DEVIEW 2020

비동기 서버 그까이꺼, Request Scoping만 알면 끝!

Minwoo Song LINE PLUS

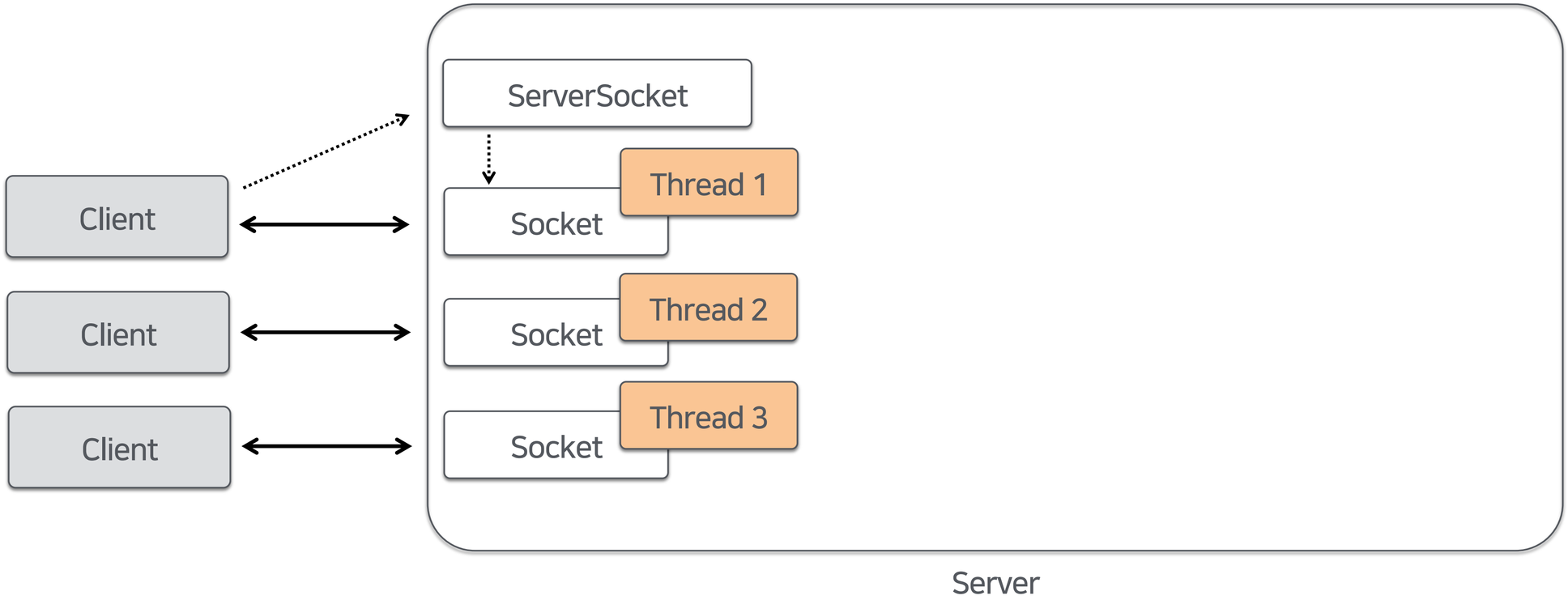
Managing and providing information
on which request the logic was derived by
when executing a specific logic

CONTENTS

1. How an asynchronous server works?

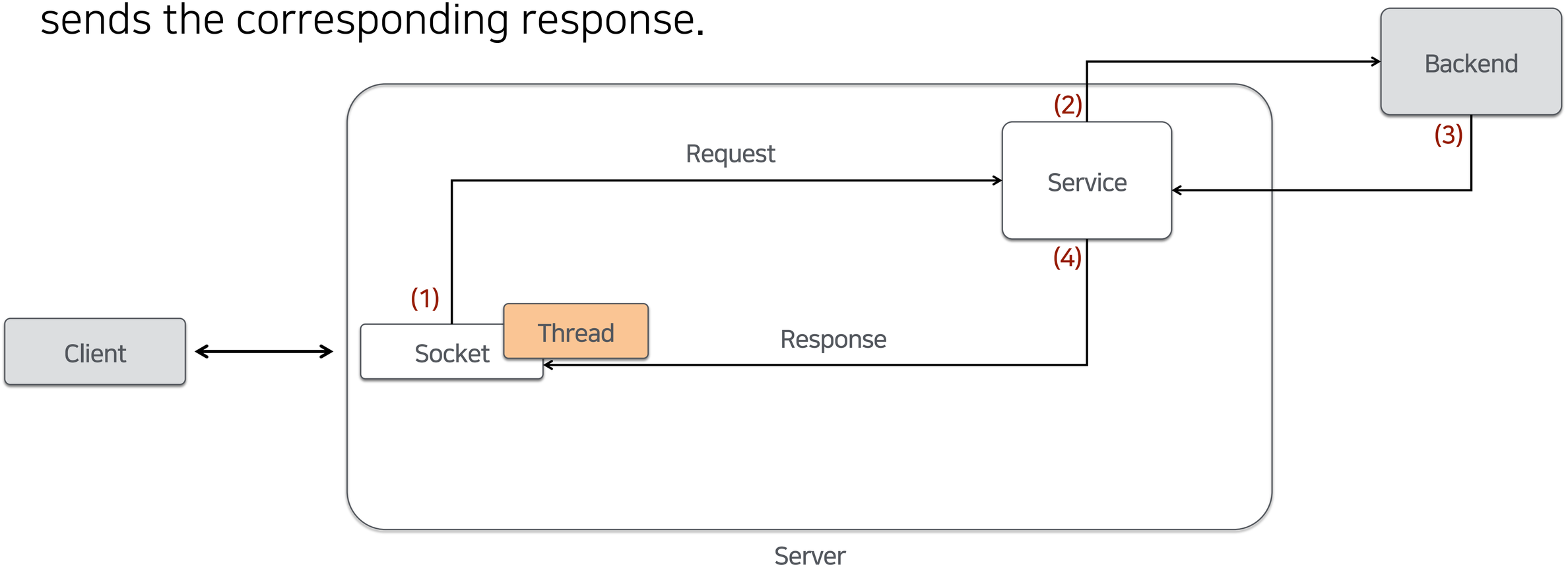
Syncronous server

- Each thread handles one socket.



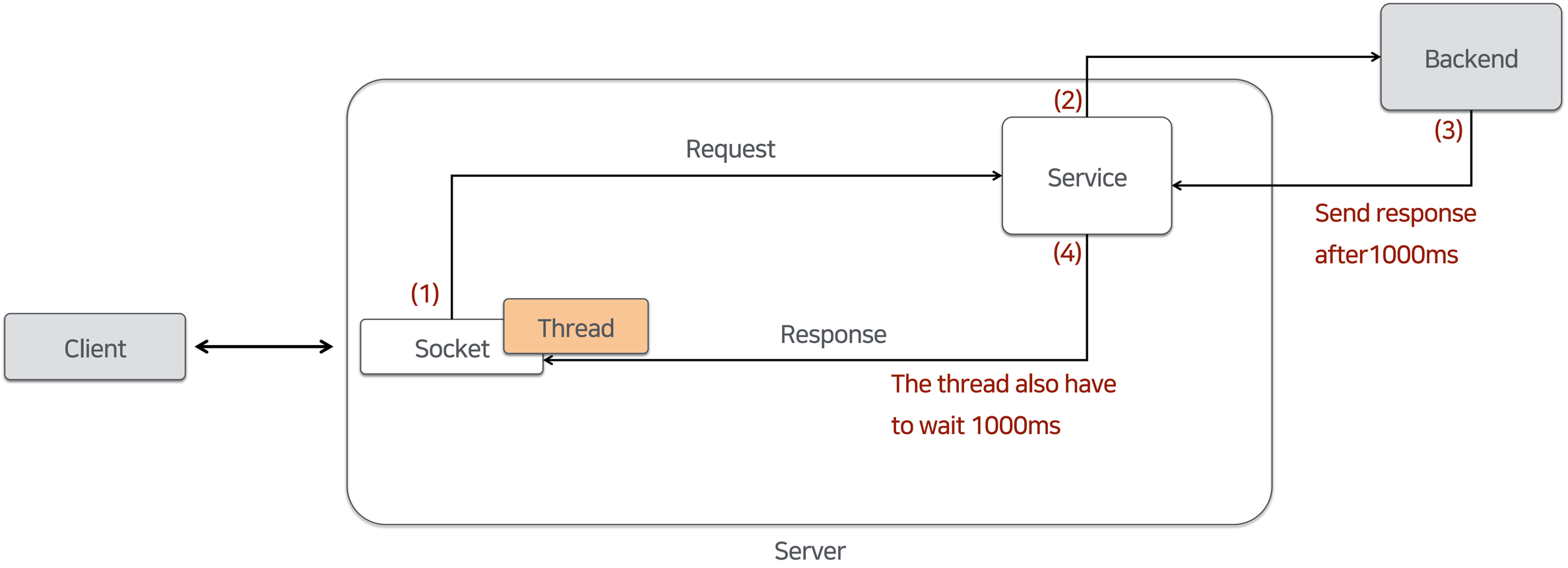
Syncronous server

- Once the thread receives a request it can't do anything until it sends the corresponding response.



Syncronous server

- Even when it takes longer to get a response from the backend.



