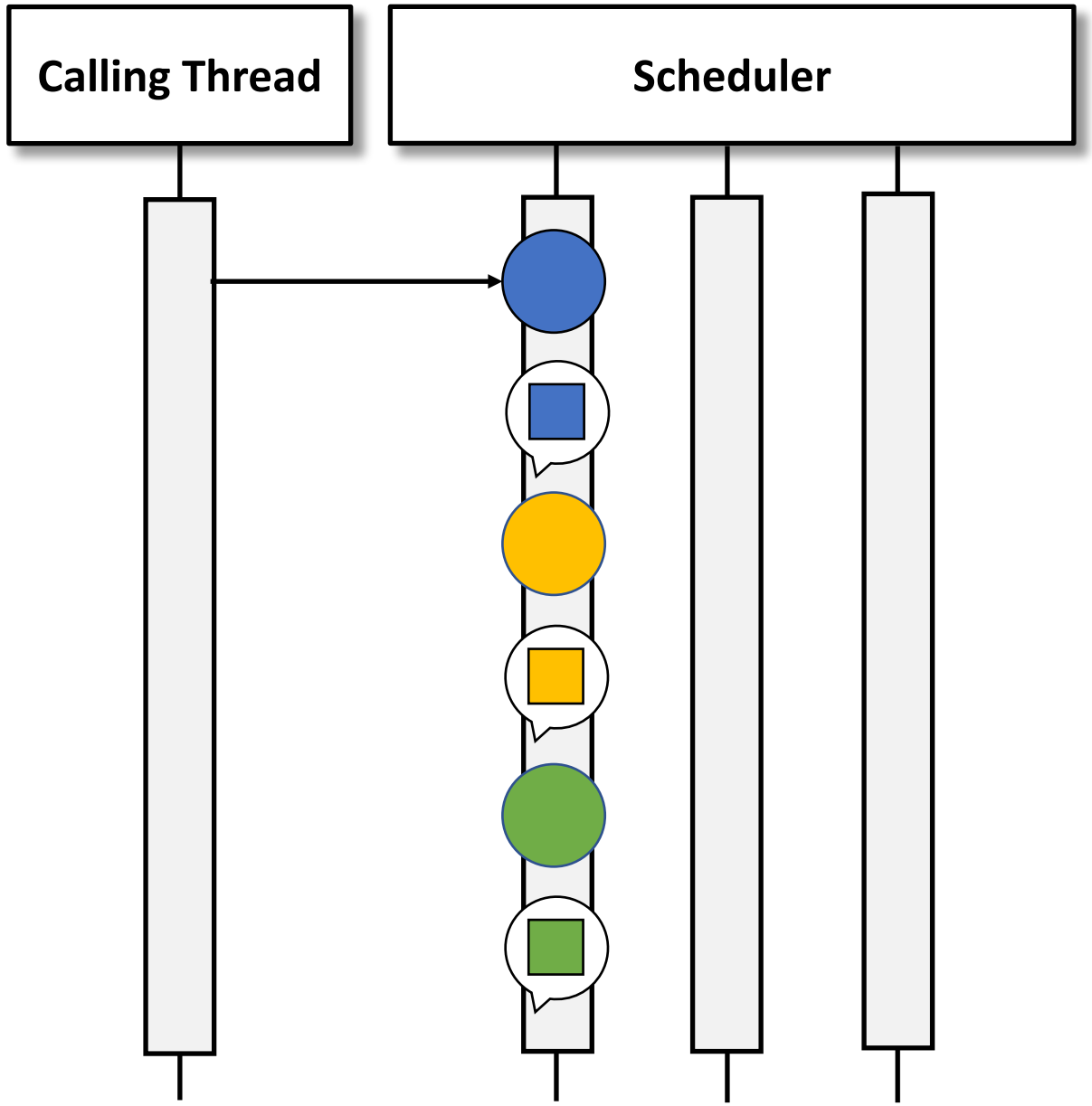


```
subscribe { □ }
```



Concurrency





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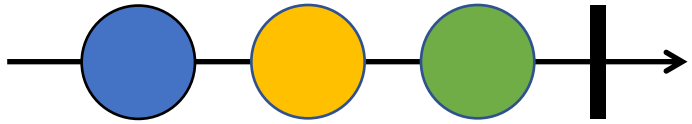
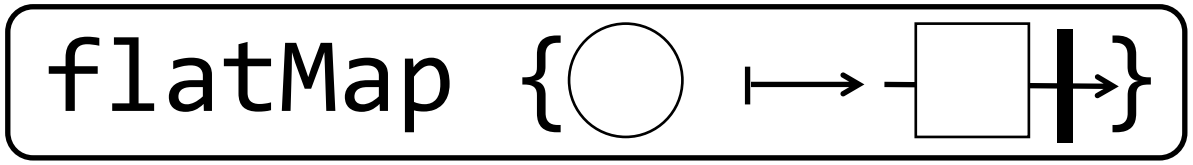
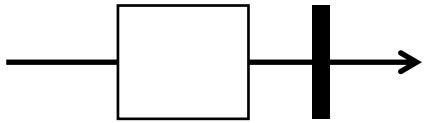
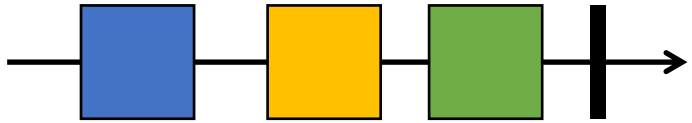
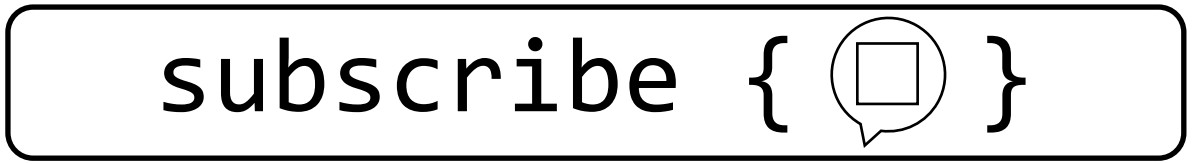
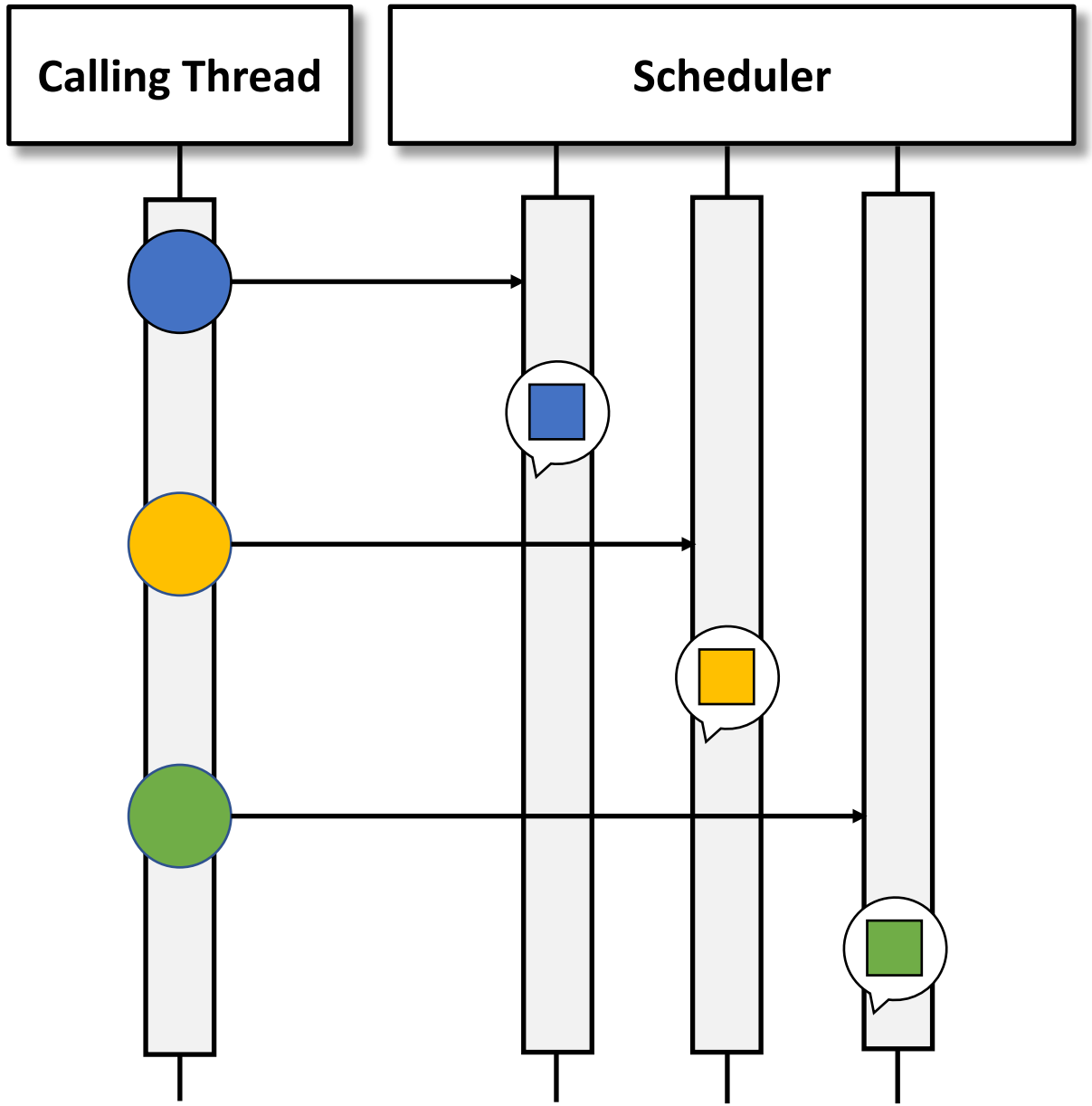








