Welcome to the Reactive Revolution: RSocket & Spring Cloud Gateway

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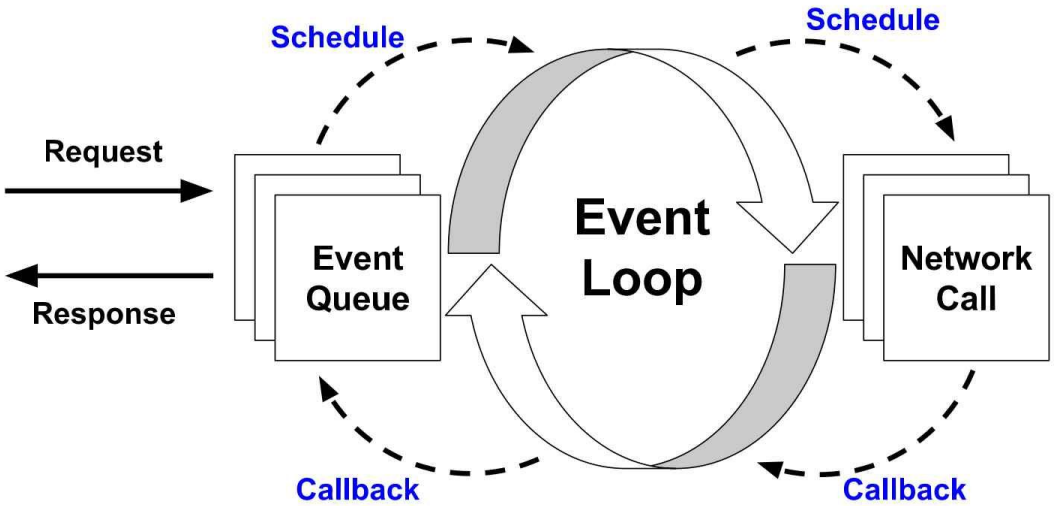
Agenda

- Introduction
  - Reactive Architecture
  - Reactive Communication
  - RSocket Protocol
- Spring Cloud Gateway RSocket
- Demo
- Recap