Syncronous server

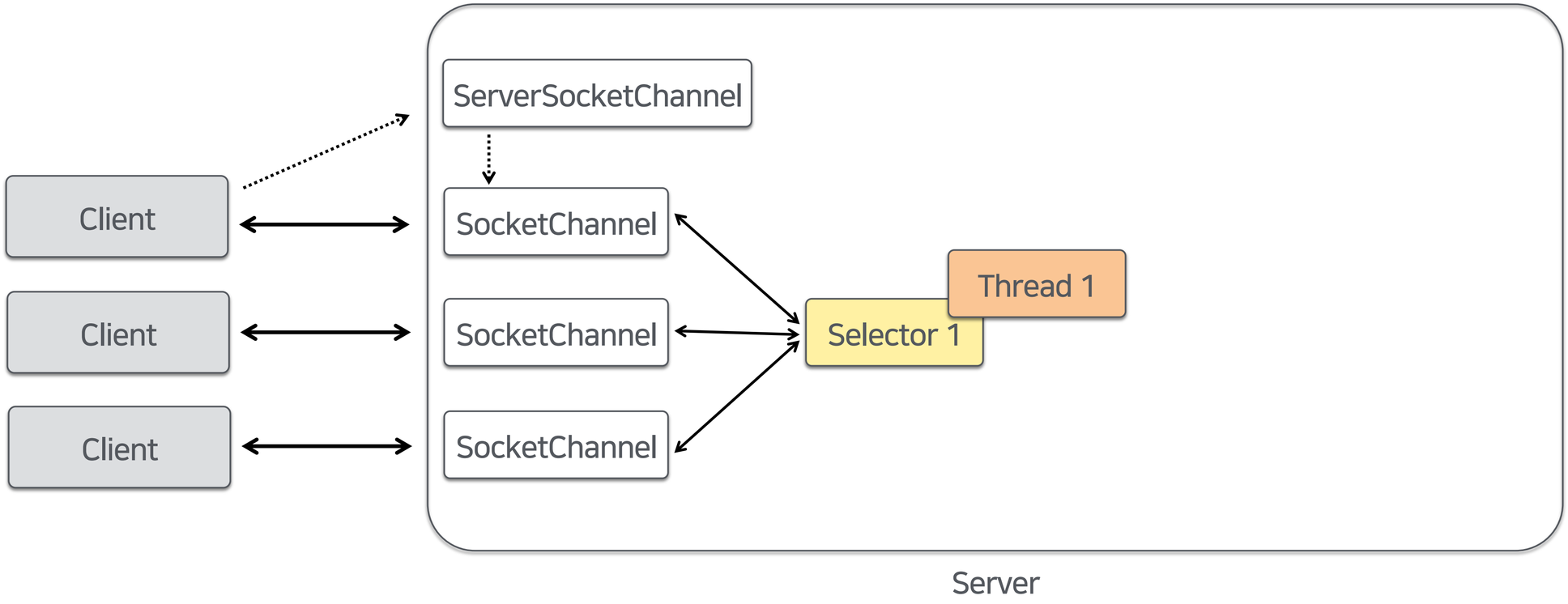
- Simpler code
- Can’t solve C10k problem

Asyncronous server

- `EventLoop`
- Wrapper

Asyncronous server

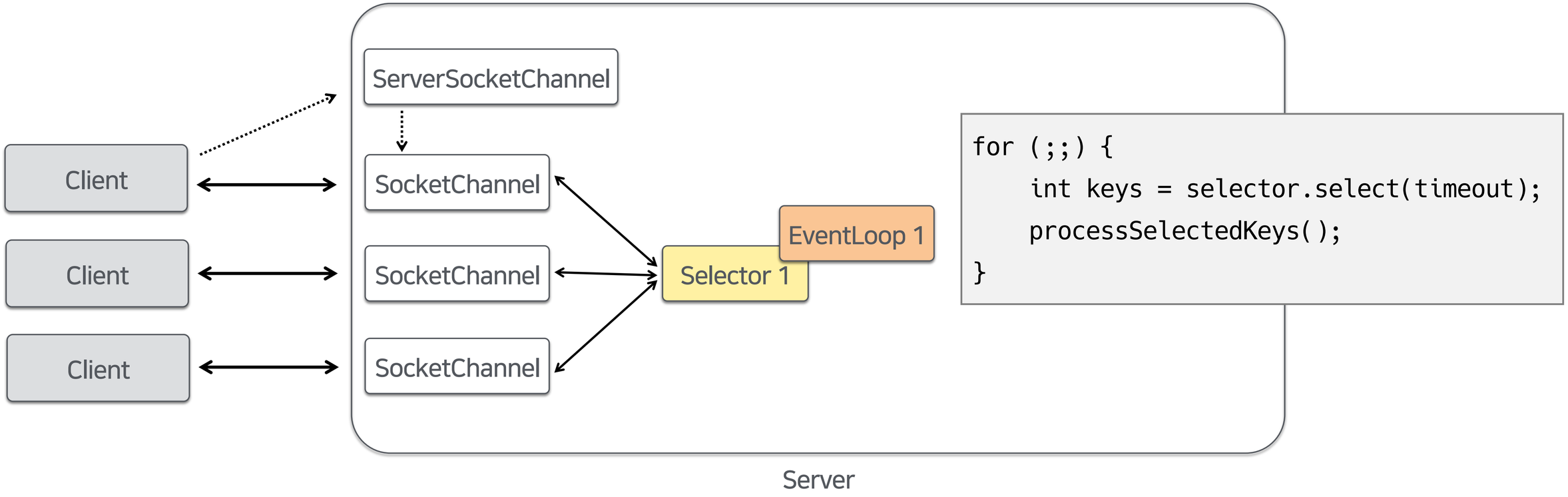
- Each thread handles many socket channels.




```
socketChannel.register(selector, SelectionKey.OP_READ, ...);
```

EventLoop

- A single thread selector loop



EventLoop

- A single thread selector loop
  - epoll, io_uring(Linux), kqueue(FreeBSD)
- Relatively few threads handle all IO.
  - Usually the number of core * 2
  - Tomcat uses 200 threads by default.

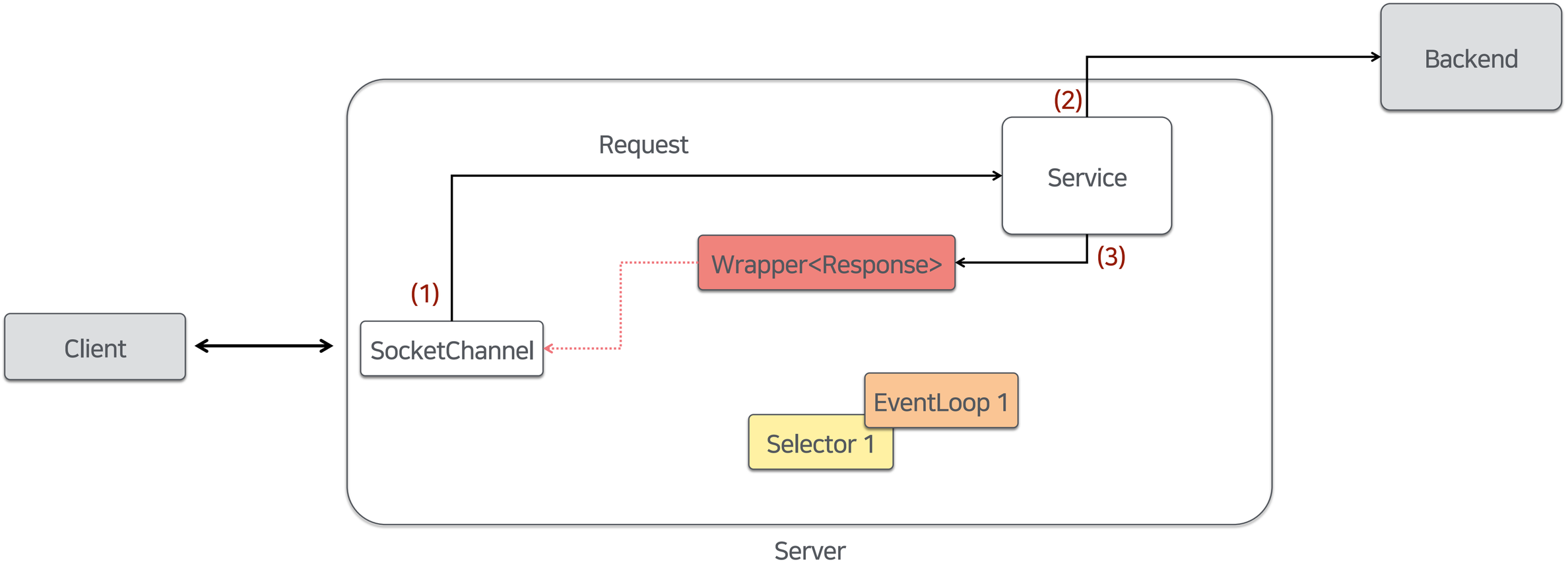
- What's the rational size of a thread pool?

$$Ncpu * Ucpu * (1 + {}^{W}/_{C})$$

Goetz, Brian. *Java concurrency in practice*. Addison-Wesley, 2006.

Wrapper

- The service returns a wrapper instead of the actual response.



Wrapper

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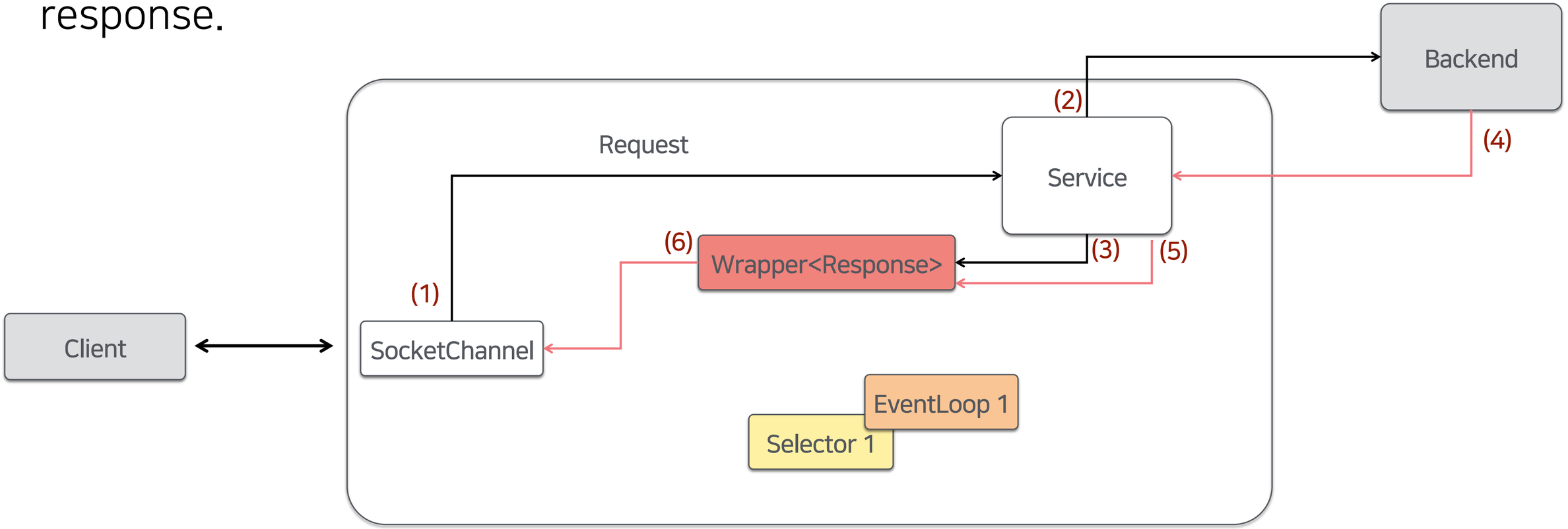
- A wrapper that will have one or more instances now or in the future
  - e.g. `Future`, `Promise`, `Publisher`, etc,
- Should use asynchronous callback (No blocking operation)
- The request could also be a wrapper because it might be composed of multiple frames. (e.g. headers and body)