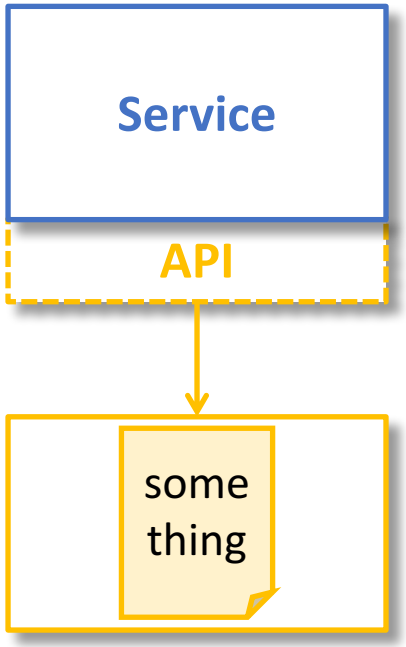




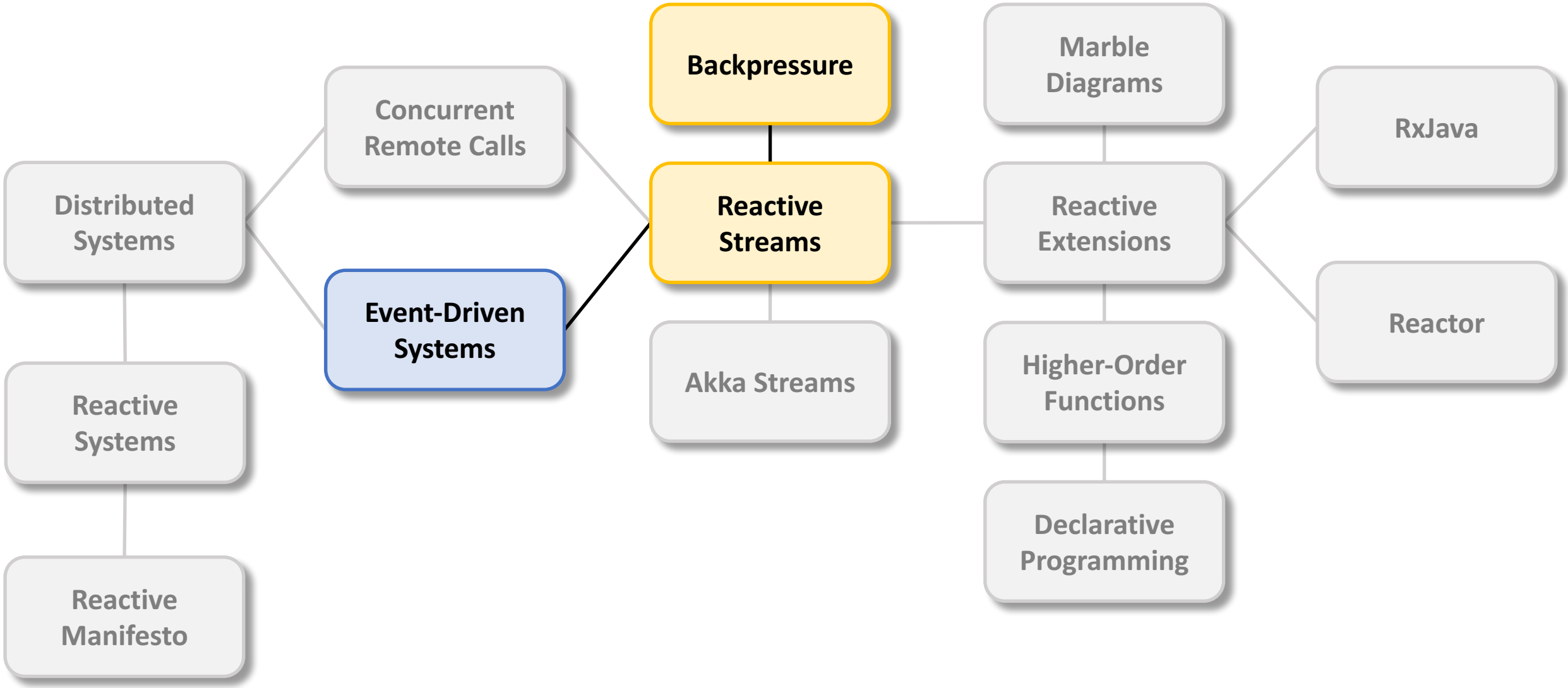
Concurrency

```
Scheduler scheduler =
    Schedulers.newParallel("pool", 8);
```

```
Flux.fromIterable(ids)

    .flatMap(id -> Mono.just(id)
        .map(somethings::loadById)
        .subscribeOn(scheduler))

    .log()

    .subscribe();
```




```
[main] INFO - onSubscribe()
[main] INFO - ?
[pool-1] INFO - onNext(Something(id=1))
[pool-2] INFO - onNext(Something(id=2))
[pool-3] INFO - onNext(Something(id=3))
[pool-3] INFO - onComplete()
```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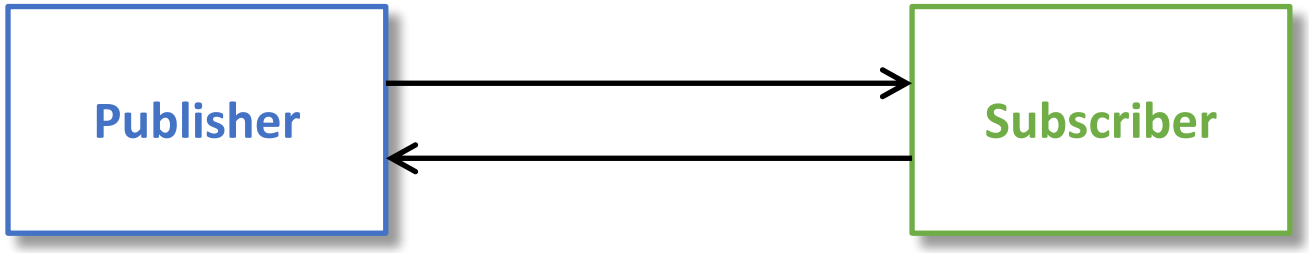
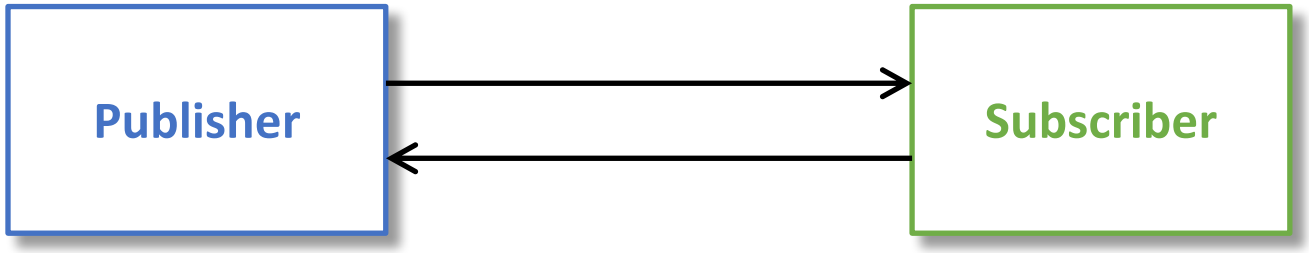
Backpressure