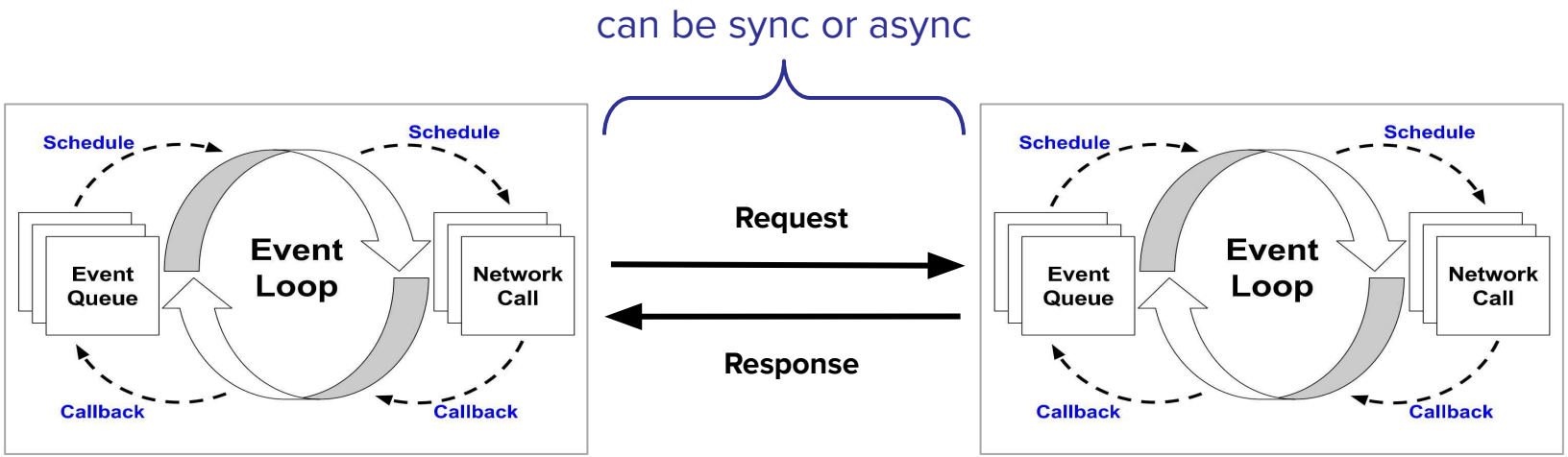
Reactive Architecture

Highly Efficient and Fundamentally Non-blocking

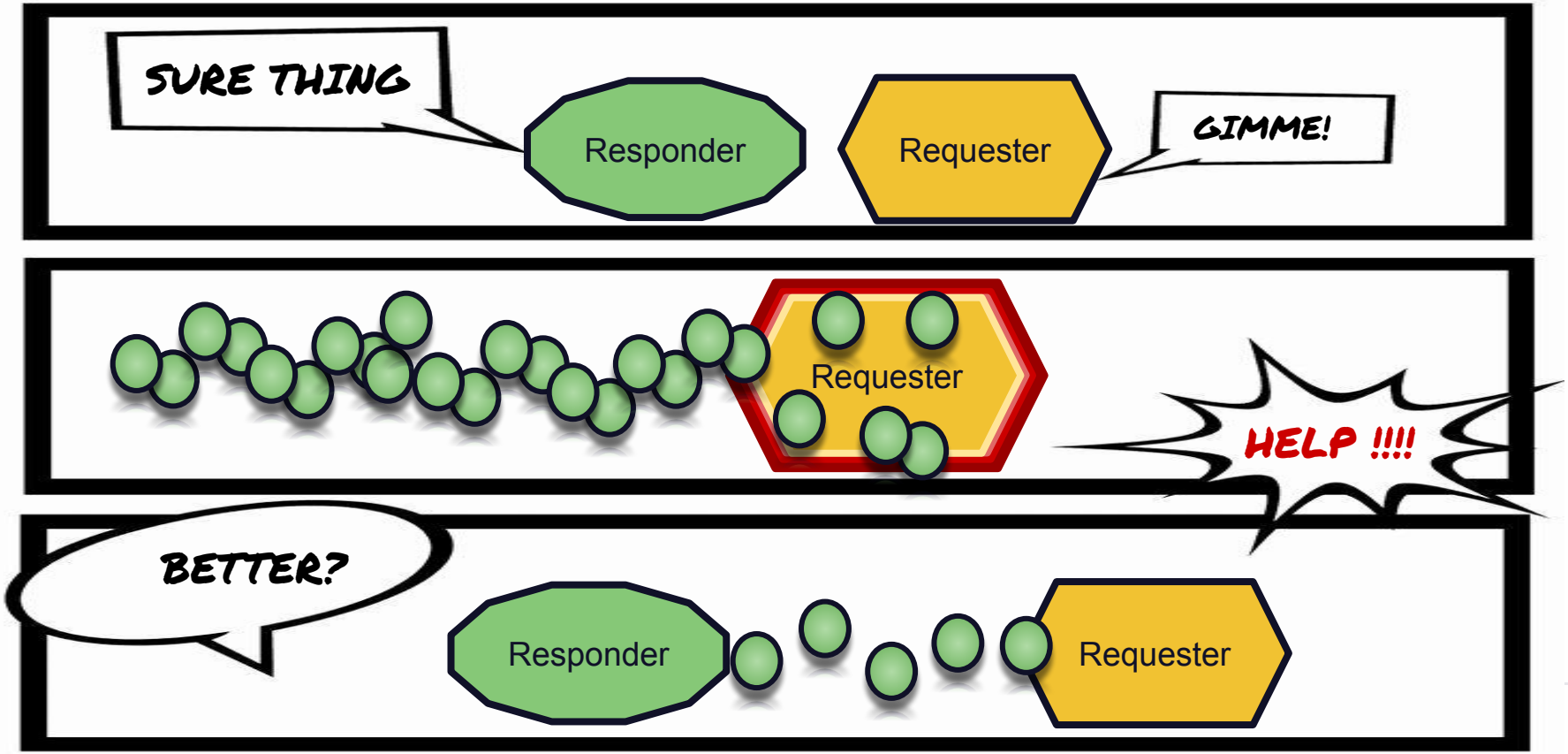


Reactive Inter-process Communication

- Reactive has no opinion on synchronous vs asynchronous
- Key differentiator is **back pressure** (Reactive pull/push)