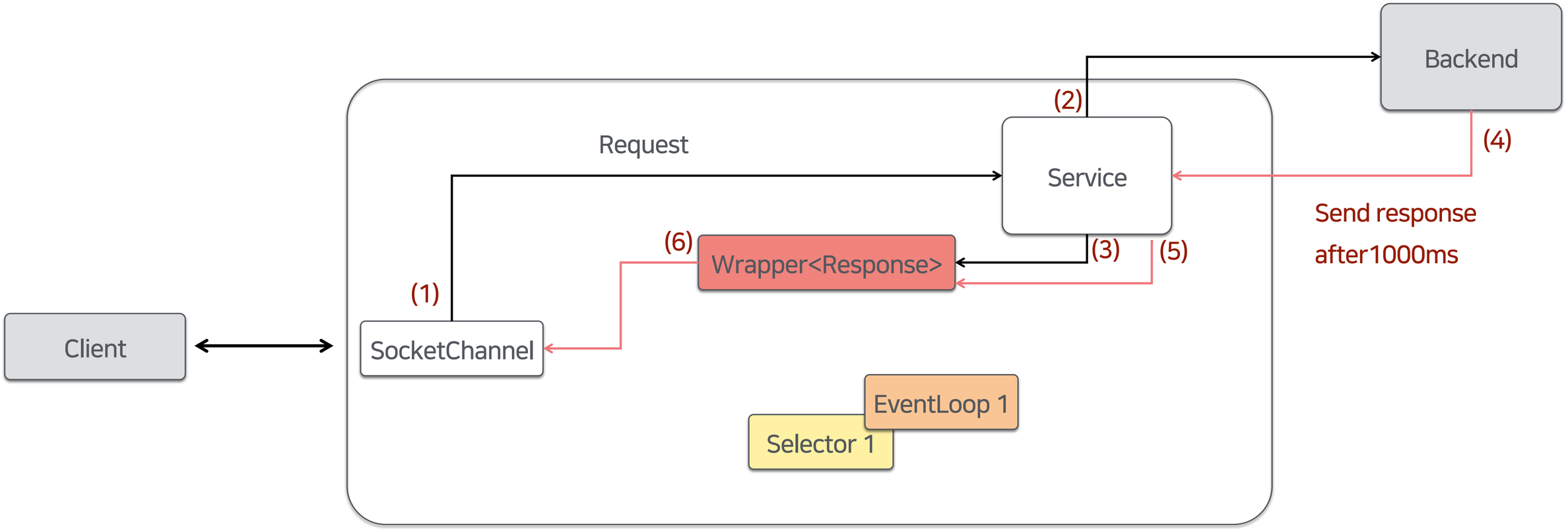
Wrapper

- The actual response will be sent later when the Backend sends the response.



Asynchronous server

- The `EventLoop` does not wait for the response from the backend.



Asyncronous server

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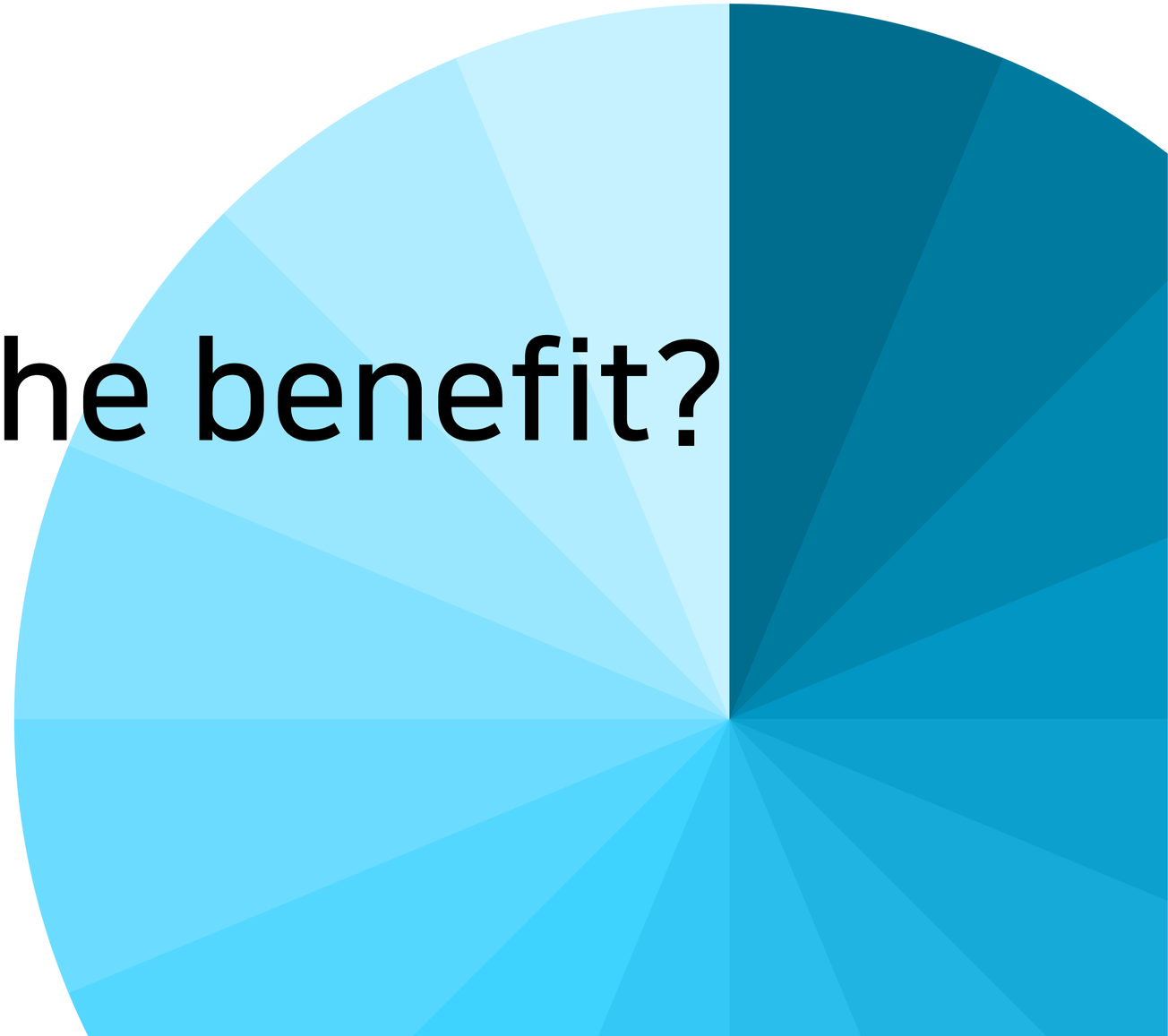
- Full example: https://github.com/minwoox/deview2020-requestscoping

2. What’s the benefit?



Performance

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- Can even achieve 1M concurrent connections on a powerful machine

Case of LINE

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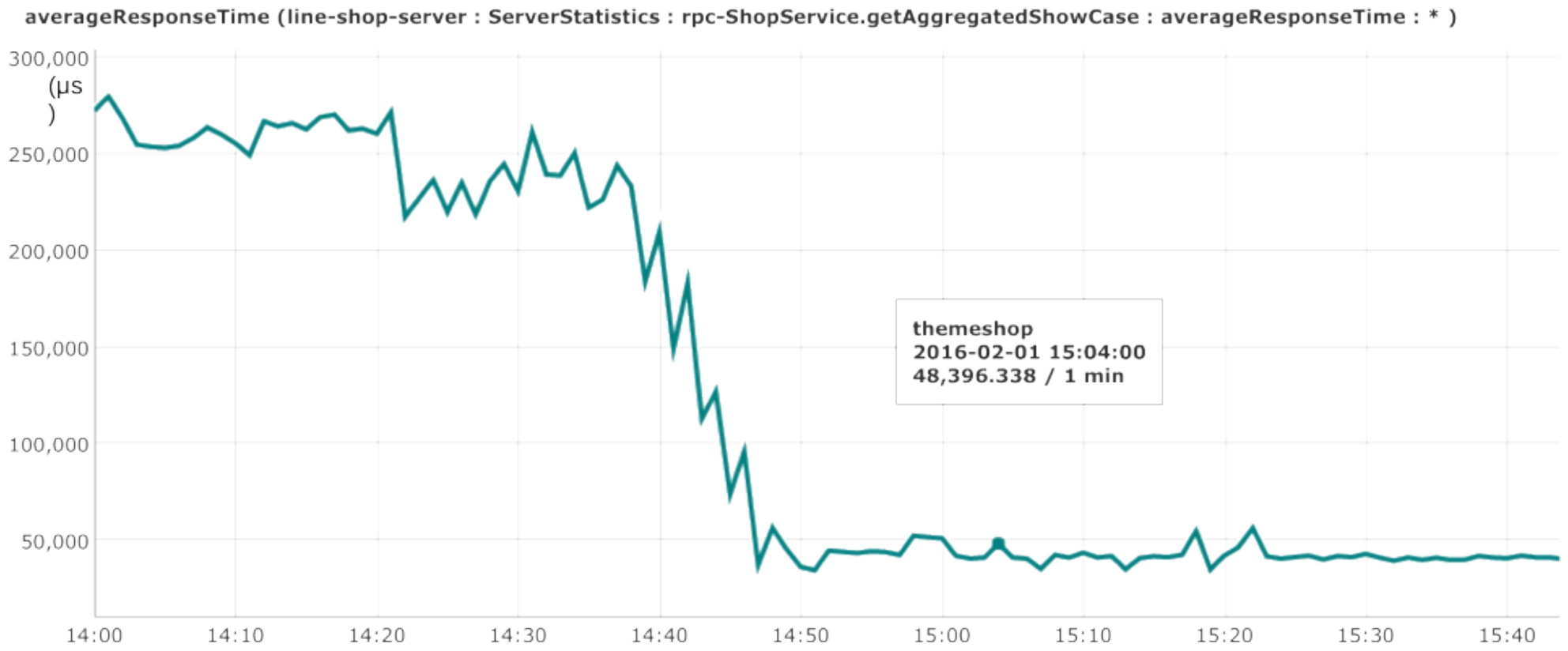
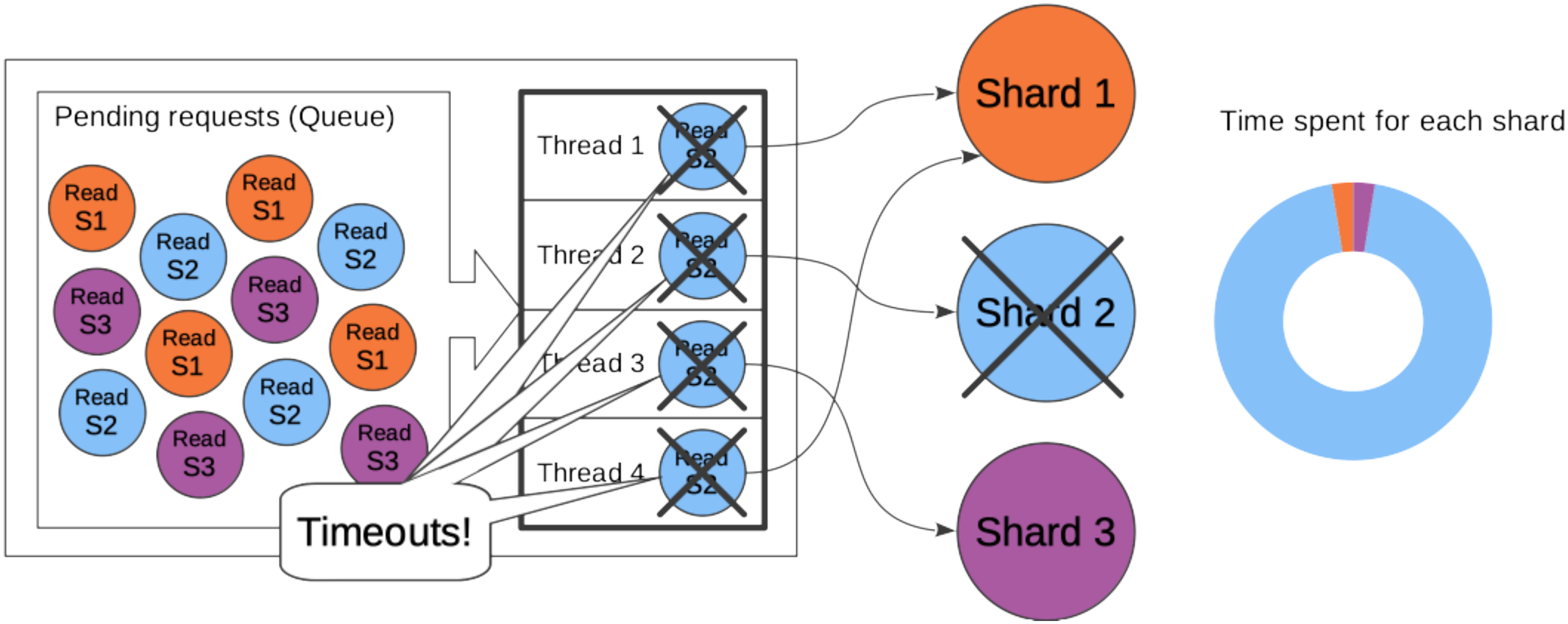
- LINE sticker store (50k -100k RPS)
  - Before: Spring Boot + Tomcat(HTTP/1.1)
  - After: Spring Boot + an async server(HTTP/2)