Backpressure

Backpressure



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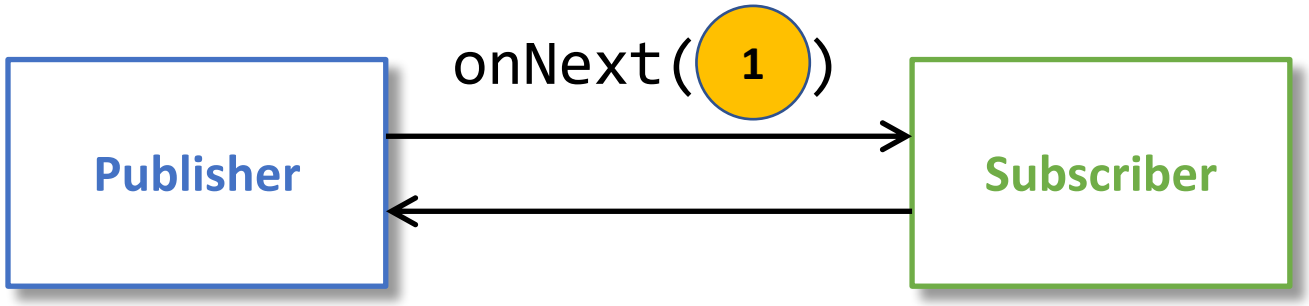

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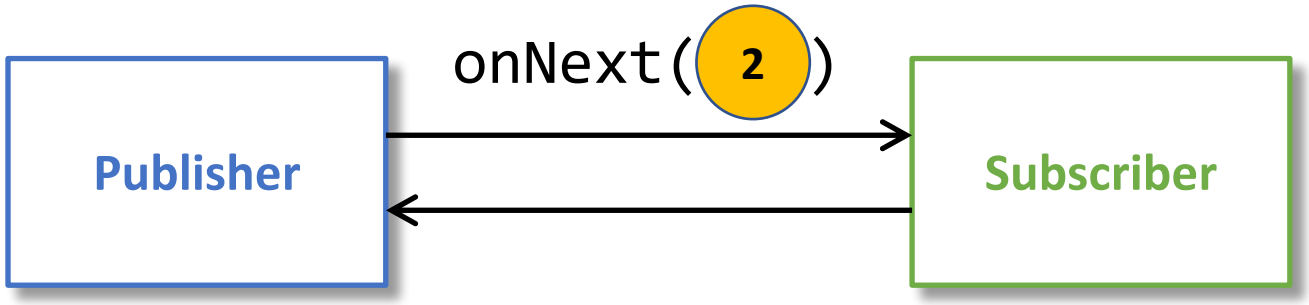

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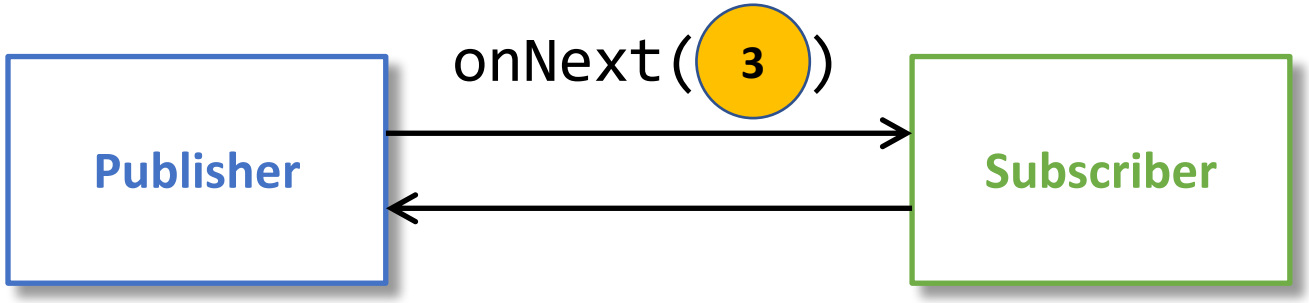
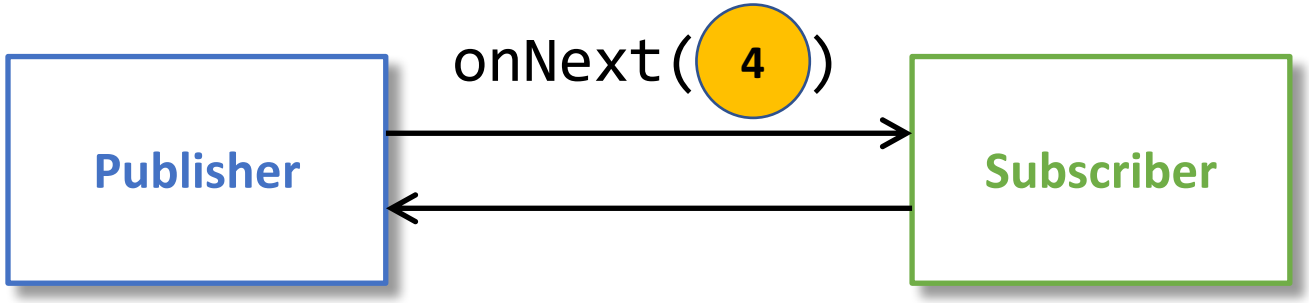


Backpressure



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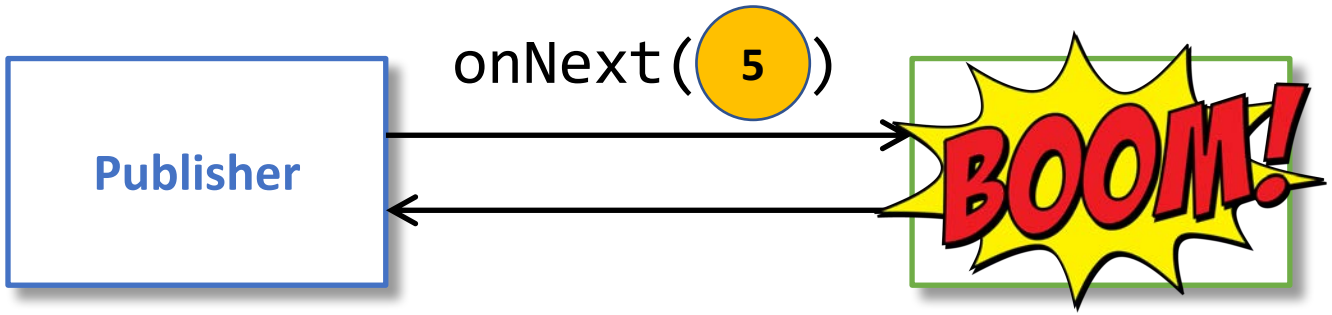
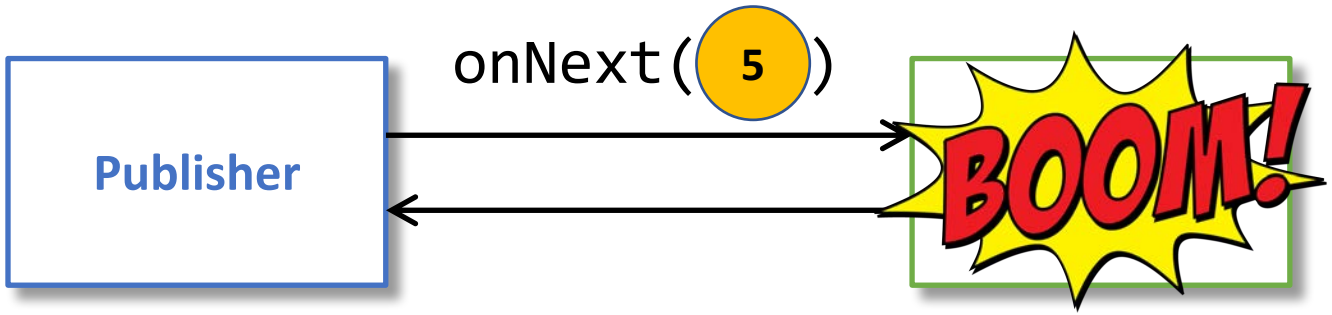