Back Pressure



Reactive Java Building Blocks

- Reactive Streams
  - **Standard** for async stream processing with non-blocking back pressure
  - **Publisher/Subscriber/Subscription/Processor**
- Project Reactor
  - **Implementation** of the Reactive Streams specification for the JVM
    - Adds **Flux** and **Mono** operators
    - Java 8 integration (Stream, CompletableFuture, Duration)

Roadblocks

- But there are still some barriers to using Reactive everywhere*

- Data Access
  - MongoDB, Apache Cassandra, and Redis
  - Relational database access (R2DBC)

- Cross-process back pressure (networking)

http://rsocket.io

RSocket

- RSocket is a bi-directional, multiplexed, message-based, binary protocol based on Reactive Streams back pressure

- It provides out of the box support for four common interaction models
  - Request-Response (1 to 1)
  - Fire-and-Forget (1 to 0)
  - Request-Stream (1 to many)
  - Request-Channel (many to many)

Transport Agnostic: TCP, WebSocket, UDP, HTTP2 ...

RSocket vs HTTP - Key Differences

RSocket
Efficient and Responsive

- Single, shared long-lived connection
- Multiplexes messages
- Communicates back pressure
- Either party can initiate requests (flexible requester/responder roles)
- Supports canceling/resuming streams

HTTP
Slowly Improving

- New connection per request (HTTP 1.0)
- Pipelines messages (HTTP 1.1)
- Does not communicate back pressure
- Only client can initiate requests (fixed client/server roles)
- Does not support canceling/resuming streams

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Multiplexed

- Connections that are only used for a single request are massively inefficient (HTTP 1.0)
- Pipelining (ordering requests and responses sequentially) is a naive attempt solving the issue, but results in head-of-line blocking (HTTP 1.1)

- Multiplexing solves the issue by annotating each message on the connection with a *`stream id`* that partitions the connection into multiple "logical streams"

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Reactive Streams Back Pressure

- Network protocols generally send a single request, and receive an arbitrarily large response in return
- There is nothing to stop the responder (or even the requestor) from sending an arbitrarily large amount of data and overwhelming the receiver
- In cases where TCP back pressure throttles the responder, queues fill with large amounts of un-transferred data

- Reactive Streams (pull-push) back pressure ensures that data is only materialized and transferred when receiver is ready to process it

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Bi-Directional

- Many protocols (notably not TCP) have a distinction between the client and server for the lifetime of a connection
- This division means that one side of the connection must initiate all requests, and the other side must initiate all responses
- Even more flexible protocols like HTTP/2 do not fully drop the distinction
  - Servers cannot start an unrequested stream of data to the client

- Once a client initiates a connection to a server, both parties can be requesters or responders to a logical stream

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Message Driven Binary Protocol

- Requester-Responder interaction is broken down into frames that encapsulate messages
- The framing is binary (not human readable like JSON or XML)
  - Massive efficiencies for machine-to-machine communication
  - Downsides only manifest rarely and can be mitigated with tooling

- Payloads are bags of bytes
  - Can be JSON, XML, Protobuf, CBOR, etc... (it's all just 1's and 0's)

Metadata and Data in Frames

- Each Frame has an optional metadata payload
- The metadata payload has a MIME-Type but is otherwise unstructured

- Very flexible
  - Can be used to carry metadata about the data payload
  - Can be used to carry metadata in order to decode the payload
  - More specific announcement and routing metadata extensions forthcoming
- Generally means that payloads can be heterogenous and each message decoded uniquely