Case of LINE



- Full story: https://www.slideshare.net/linecorp/a-9-line-shop-powered-by-armeria

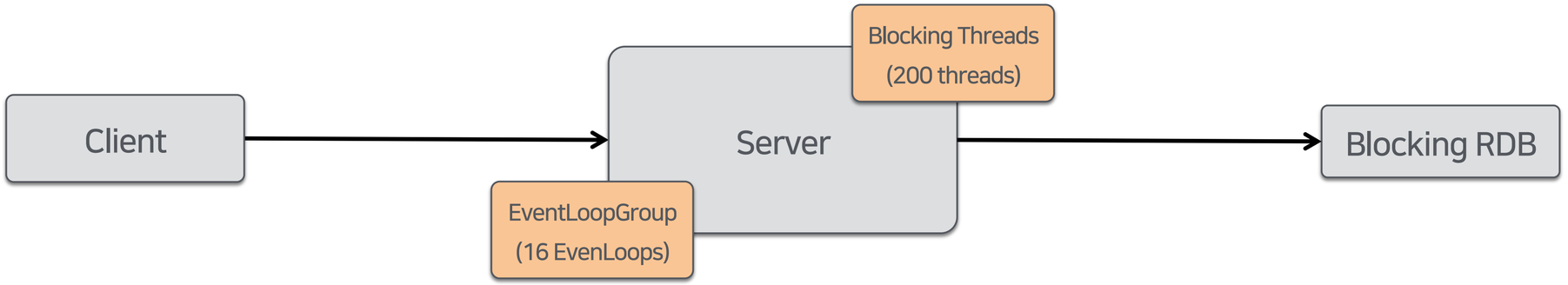
Works even on a shard failure



- Full story: https://tv.naver.com/v/11267414

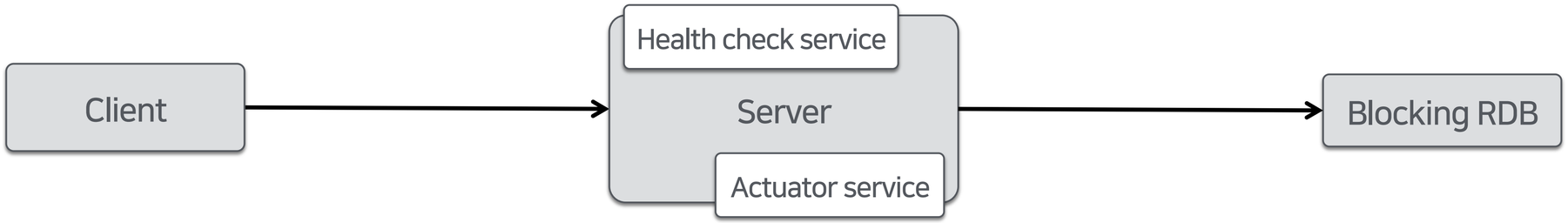
I'm just using blocking RDB!

- Blocking calls happen by delegating to the blocking threads.
  - 200 threads by default
- In addition to the blocking threads, the asynchronous server needs 16 more threads! (if the machine has 8 cores.)



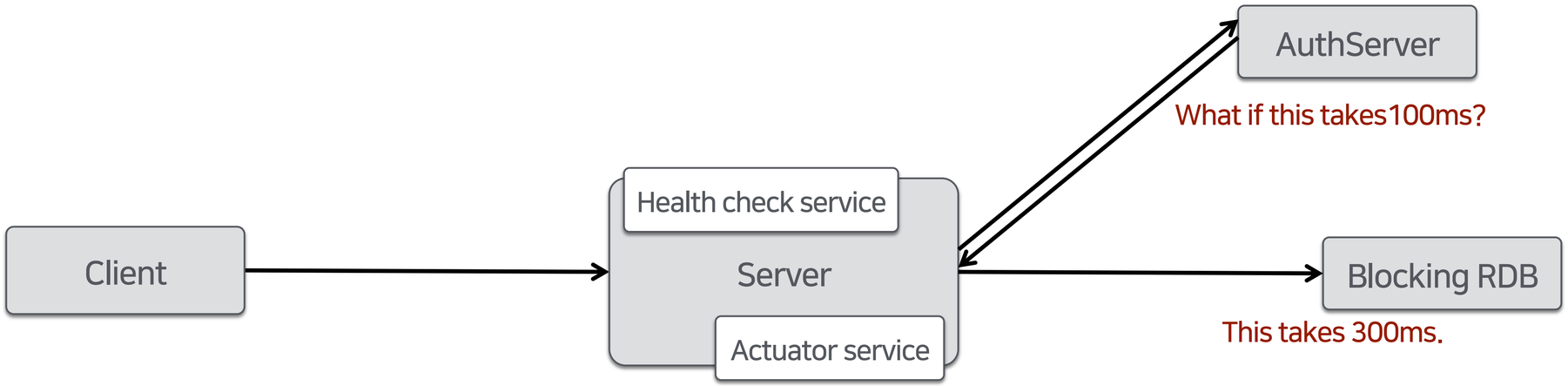
I'm just using blocking RDB!

- What if there's a health check service?
- What if there's an actuator service?



I'm just using blocking RDB!

- What if there's a health check service?
- What if there's an actuator service?
- What if requests have to go to the authentication server before querying?
- What if it's microservice?



3. Is it always good?

Drawbacks?

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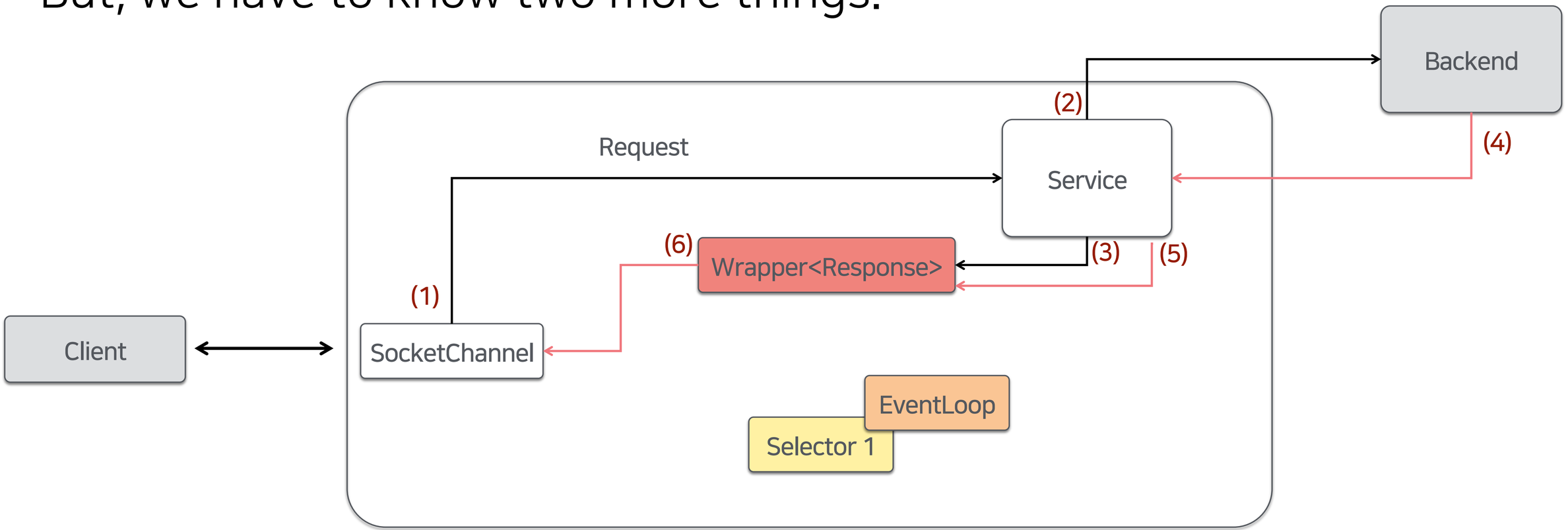
- Not easy to understand the control flow
- Callback hell
- Coloring problem
- Lost context

Control flow

- We've already learned it.
- But, we have to know two more things.