Backpressure

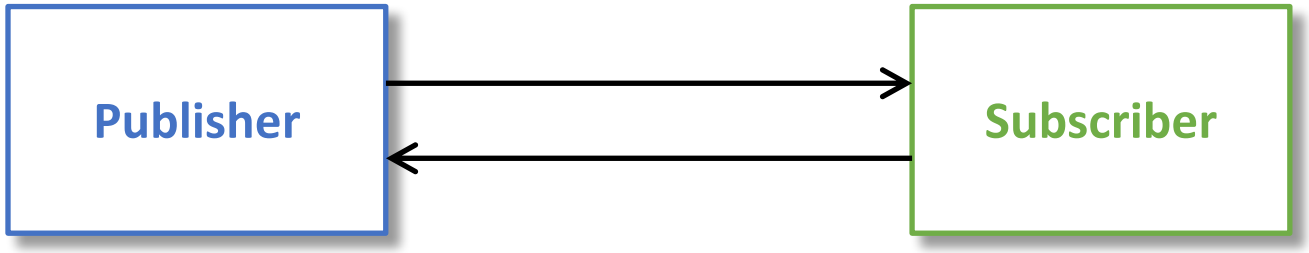
```
java.util.concurrent.RejectedExecutionException:
Task rejected from ThreadPoolExecutor [
  Running, pool size = 2, active threads = 2,
  queued tasks = 4, completed tasks = 0
]
```




```
ExecutorService executorService =
  new ThreadPoolExecutor(
      nThreads, nThreads,
      0L, TimeUnit.MILLISECONDS,
      new LinkedBlockingQueue<>(capacity)
  );
```

```
ids.stream()
   .map(id -> executorService
     .submit(() -> somethings.loadById(id)))
   .collect(toList())
   .stream()
   .map(waitForSomething())
   .forEach(handleSomething());
```

Backpressure



Backpressure

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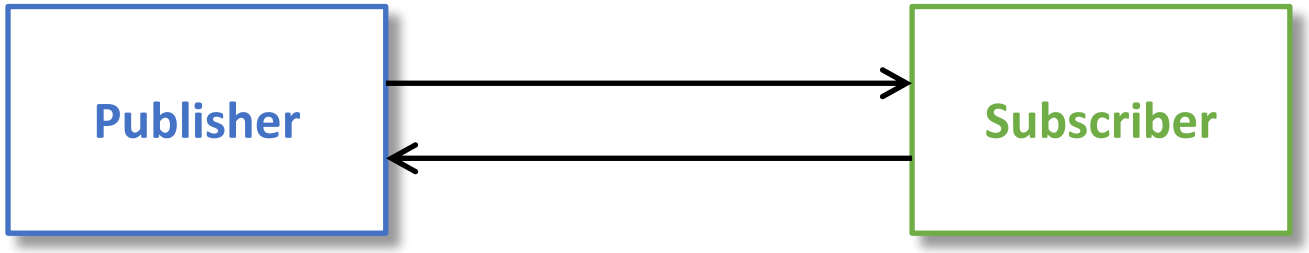

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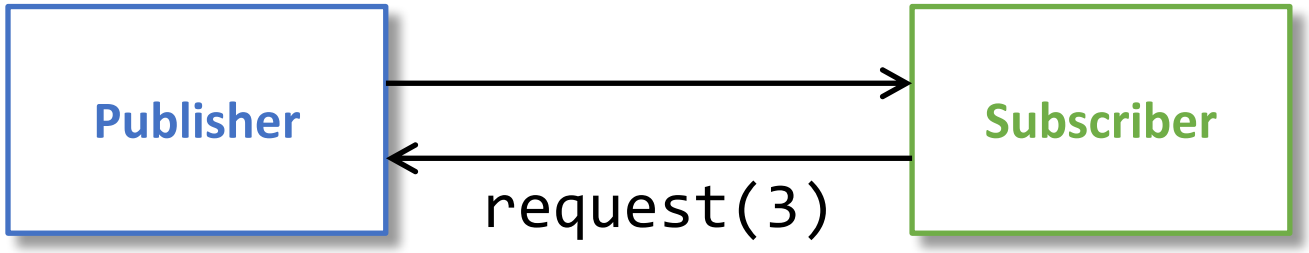

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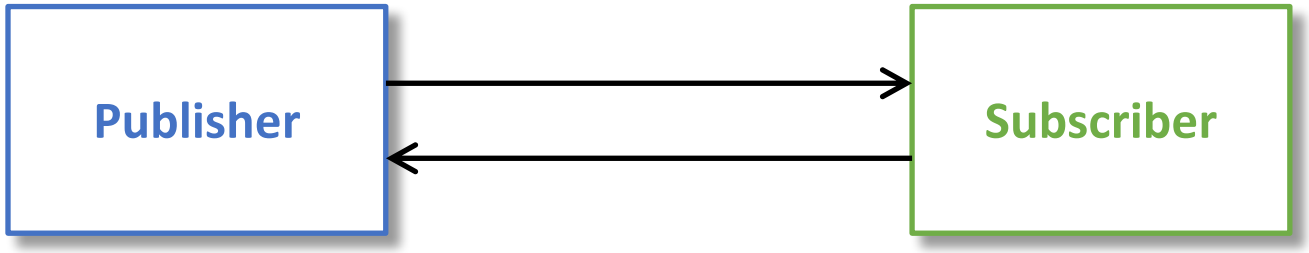
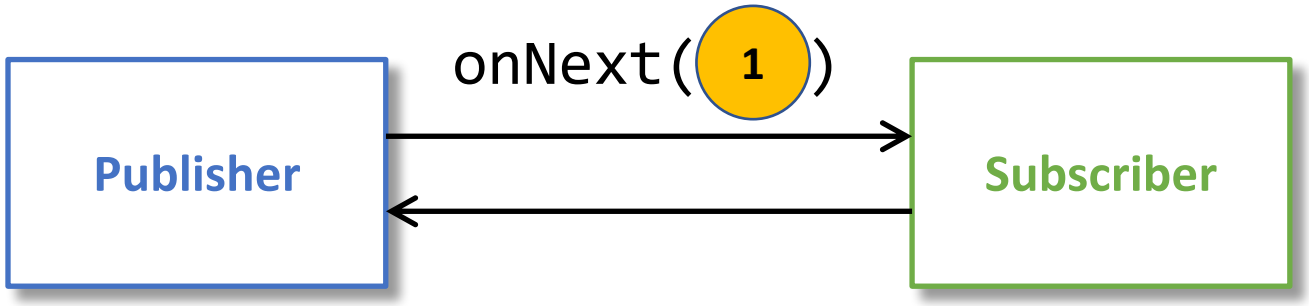
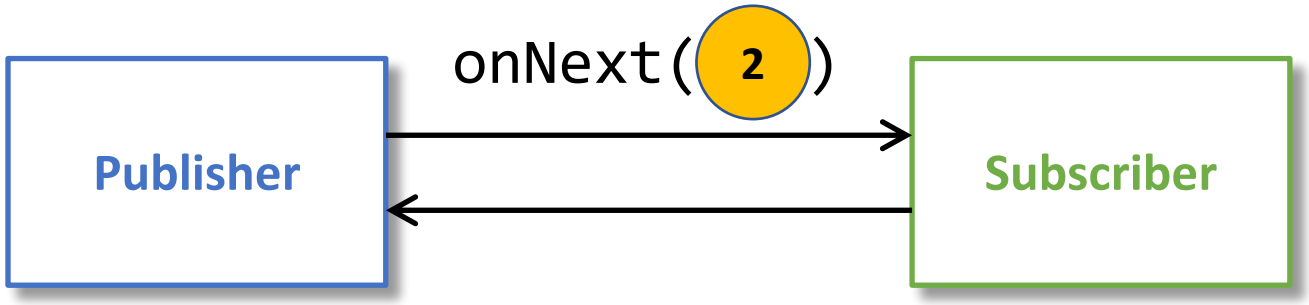