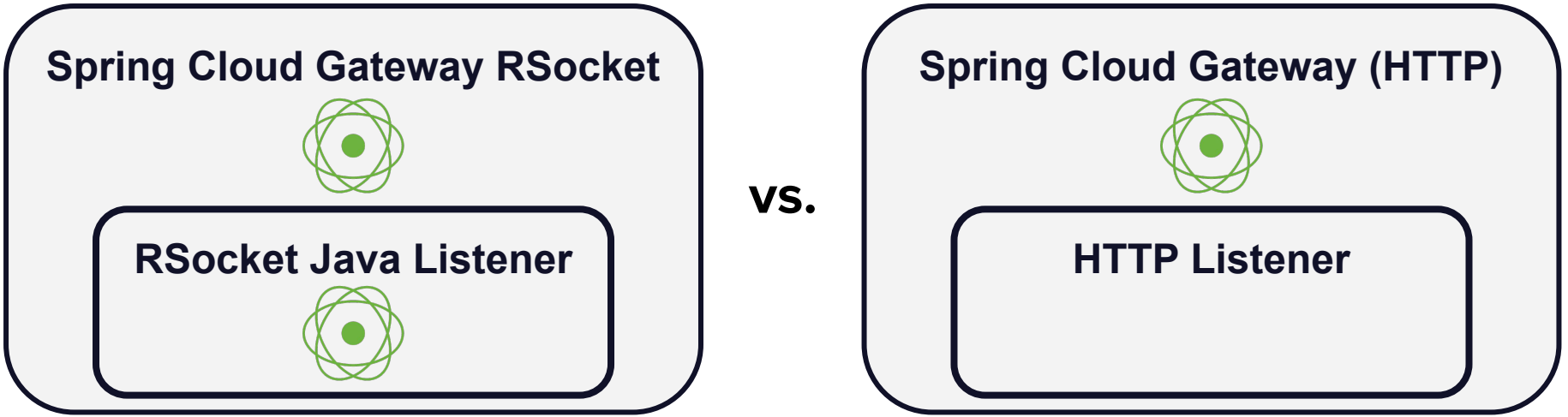
Spring Support

- Spring Framework 5.2 Messaging Support
- Spring Boot Auto-configuration
- Spring Security (future)

Spring Cloud Gateway RSocket

Spring Cloud Gateway RSocket

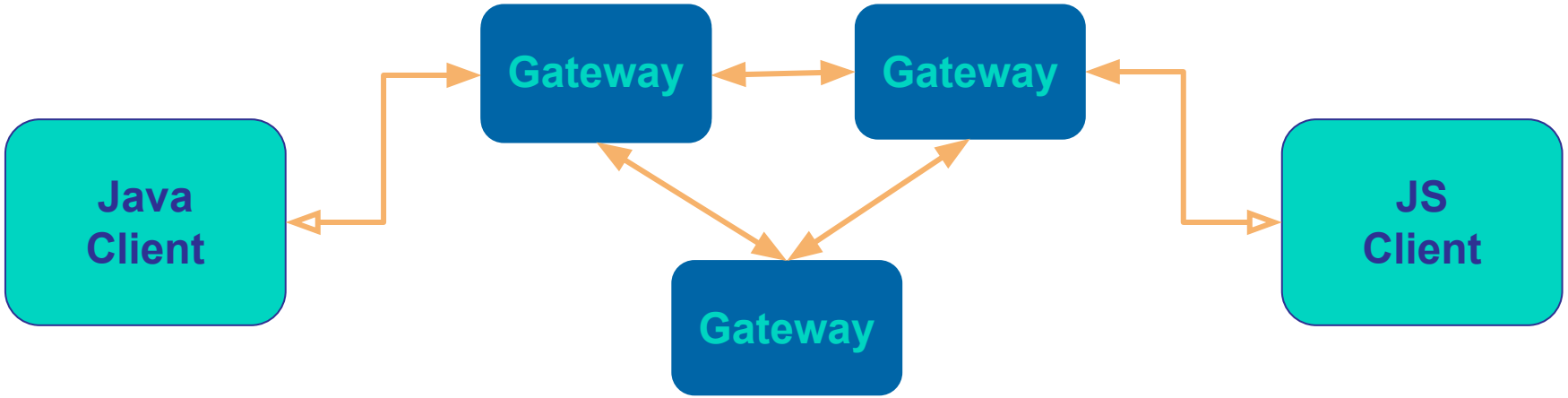
Reactive Runtime + Reactive Network Protocol



- With RSocket Java, the network layer is also built with Project Reactor
- Spring Boot auto-configures the RSocket listener