Quiz

- What's the result?

```
1:  // Executed by the thread-A.
2:  CompletableFuture<String> future = new CompletableFuture<>();
3:  Executor threadB = …; // The name of this executor is thread-B.
4:  threadB.execute(() -> {
5:      future.complete("foo")
6:  });
7:
8:  future.thenAccept(value -> {
9:      System.err.println("Executed by: " + Thread.currentThread.getName());
10: });
```

Which thread executes the Callback?

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- The thread that calls callback
  (The wrapper is already complete.)

```
// Executed by the thread-A.
completedFuture.thenAccept(value -> {
    // Executed by the same thread-A.
});
```

- The thread that completes the wrapper
  (The wrapper is not complete yet.)

```
// Executed by the thread-A.
incompleteFuture.thenAccept(value -> {
    // Executed by a thread named
    // thread-B which completes the
    // incompleteFuture.
});
```

- The thread that is specified when calling callback
  (No matter the wrapper is complete or not.)

```
future.thenAcceptAsync(value -> {
    // Executed by the executorC.
}, executorC);
```

Blocking operation

- Blocks the current thread to wait for some event
  - e.g. `future.get()`, `future.join()`, `flux.blockFirst()`, etc.
- Never use blocking operation in asynchrony world except:
  - In test code
  - When starting(stopping) a server, or in the process of it
  - In a dedicated blocking thread
- Otherwise, you might be doing like this:

```
// Executed by thread-A
CompletableFuture<String> future = new CompletableFuture<>();
String fooString = future.get(); // Never complete.
…
future.complete("foo"); // The thread waiting above is the one who completes the future.
```

Reactive Streams

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- Most modern JVM frameworks use it for stream processing.
- A standard for asynchronous stream processing with non-blocking backpressure

Reactive Streams

- Most modern JVM frameworks use it for stream processing.
- ~~A standard for asynchronous stream processing with non-blocking backpressure~~
- Just 7 methods in 3 interfaces
  - Not easy to implement in multi threading
  - Not hard to understand the flow
- Good material: https://engineering.linecorp.com/ko/blog/reactive-streams-with-armeria-1/

Callback hell

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```
function hell(win) {
 // for listener purpose
 return function() {
   loadLink(win, REMOTE_SRC+'/assets/css/style.css', function() {
     loadLink(win, REMOTE_SRC+'/lib/async.js', function() {
       loadLink(win, REMOTE_SRC+'/lib/easyXDM.js', function() {
         loadLink(win, REMOTE_SRC+'/lib/json2.js', function() {
           loadLink(win, REMOTE_SRC+'/lib/underscode.min.js', function() {
             loadLink(win, REMOTE_SRC+'/lib/backbone.min.js', function() {
               loadLink(win, REMOTE_SRC+'/dev/base_dev.js', function() {
                 loadLink(win, REMOTE_SRC+'/assets/js/deps.js', function() {
                   loadLink(win, REMOTE_SRC+'/src/' + win.loader_path + '/loader.js', function() {
                     async.eachSeries(SCRIPTS, function(src, callback) {
                       loadScript(win, BASE_URL+src, callback);
                     });
                   });
                 });
               });
             });
           });
         });
       });
     });
   });
 };
}
```

- https://anexsoft.com/javascript-callbacks-vs-promise-vs-asyncawait

Callback hell

- What if the programmer makes the code in synchronous way?
- Not a problem of asynchrony but the lack of peers who can properly do the code review

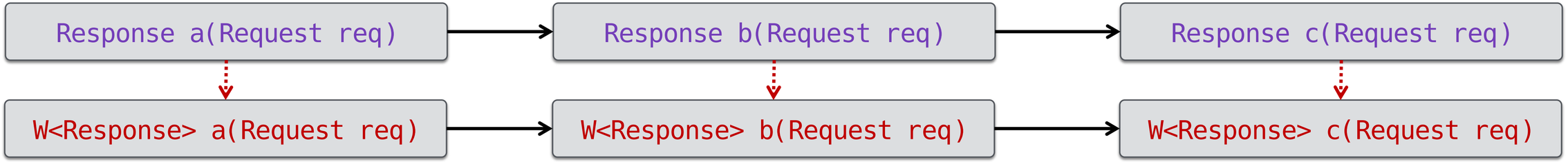
Coloring problem

- Can’t call asynchronous methods in a synchronous method.

```
1:  // Asynchronous method
2:  CompletableFuture<BackendResponse> getResponse(…) {…}
3:
4:  // Synchronous method
5:  Response helloService(Request req) {
6:      CompletableFuture<BackendResponse> future =
7:          getResponse(…);
8:      BackendResponse res = future.get(); // Should call get()!!
9:      return makeRespone(res);
10: }
```

Coloring problem

- Have to change all methods in the call stack as asynchronous methods.

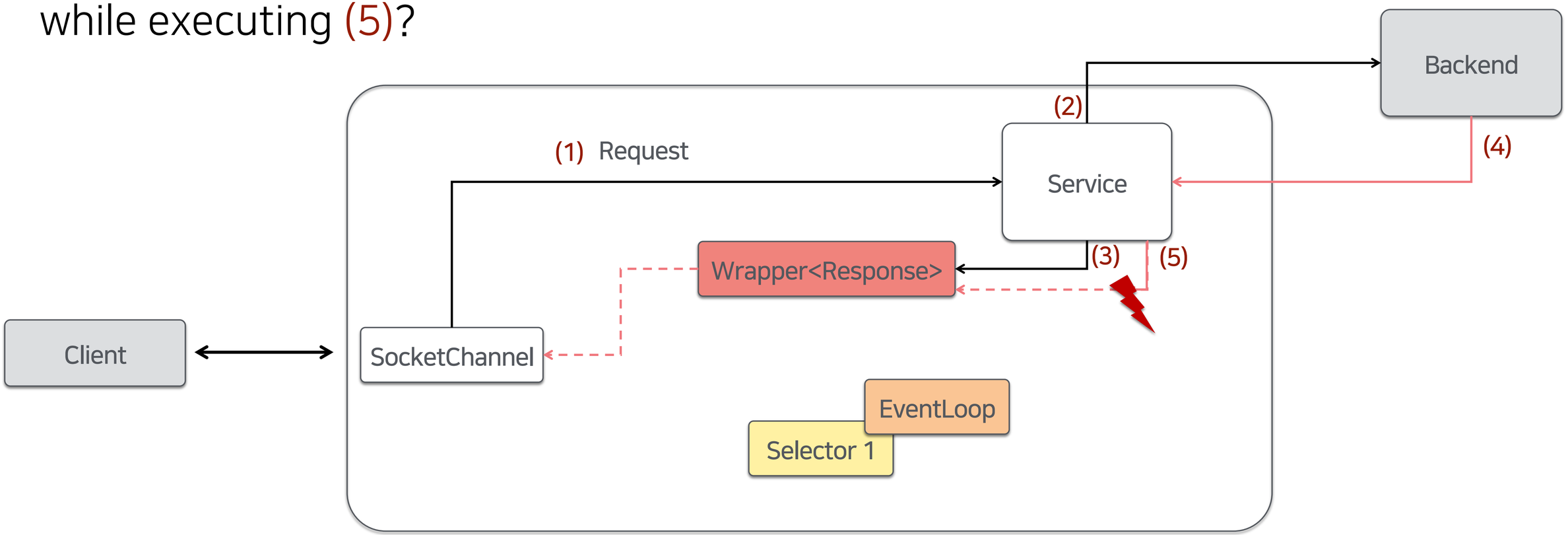


- But, what if you build your server with asynchrony from the first?
  - Just use a blocking thread at the end.