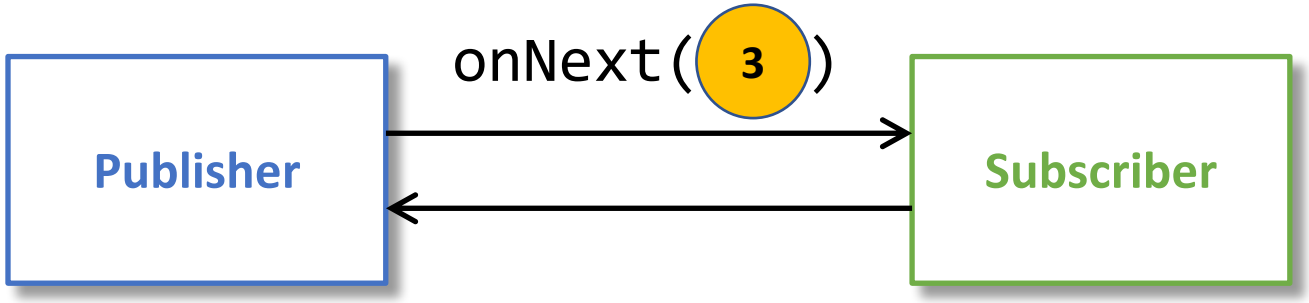
Backpressure



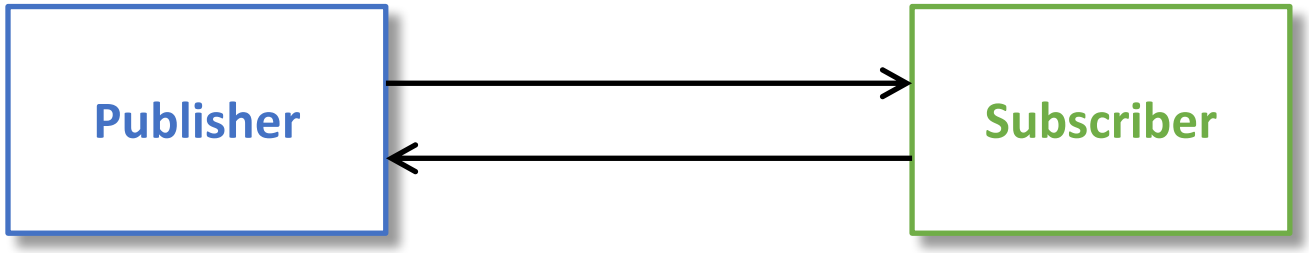
Backpressure



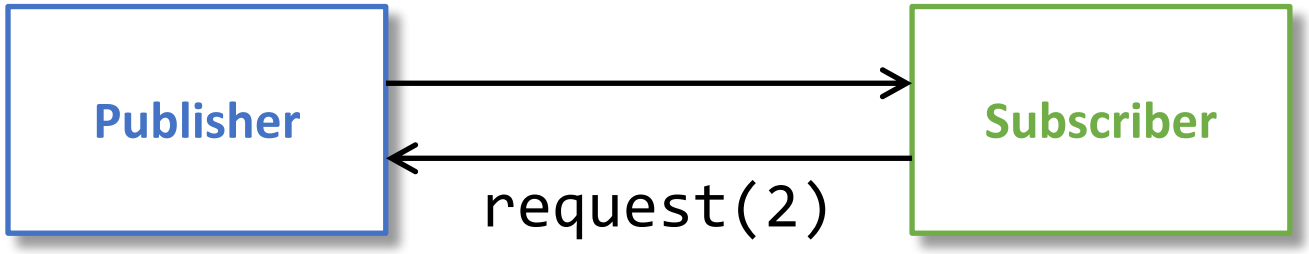
Backpressure



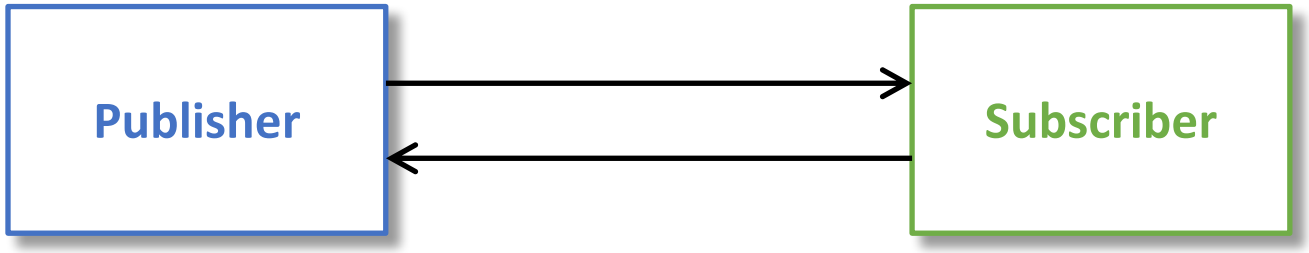
Backpressure



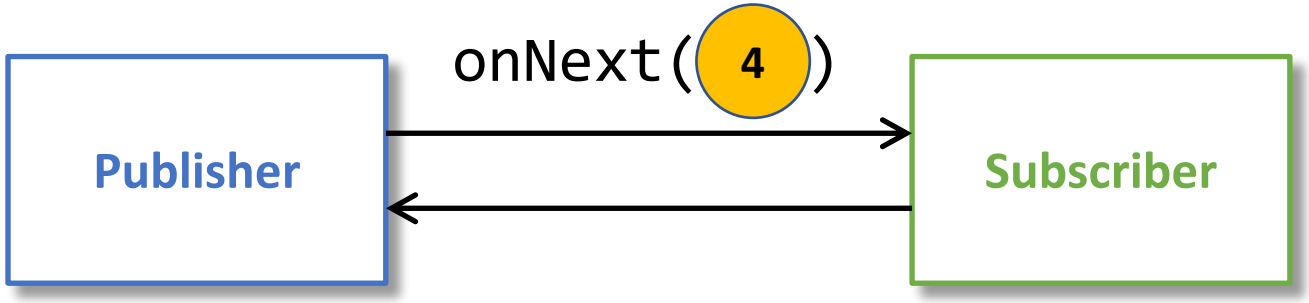
Backpressure



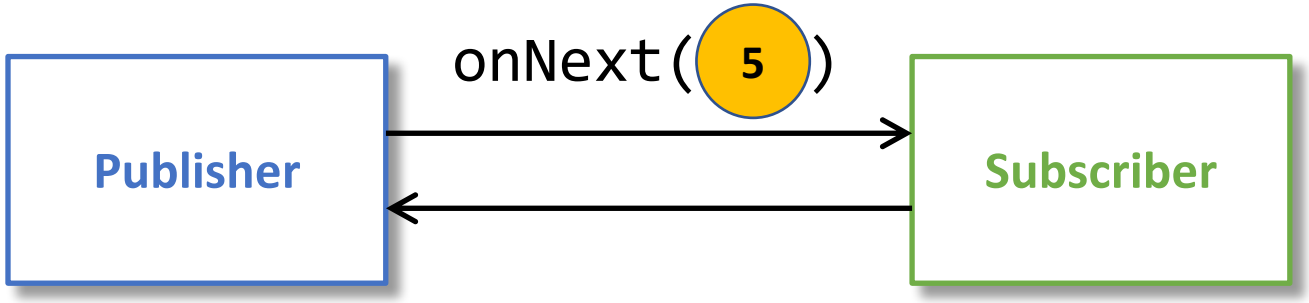
Backpressure



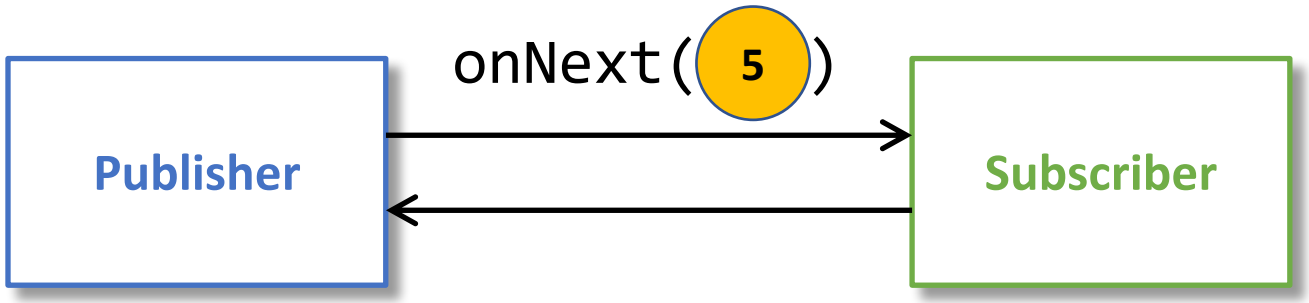
Backpressure



Backpressure



Backpressure



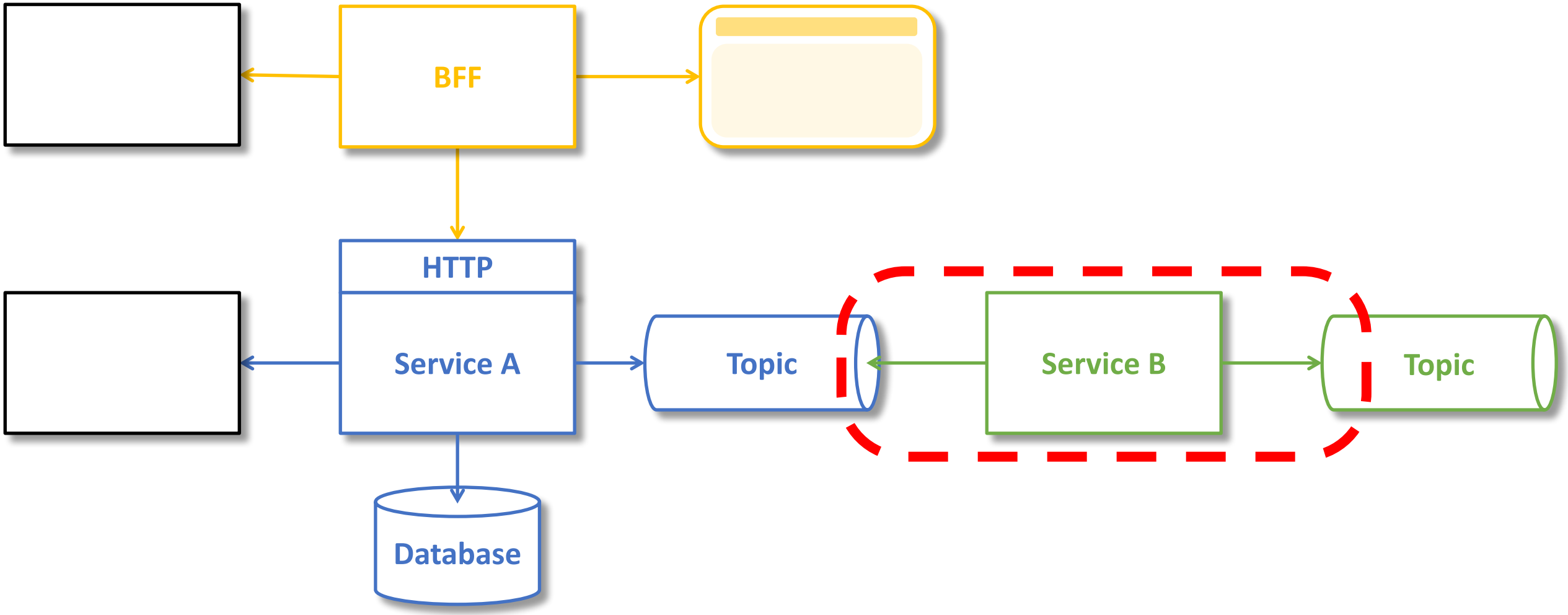

```
[main] INFO - | onSubscribe()
[main] INFO - | request(3)
[main] INFO - | onNext(1)
[main] INFO - | onNext(2)
[main] INFO - | onNext(3)
[pool-1] INFO - | request(1)
[pool-1] INFO - | onNext(4)
[pool-2] INFO - | request(1)
[pool-2] INFO - | onNext(5)
[pool-2] INFO - | onComplete()
```

```