PROJECT REACTOR

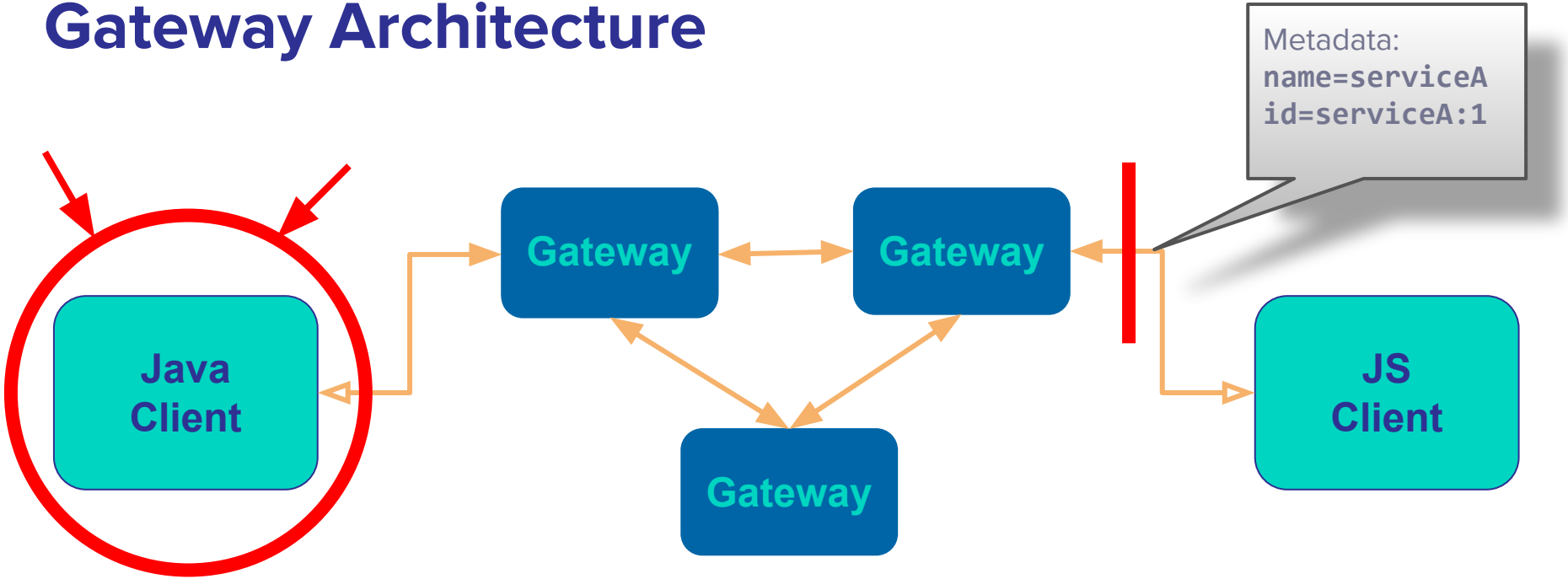
Gateway Architecture



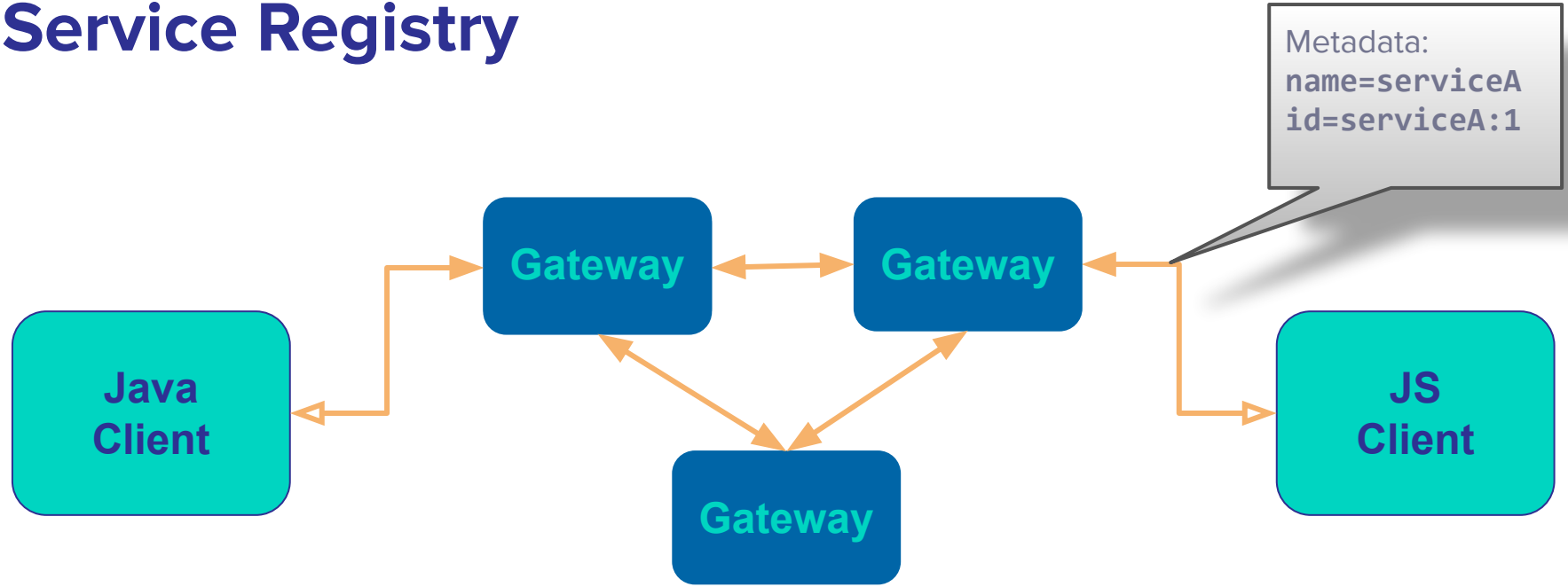
Connecting to Gateway RSocket

- Client makes connection to Gateway Cluster
- Sends connection level metadata