```
1: W<Response> c(Reqeust req) {
2:     W<Response> wrapper = …;
3:     blockingTaskExecutor.execute(() -> {
4:         // Do some blocking job!
5:         wrapper.complete(…);
6:     });
7:     return wrapper;
8: }
```

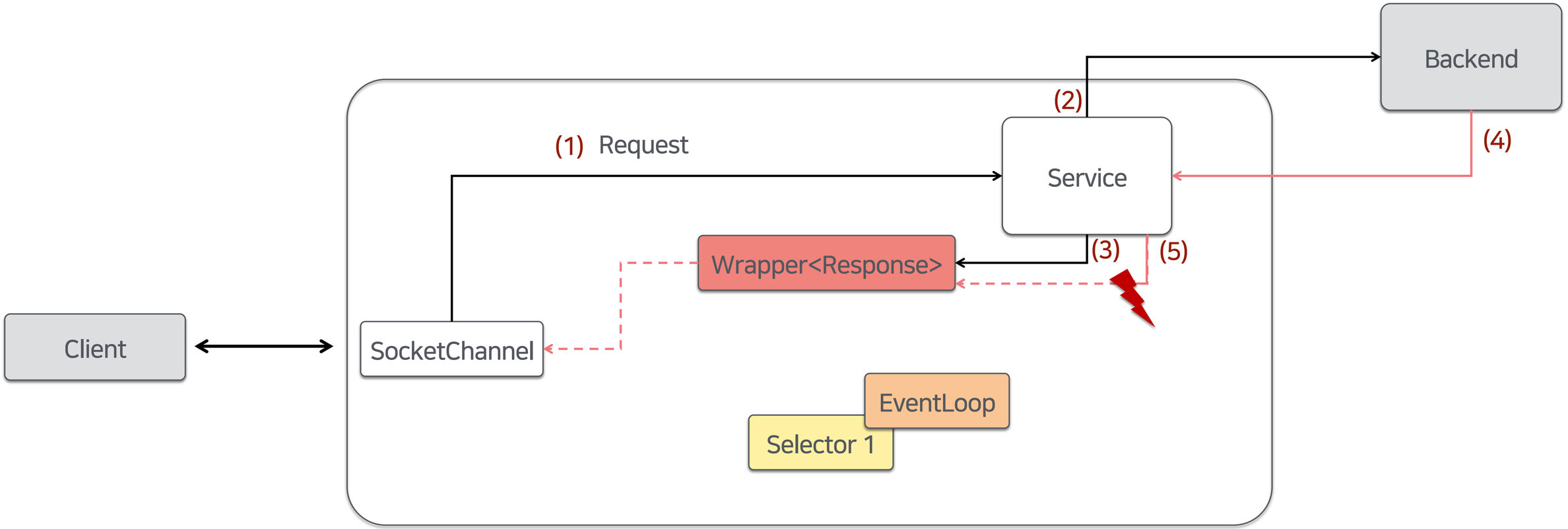
Lost Context

- Does the stack trace show (1), (2) and (3) if an exception is raised while executing (5)?



Lost Context

- We have to designate that (5) is derived by the (1) request.



4. Request scoping

Request scoping

- Managing and providing information on which request the logic was derived by when executing a specific logic
- Don’t know how others are doing, but I know how **Armeria** is doing.

Armeria

- Your go-to microservice framework for any situation. You can build any type of microservice leveraging your favorite technologies, including gRPC, Thrift, Kotlin, Retrofit, Reactive Streams, Spring Boot and Dropwizard.

Request scoping

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- Let’s put aside the stack trace thing for now, but focus on more realistic example.

Zipkin

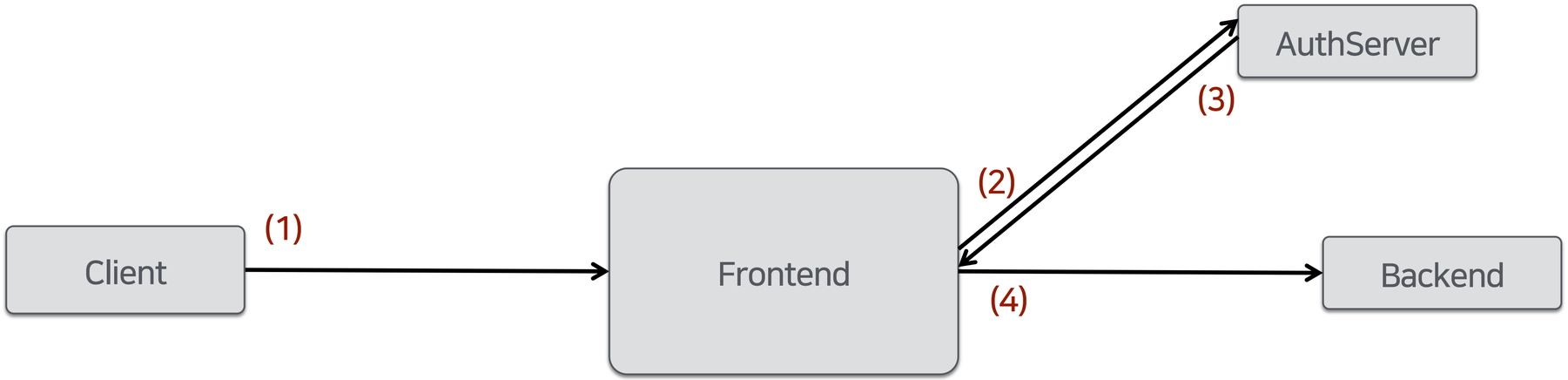
- Great open source for Distributed tracing
  - A method used to profile and monitor applications, especially those built using microservice architecture
- Can do distributed tracing with just one decorator.

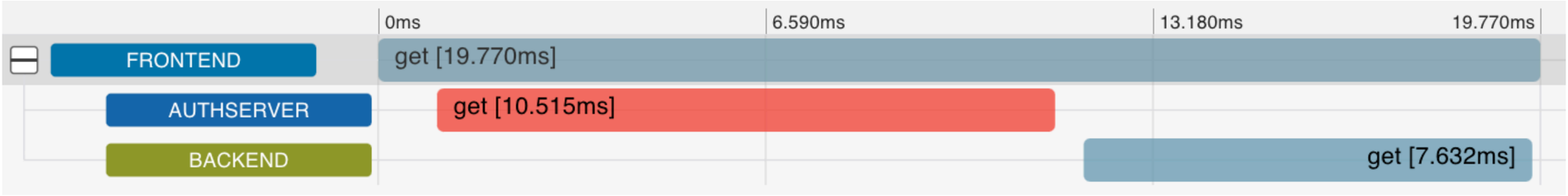
```
ServerBuilder sb = …;
sb.decorator(BraveService.newDecorator(tracing));
```

- Zipkin also uses Armeria!

Distributed tracing

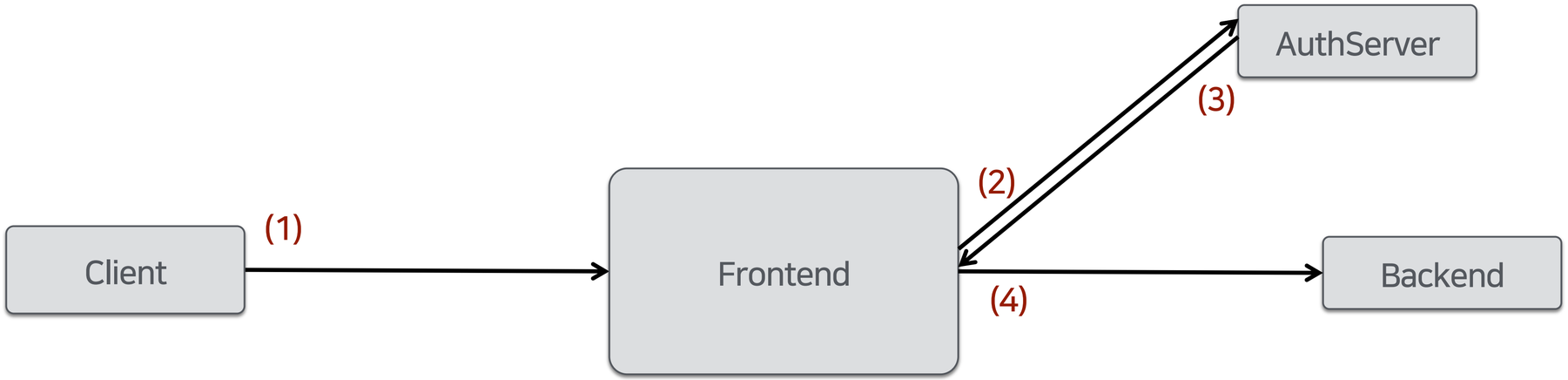
- Perfect request scoping!

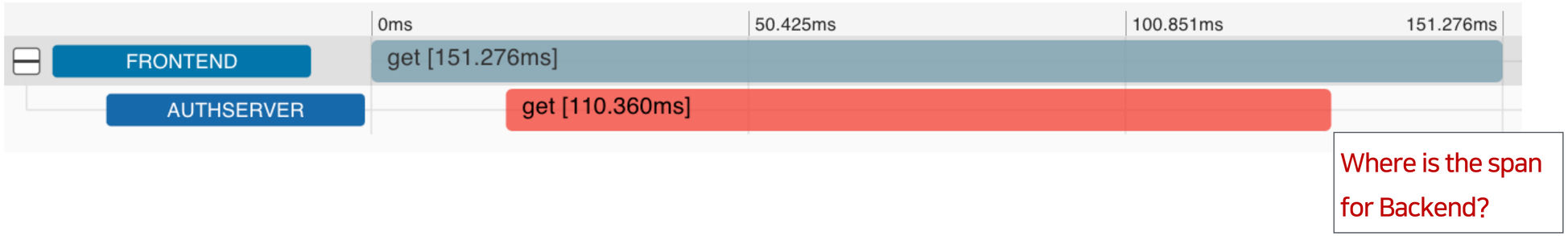




Distributed tracing

- What if it fails to do the request scoping?





Where is the span for Backend?

Request scoping

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```
1:  ServerBuilder sb = …;
2:  sb.service("/api", (ctx, req) -> {
3:        CompletableFuture<HttpResponse> future = new CompletableFuture<>();
4:        // Request scoping is done by Armeria.
5:        HttpResponse authResponse = authClient.execute(req.headers());
6:        CompletableFuture<AggregatedHttpResponse> aggregated = authResponse.aggregate();
7:        aggregated.thenAccept(aggregatedRes -> {
8:            // You should do the request scoping by yourself because this thread
9:            // does not know which request this logic was derived by.
10:           HttpResponse response = backendClient.execute(req);
11:           future.complete(response);
12:       });
13:       return HttpResponse.from(future);
14:   );
```

How to check?

- A `ServiceRequestContext` is created whenever the server receives a request.
- The context is pushed to the thread-local to indicate the request scope.
- If `RequestContext.currentOrNull()` returns `null`, request scoping hasn't done.

How to check?

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```
1:  sb.service("/api", (ctx, req) -> {
2:        CompletableFuture<HttpResponse> future = new CompletableFuture<>();
3:        // Request scoping is done by Armeria.
4:        assert RequestContext.currentOrNull() != null;
5:        HttpResponse authResponse = authClient.execute(req.headers());
6:        CompletableFuture<AggregatedHttpResponse> aggregated = authResponse.aggregate();
7:        aggregated.thenAccept(aggregatedRes -> {
8:            // You should do the request scoping by yourself.
9:            assert RequestContext.currentOrNull() == null;
10:           HttpResponse response = backendClient.execute(req);
11:           future.complete(response);
12:       });
13:       return HttpResponse.from(future);
14:   );
```

Do it manually


```
1:  ServerBuilder sb = …;
2:  sb.service("/api", (ctx, req) -> {
3:        CompletableFuture<HttpResponse> future = new CompletableFuture<>();
4:        HttpResponse authResponse = authClient.execute(req.headers());
5:        authResponse.aggregate().thenAccept(aggregatedRes -> {
6:            try (SafeCloseable ignored = ctx.push()) {
7:                HttpResponse response = backendClient.execute(req);
8:                future.complete(response);
9:            }
10:       });
11:       return HttpResponse.from(future);
12:   );
```

ContextAwareFuture

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```
1:  ServerBuilder sb = …;
2:  sb.service("/api", (ctx, req) -> {
3:        CompletableFuture<HttpResponse> future = new CompletableFuture<>();
4:        HttpResponse authResponse = authClient.execute(req.headers());
5:        CompletableFuture<AggregatedHttpResponse> aggregated = authResponse.aggregate();
6:        CompletableFuture<AggregatedHttpResponse> contextAwareFuture =
7:            ctx.makeContextAware(aggregated);
8:        contextAwareFuture.thenAccept(aggregatedRes -> {
9:            HttpResponse response = backendClient.execute(req);
10:           future.complete(response);
11:       });
12:       return HttpResponse.from(future);
13:   );
```

@armeria_project line/armeria

What? Hold on.

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- Can’t just return the context aware future from `authResponse.aggregate()`?

```
1:  CompletableFuture<AggregatedHttpResponse> aggregated = authResponse.aggregate();
2:  CompletableFuture<AggregatedHttpResponse> contextAwareFuture =
3:      authResponse.aggregate();
4:  contextAwareFuture.thenAccept(aggregatedRes -> {
5:      HttpResponse response = backendClient.execute(req);
6:      future.complete(response);
7:  });
```

What? Hold on.

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- We have decided not to because we can’t automatically do that in all situations.

```
1:  CompletableFuture<AggregatedHttpResponse> backend1 = …;
2:  CompletableFuture<AggregatedHttpResponse> backend2 = …;
3:  CompletableFuture<Void> allOfFuture =
4:      CompletableFuture.allOf(backend1, backend2);
5:  // We can’t make the allOfFuture context aware.
6:  allOfFuture.thenRun(() → {…});
```

What? Hold on.