ExecutorService executorService =
  new ThreadPoolExecutor(
      nThreads, nThreads,
      0L, TimeUnit.MILLISECONDS,
      new LinkedBlockingQueue<>(capacity)
  );
```

```
Scheduler scheduler = Schedulers
  .fromExecutorService(executorService);
```

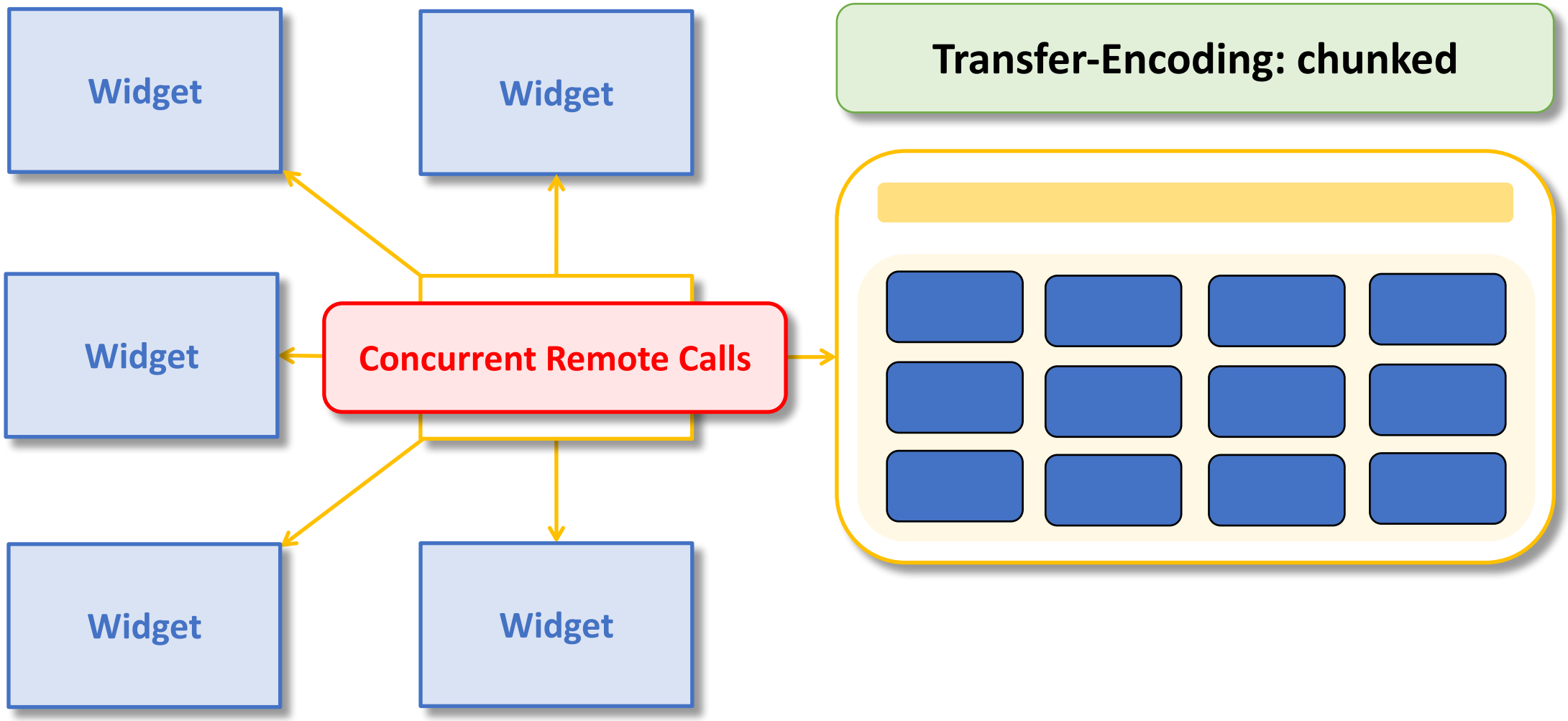
```
Flux.fromIterable(ids)
  .log()
  .flatMap(id -> Mono.just(id)
    .map(somethings::loadById)
    .subscribeOn(scheduler), 3)
  .doOnNext(handleSomething())
  .subscribe();
```

Backpressure



Progressive HTML Rendering

Progressive HTML Rendering



Progressive HTML Rendering

```
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-web</artifactId>
</dependency>

<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-webflux</artifactId>
</dependency>
```