  - Who am I? Name and `Id`

Gateway Architecture



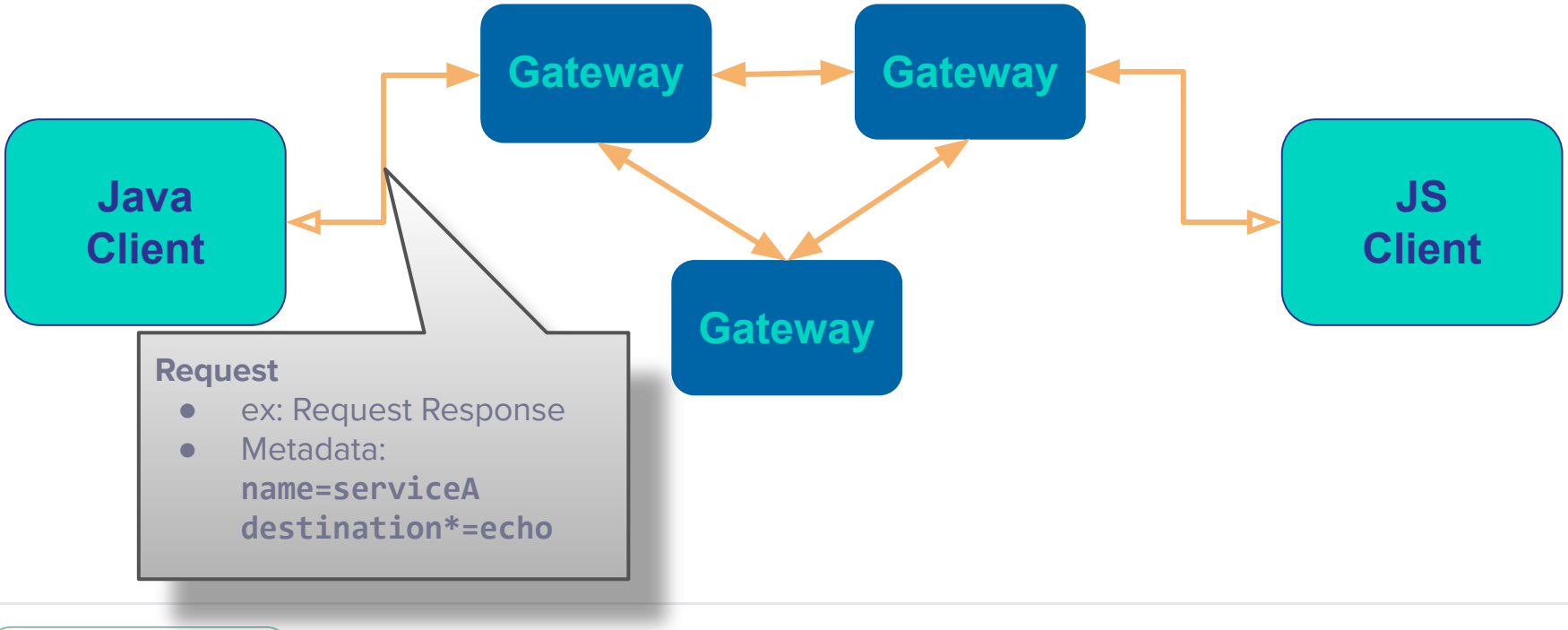
Service Registry



Making a request

- Client makes connection to Gateway Cluster
- Request level metadata
  - Who do I want to call? Name and Destination*