- Well-suited everywhere
  - A user should be able to use the library what he/she wants.
- If we can't fully automate request scoping, then we'd better crash loudly in the early stages and let people know and understand what's going on.

Executor

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```
1:  ServerBuilder sb = …;
2:  sb.service("/api", (ctx, req) -> {
3:        CompletableFuture<HttpResponse> future = new CompletableFuture<>();
4:        HttpResponse authResponse = authClient.execute(req.headers());
5:        CompletableFuture<AggregatedHttpResponse> aggregated = authResponse.aggregate();
6:        Executor contextAwareExecutor = ctx.eventLoop();
7:        aggregated.thenAcceptAsync(aggregatedRes -> {
8:            HttpResponse response = backendClient.execute("/api");
9:            future.complete(response);
10:       }, contextAwareExecutor);
11:       return HttpResponse.from(future);
12:   );
```

- Full example: https://github.com/line/armeria/tree/master/examples/context-propagation

Best practice

- Use callbacks that takes an executor which automatically does the request scoping for you.

```
ServiceRequestContext ctx = …;
future.thenAcceptAsync(…, ctx.eventLoop());

// for Reactor
Flux flux = …;
flux.subscribeOn(Schedulers.fromExecutor(ctx.eventLoop()));
```

Coroutine

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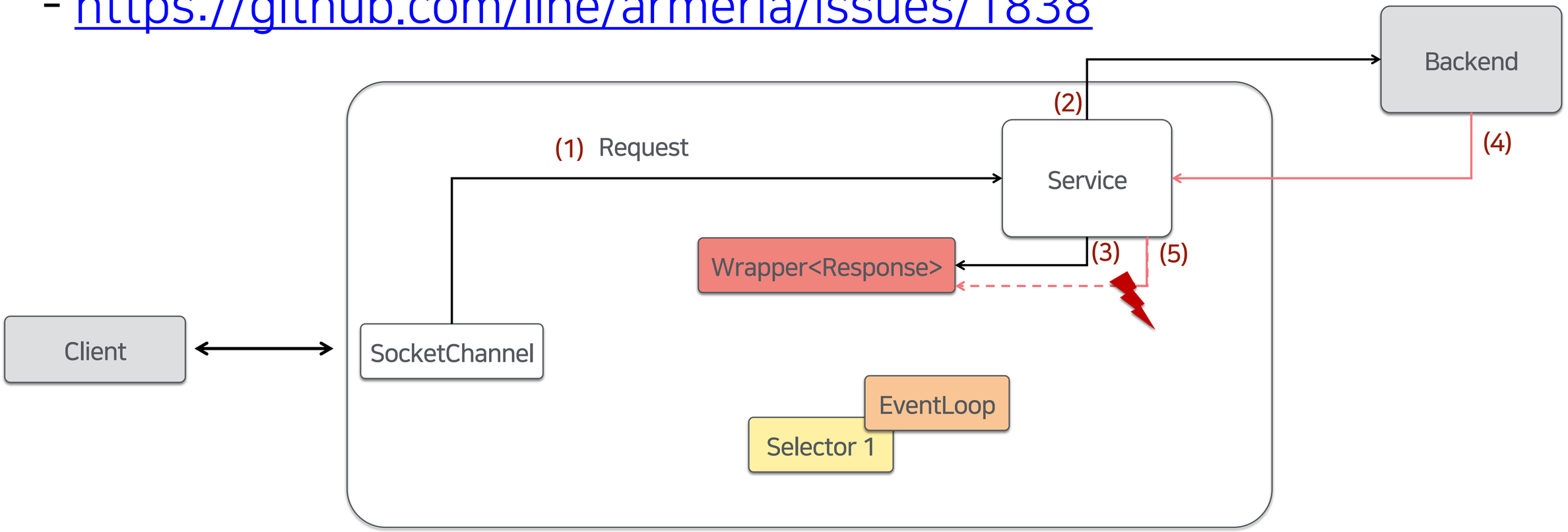
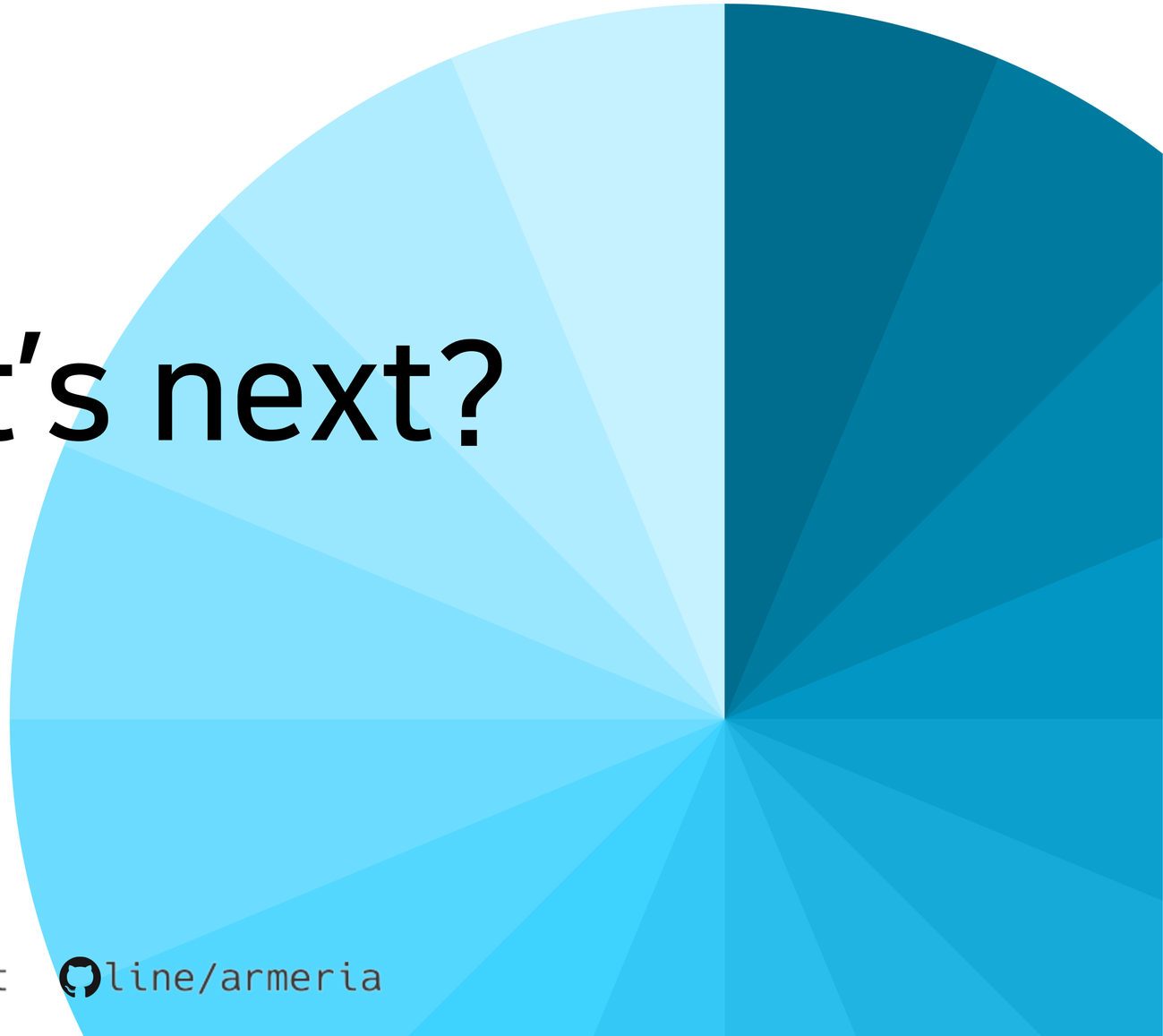
```
1:  val response = GlobalScope.future(ctx.eventLoop().asCoroutineDispatcher()) {
2:      val authResponse = authClient.execute(req.headers()).aggregate().await()
3:      require(httpResponse.status() == HttpStatus.OK)
4:      backendClient.execute(req)
5:  }
6:  return HttpResponse.from(response)
```

Stack trace

- We still do not know the stack trace because we haven't implemented it yet.
  - https://github.com/line/armeria/issues/1838

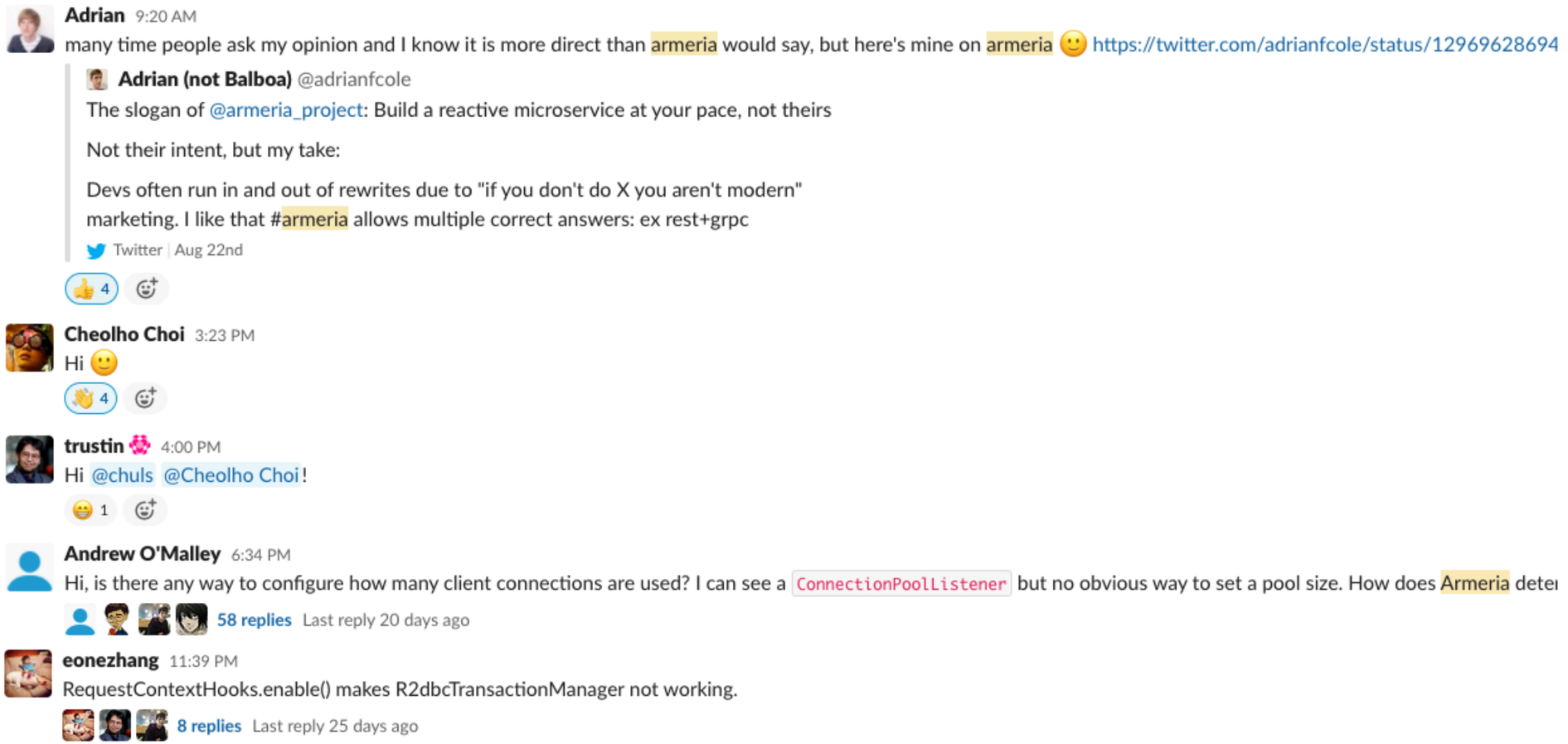


5. What's next?



We got our Slack!

DEVIEW 2020



@armeria_project line/armeria

We got our Slack! (Korean)

dino 4:01 PM
안녕하세요 아르메리아 적용을 위해서 문서를 보고 있습니다.
보던 중, CB 관련해서 문의 드립니다.
아르메리아의 Circuit Breaker 는 객체 단위로 설정이 되는걸로 봤는데요
Thread pool 없이 라이프 싸이클이 Request Thread 내에서만 동작하고 소멸되는 형태로
이해를 하면 되는지.. 궁금합니다. 써본 CB 라이브러리가 Hystrix 다보니
다소 생소해서 문의 드립니다 🙏
9 replies Last reply 1 month ago

eonezhang 5:19 PM
joined #general-ko along with 4 others.

Thursday, September 24th

Joonhaeng Lee 5:40 PM
혹시 클라이언트에서 Content-Encoding: gzip헤더붙여서 날아오는 gzip 인코딩된 post 본문데이터를 armeria+spring webflux 에서 받아서 디코딩하는 편한 방법이 있을까요?ㅎㅎ (edited)
199 replies Last reply 5 days ago

Friday, September 25th

sehajyang 11:34 AM
joined #general-ko along with ryan.

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What's next

- A message the team leader got

  "...

  Finally, thank you so much for making Armeria. This saved development time so that I could make time for warm dinners with my family. Thank you again."

Meet us at GitHub & Slack

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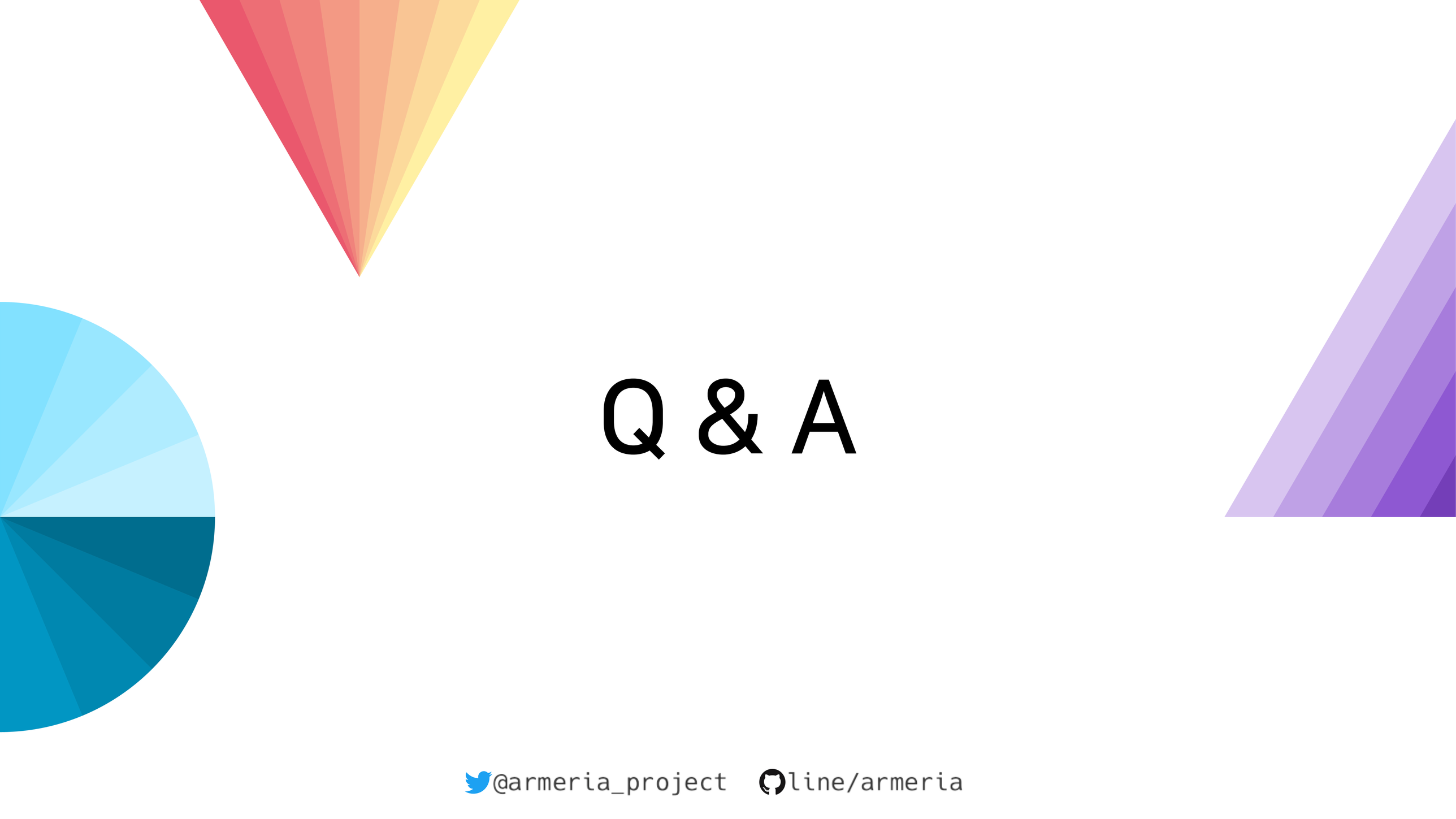
github.com/line/armeria

armeria.dev

@armeria_project line/armeria


Q & A

Thank You

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Reactor and RxJava

DEVIEW 2020

- Armeria provides the global hooks.