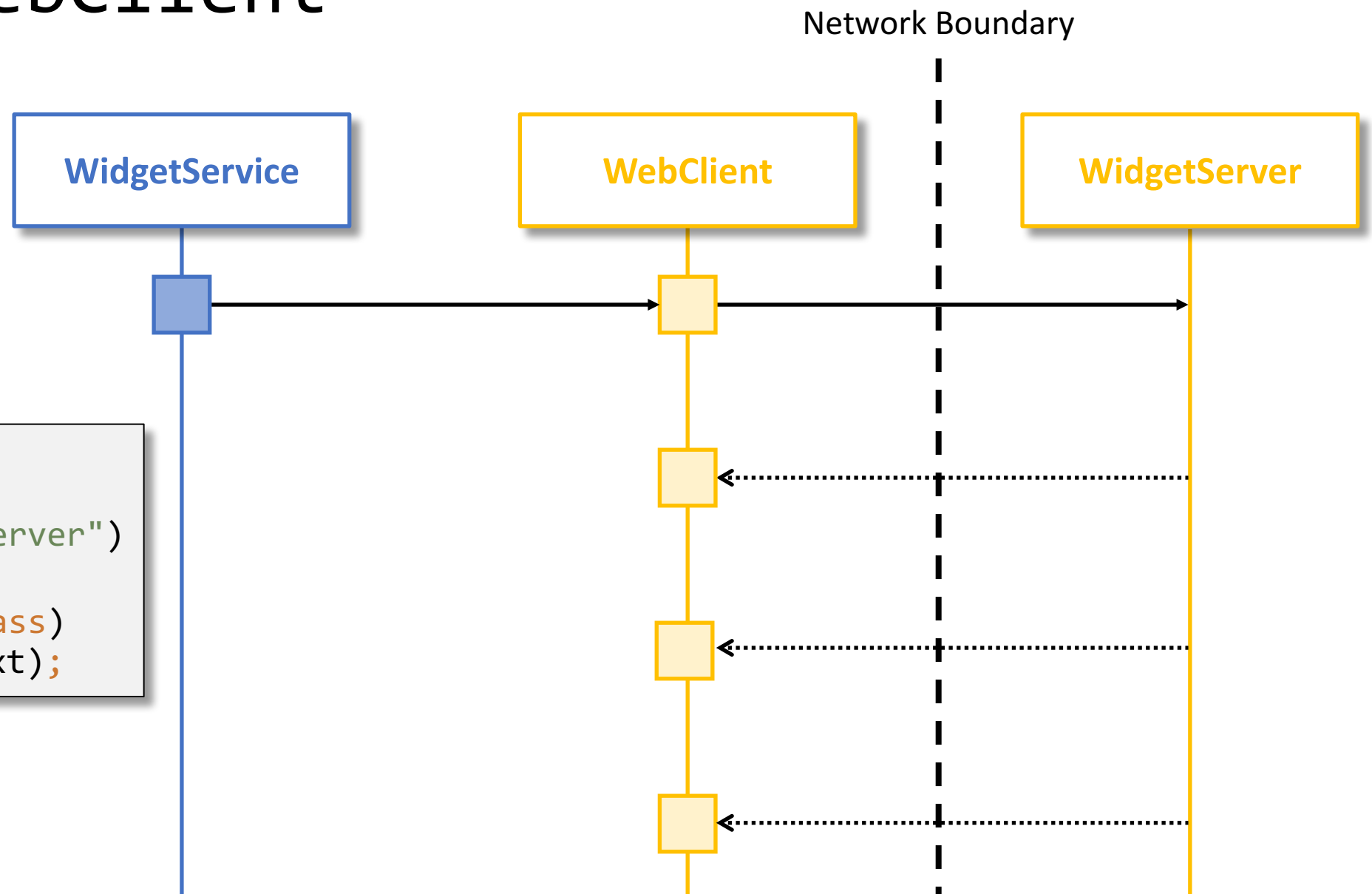
Progressive HTML Rendering

```
curl -i -N localhost:8080/hello

HTTP/1.1 200
Content-Type: text/plain
Transfer-Encoding: chunked

Hello
Hello
Hello
Hello
Hello
```

```
@SpringBootApplication
@RestController
public class Application {

  public static void main(String[] args) {
    SpringApplication.run(Application.class, args);
  }

  @GetMapping(value = "hello")
  public Flux<String> sayHello() {
    return Flux.interval(Duration.ofMillis(500)).map(tick -> "Hello\n");
  }

}
```

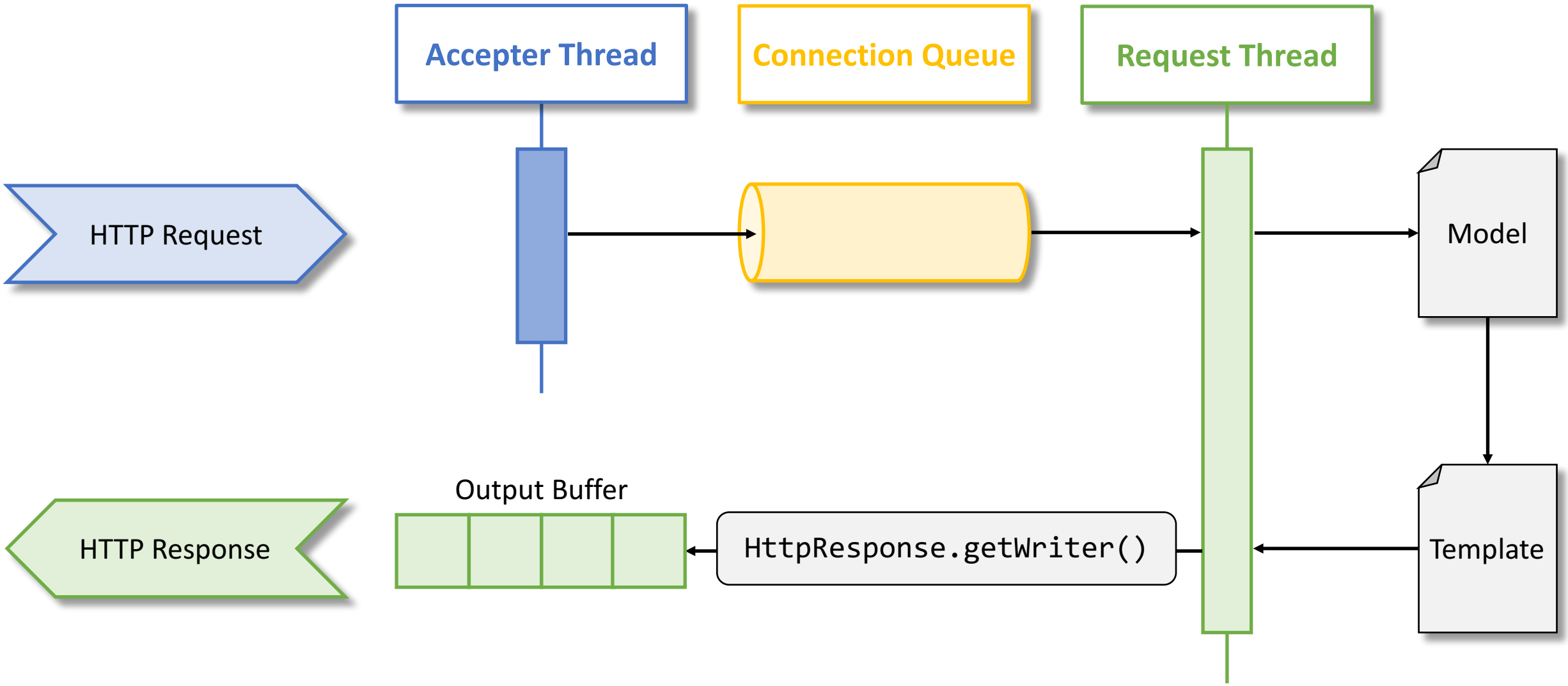
Baking an HTML stream

Spring 5 `WebClient`

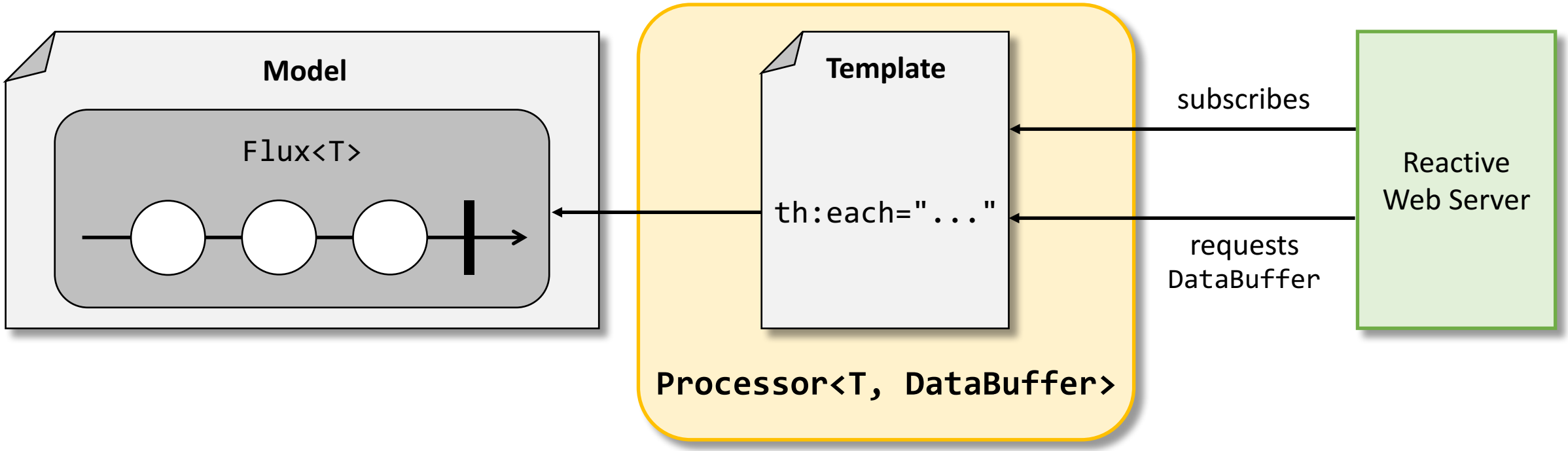



```
WebClient.create()
   .get()
   .uri("http://widget-server")
   .retrieve()
   .bodyToFlux(String.class)
   .subscribe(this::onNext);
```