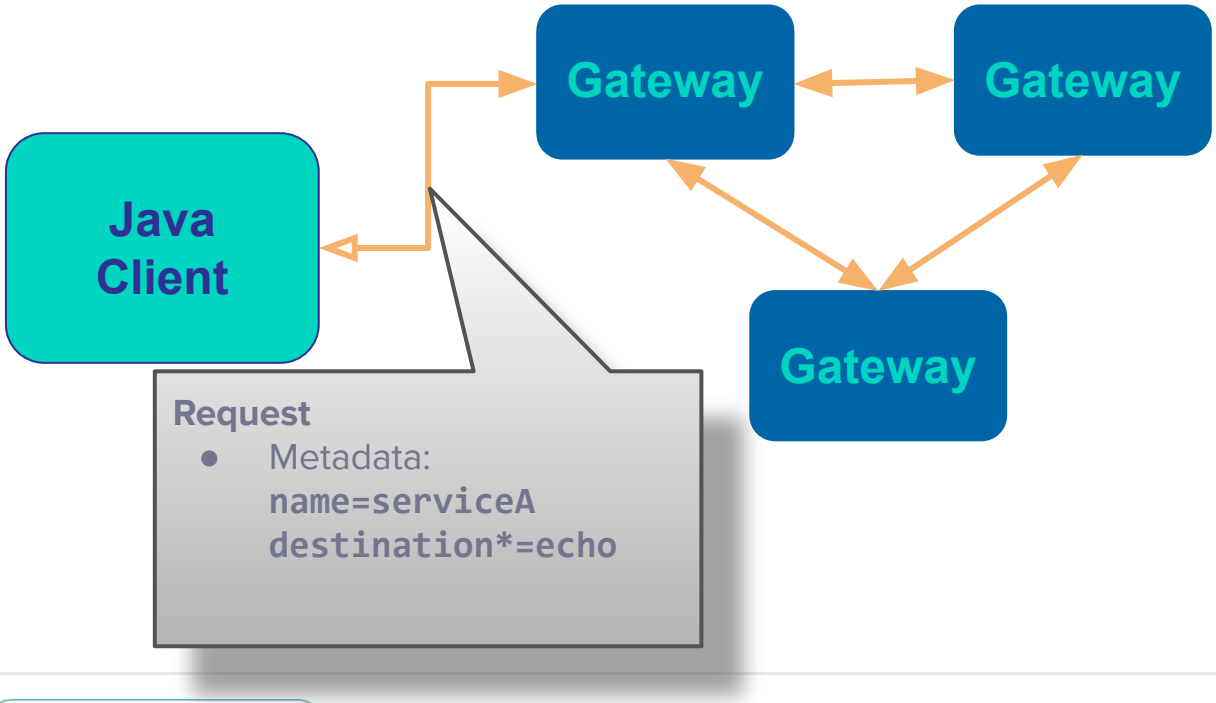
Gateway Architecture



Making a request

- No client side loadbalancer
- No sidecar
- No circuit breaker

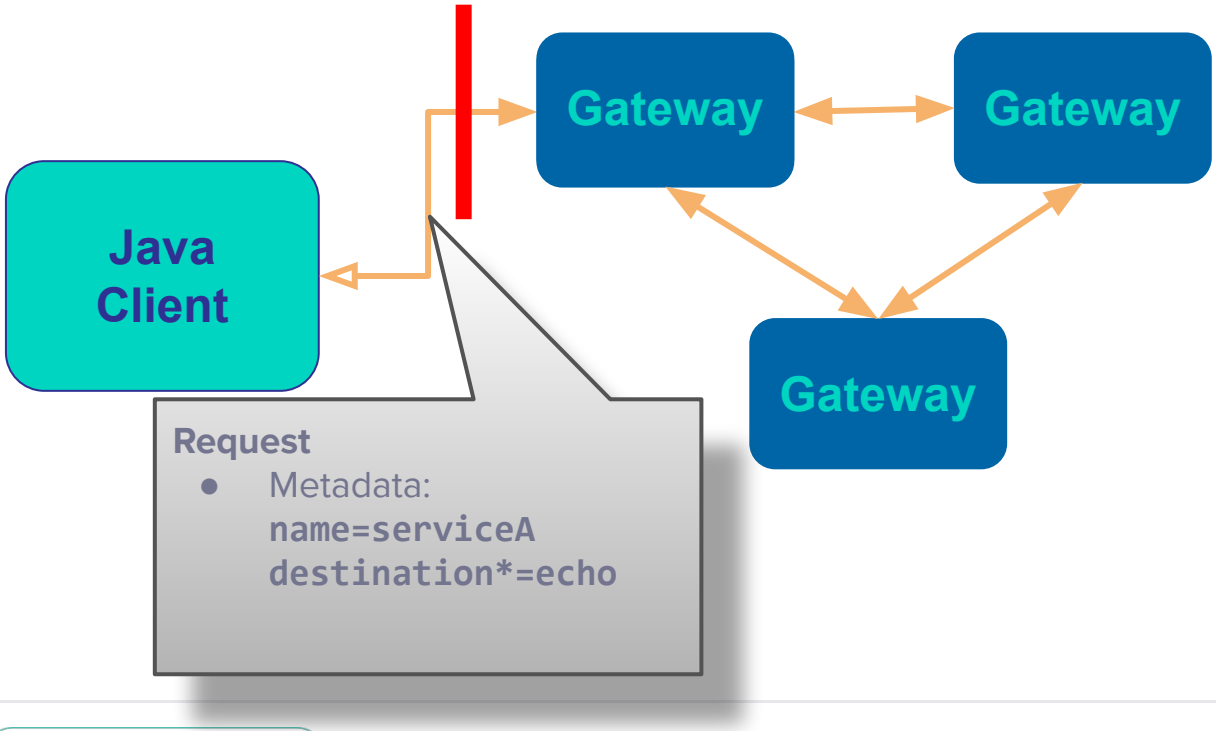
Gateway Architecture



Requests to non-existant services

- Gateway creates a placeholder
  - Applies 100% backpressure
- Avoids service startup ordering problems

Gateway Architecture

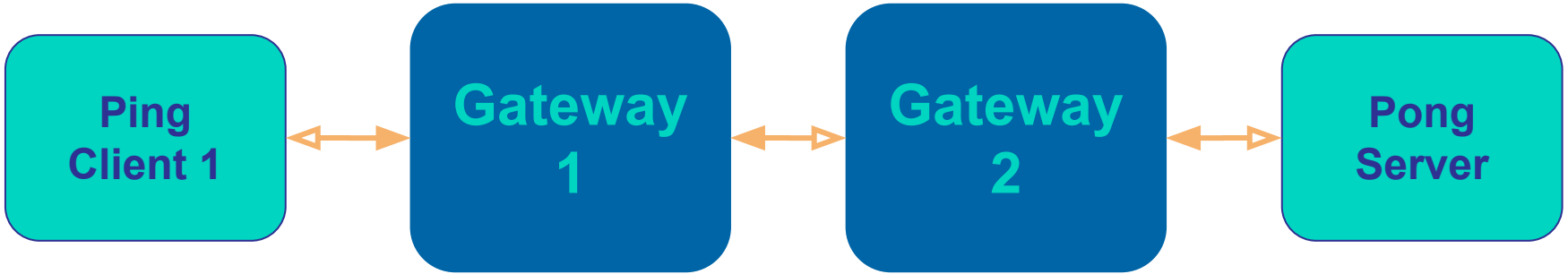


Requests are filtered

- Allows security at the request level
  - Is “Service A” allowed to talk to “Service B”
- Metrics collected at request level

Demo

Demo setup



To recap: Things you won't need...

- Ingress permissions (except Gateway)
- Separate Service Discovery
- Message Broker
- Circuit Breaker
- Client-side load balancer
- Sidecar
- Startup ordering problems
- Special cases for warmup
- Thundering Herd

To recap: Additional Benefits

- via RSocket
  - persistent, multiplexed connections
  - multiple transports (TCP, Websockets, Http/2, etc...)
  - polyglot
    - only need standardized connection and request metadata
- Metrics via Micrometer

Roadmap

- Clustering Enhancements
- Messaging Semantincs (topic vs queue)
- Tracing integration
- Routing optimization
- Failure tolerance improvements
- Release
  - Builds on Spring Framework 5.2 & Spring Boot 2.2
  - Part of Spring Cloud Hoxton
  - Targets Q3 2019

Questions?

http://rsocket.io
https://github.com/spring-cloud/spring-cloud-gateway
https://github.com/spencergibb/spring-cloud-gateway-rsocket-sample
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