```
// For Reactor
RequestContextHooks.enable();

// For RxJava
RequestContextAssembly.enable();
```

Mixed request scope

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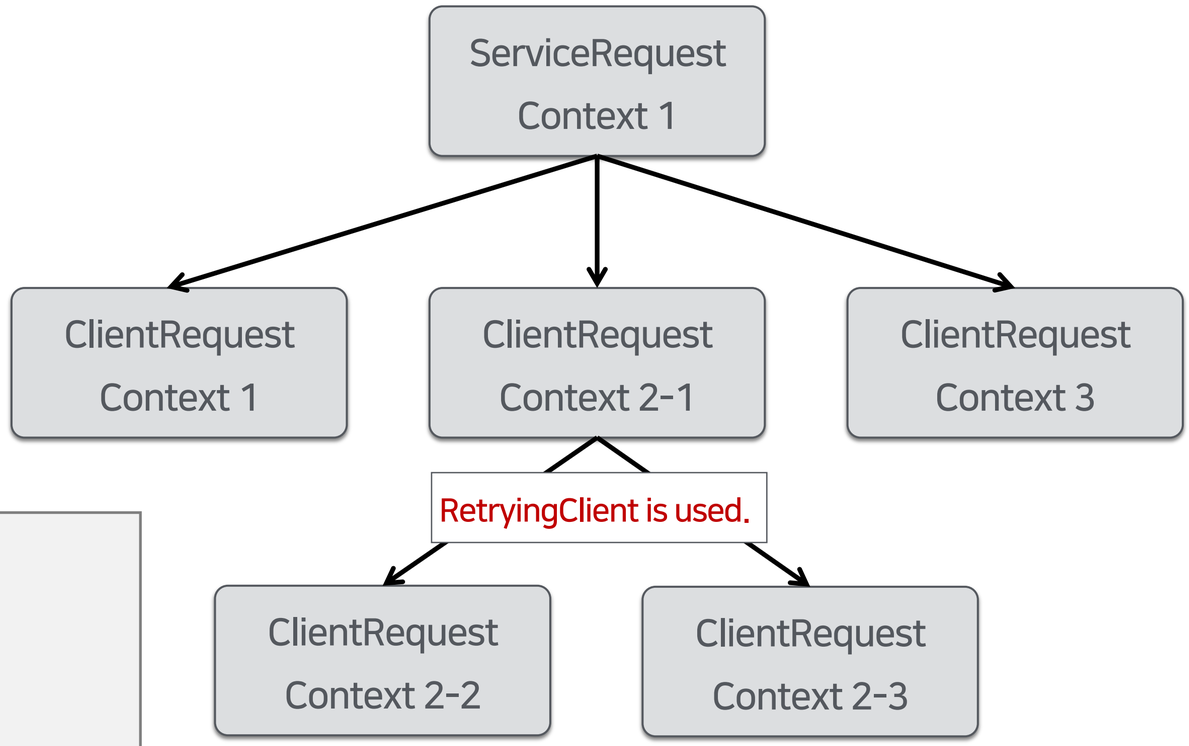
- Each request must have its own scope.
- If the request scope is mixed which is caused by context leak or coding mistakes, an `IllegalStateException` is raised.

```
ServiceRequstContext ctx1 = …;
try (SafeCloseable ignored = ctx1.push()) {
    …
    ServiceRequestContext ctx2 = …;
    try (SafeCloseable ignored = ctx2.push()) { // IllegalStateExcepion!
        …
    }
}
```

Mixed request scope

- We mange a request scope as a tree!
- A `ClientRequestContext` is created when the client sends a request to another backend.
- The `root()` of a `ClientRequestContext` is the `ServiceRequestContext` which the request is derived by.
- `ctx.push()` is valid if the `root()` of the old ctx and the new ctx are the same.




```
ServiceRequstContext serviceCtx1 = …;
try (SafeCloseable ignored = serviceCtx1.push()) {
    …
    ClientRequestContext clientCtx1 = …;
    assert clientCtx1.root() == serviceCtx1;
    try (SafeCloseable ignored = clientCtx1.push()) { // Valid!
        …
    }
}
```