HTML Rendering

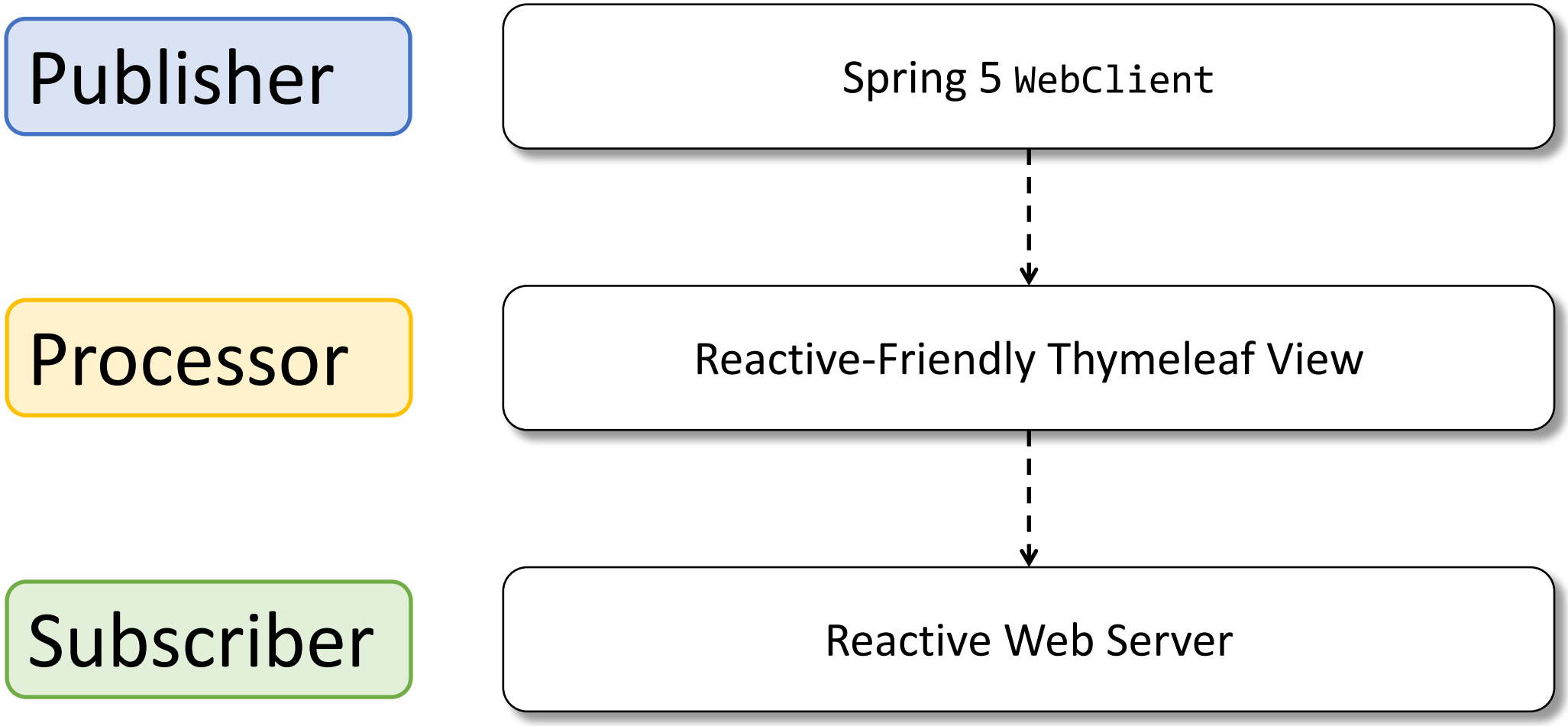


Reactive-Friendly Template Engine



HTML rendered as values are published

Progressive HTML Rendering



Progressive HTML Rendering

Publisher

Spring 5 `WebClient`

```
URI uri = ...
String name = ...

Mono<Pagelet> pageletMono = webClient.get().uri(uri).exchange()
  .flatMap(res -> res.bodyToMono(String.class))
  .map(body -> new Pagelet(name, body));
```

```
List<Mono<Pagelet>> pageletMonos = ...;

... = Flux.merge(pageletMonos);
```

Progressive HTML Rendering

Processor

Reactive Thymeleaf View

```
@GetMapping(value = "/widgets")
public String widgets(Model model) {
  List<String> pageletNames = widgetService.getPageletNames();
  Flux<Pagelet> pagelets = widgetService.loadPagelets();

  model.addAttribute("pageletNames", pageletNames);
  model.addAttribute("pagelets", new ReactiveDataDriverContextVariable(pagelets, 1));

  return "widgets";
}
```

Progressive HTML Rendering

Processor

Reactive Thymeleaf View

```
<article th:each="pageletName: ${pageletNames}" class="...">
  <section class="...">
    <div th:id="${pageletName}" class="...">
      <div class="...">...</div>
    </div>
  </section>
</article>
```

Progressive HTML Rendering

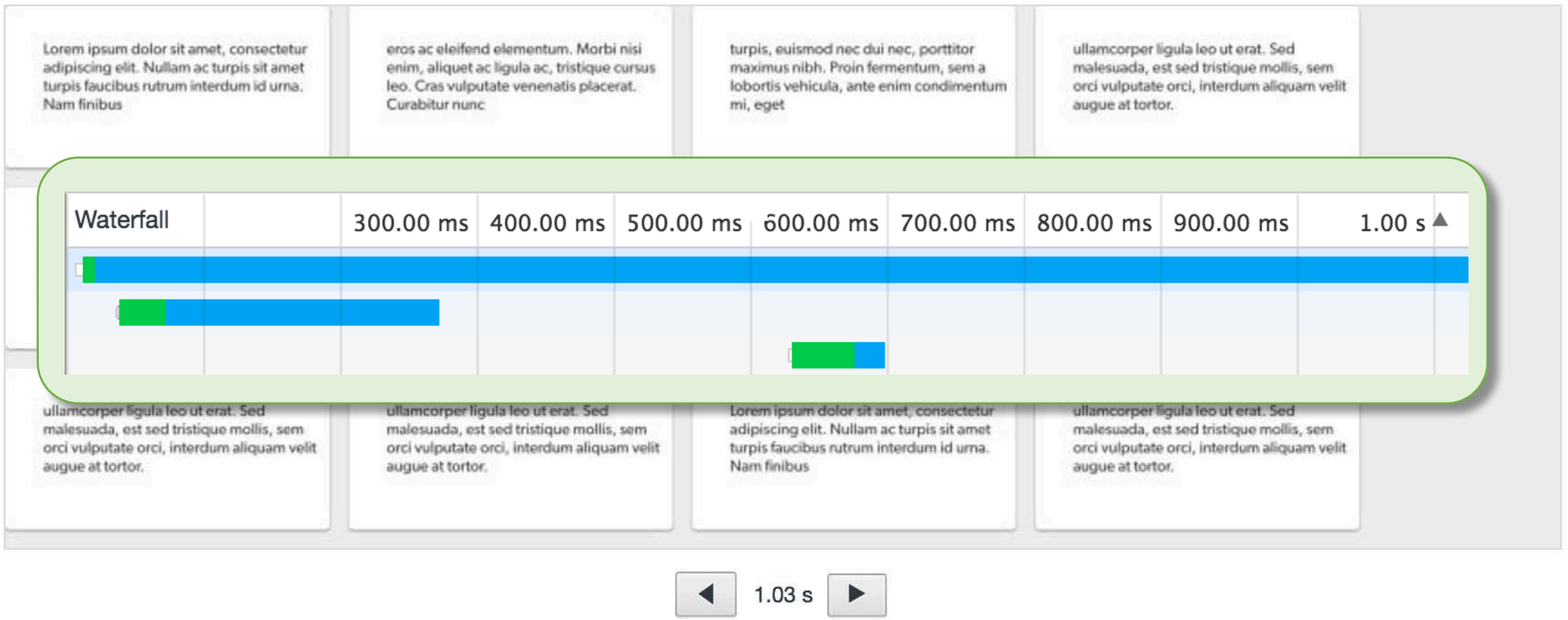
Processor

Reactive Thymeleaf View

```
<script th-inline="javascript" th:each="pagelet : ${pagelets}">
    (function() {
        var element = document.getElementById("[[${pagelet.name}]]");
        if(element) {
            element.innerHTML = "[(${pagelet.content})]";
        }
    })();
</script>
```

Does it work?

Progressive HTML Rendering



What‘s more?

- Cold Streams vs. Hot Streams
- Reactive Database Drivers
- Backpressure Strategies
- Threaded vs. Evented Server Model
- WebSockets and Server-Sent Events

Thank you!

Questions?