API Toolbox with Spring

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Tweet by James Smith from NounProject.com
Mastodon by Icon 54 from iconscout.com

Agenda

- HTTP
- GraphQL
- Messaging
- Testing
- Consuming APIs
- Q+A

Old wooden toolbox filled with work tools by Thomas Baker from Noun Project (CC BY-NC-ND 2.0)

spring

HTTP

Spring Web MVC


https://docs.spring.io/spring-framework/reference/web/webmvc.html


https://docs.spring.io/spring-boot/docs/current/reference/html/web.html#web.servlet

- Original Servlet-based Model-View-Controller framework
- Use **`@Controller`** or **`@RestController`** to create beans to handle incoming HTTP requests
- The **`@RequestMapping`** and friends (**`@GetMapping`**, etc.) are used to map HTTP Methods
- All Servlet interfaces can be registered as beans.
- Tomcat, Jetty, and Undertow
- Can use JAX-RS implementations as Spring MVC alternative.

Spring Web MVC

```
@RestController
@RequestMapping("/users")
public class MyRestController {
    // fields and constructor omitted

    @GetMapping("/{userId}")
    public Mono<User> getUser(@PathVariable Long userId) {
        return userRepo.findById(userId);
    }

    @GetMapping("/{userId}/customers")
    public Flux<Customer> getUserCustomers(@PathVariable Long userId) {
        return userRepo.findById(userId).flatMapMany(customerRepo::findByUser);
    }

    @DeleteMapping("/{userId}")
    public Mono<Void> deleteUser(@PathVariable Long userId) {
        return userRepo.deleteById(userId);
    }
}
```

spring

Spring WebFlux


https://docs.spring.io/spring-framework/reference/web-reactive.html


https://docs.spring.io/spring-boot/docs/current/reference/html/web.html#web.reactive

- New asynchronous, non-blocking web framework based on the Project Reactor implementation of Reactive Streams
- Able to handle concurrency with a small number of threads and fewer hardware resources
- **`Mono`** is zero to one, and **`Flux`** is zero to many.
- Similar annotation style to Spring MVC
- Netty, Undertow, and the Tomcat and Jetty Servlet Containers

Spring WebFlux

```
@RestController
@RequestMapping("/users")
public class MyRestController {
    // fields and constructor omitted

    @GetMapping("/{userId}")
    public Mono<User> getUser(@PathVariable Long userId) {
        return userRepo.findById(userId);
    }

    @GetMapping("/{userId}/customers")
    public Flux<Customer> getUserCustomers(@PathVariable Long userId) {
        return userRepo.findById(userId).flatMapMany(customerRepo::findByUser);
    }

    @DeleteMapping("/{userId}")
    public Mono<Void> deleteUser(@PathVariable Long userId) {
        return userRepo.deleteById(userId);
    }
}
```

spring

Spring WebMVC.fn


https://docs.spring.io/spring-framework/reference/web/webmvc-functional.html


https://docs.spring.io/spring-boot/docs/current/reference/html/web.html#web.servlet

- Lightweight functional programming model
- Functions are used to route and handle requests
- Alternative to annotation-based model of Spring MVC
- **`RouterFunction`** beans are created using the **`RouterFunctions.route()`** builder
- Same Servlet containers

Spring WebMVC.fn

```
@Configuration(proxyBeanMethods = false)
public class MyRoutingConfiguration {

    private static final RequestPredicate ACCEPT_JSON =
            RequestPredicates.accept(MediaType.APPLICATION_JSON);

    @Bean
    public RouterFunction<ServerResponse> routerFunction(MyUserHandler users) {
        return RouterFunctions.route()
            .GET("/{user}", ACCEPT_JSON, users::getUser)
            .GET("/{user}/customers", ACCEPT_JSON, users::getUserCustomers)
            .DELETE("/{user}", ACCEPT_JSON, users::deleteUser)
            .build();
    }

}
```

Spring WebFlux.fn


https://docs.spring.io/spring-framework/reference/web/webflux-functional.html


https://docs.spring.io/spring-boot/docs/current/reference/html/web.html#web.reactive.webflux

- Lightweight functional programming model
- Functions are used to route and handle requests
- Alternative to annotation-based model of Spring WebFlux
- **`RouterFunction`** beans are created using the **`RouterFunctions.route()`** builder
- Same reactive programing model

Spring WebFlux.fn

```
@Configuration(proxyBeanMethods = false)
public class MyRoutingConfiguration {
    private static final RequestPredicate ACCEPT_JSON =
                RequestPredicates.accept(MediaType.APPLICATION_JSON);

    @Bean
    public RouterFunction<ServerResponse> monoRouterFunction(MyUserHandler users) {
        return RouterFunctions.route()
                .GET("/{user}", ACCEPT_JSON, users::getUser)
                .GET("/{user}/customers", ACCEPT_JSON, users::getUserCustomers)
                .DELETE("/{user}", ACCEPT_JSON, users::deleteUser)
                .build();
    }
}
```

HTTP Content


https://docs.spring.io/spring-framework/docs/current/javadoc-api/org/springframework/http/MediaType.html


https://docs.spring.io/spring-framework/reference/web/webmvc/mvc-ann-async.html

- JSON, XML, plain text, CBOR and many more defined in **`MediaType`**.
- Supports streaming with asynchronous requests using **`DeferredResult`** and **`Callable`**.
- Pluggable view technologies from Thymeleaf to PDFs.

Spring Data Rest

https://spring.io/projects/spring-data

https://docs.spring.io/spring-data/rest/reference/

- Spring Data provides a consistent programming model for data access using a **`Repository`** abstraction.
- Relational support for JDBC & JPA
- Non-relational support for Redis, MongoDB, and Cassandra and community support for various IaaS databases
- Spring Data Rest exports Spring Data repositories as hypermedia-driven RESTful resources.
- Spring HATEOAS: Hypermedia as the engine of application state.

Spring Data Rest

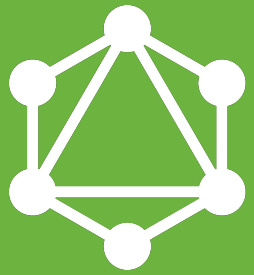

```
{ "_embedded": {
    "employees": [
      {
        "id": 1,
        "name": "Bilbo Baggins",
        "role": "burglar",
        "_links": {
          "self": {
            "href": "https://example.com:9001/employees/1"
          },
          "employees": {
            "href": "https://example.com:9001/employees"
          }}}]}
```


spring

Spring Cloud Gateway

- https://docs.spring.io/spring-cloud-gateway/reference/index.html
- https://youtu.be/BEjfwYiu4RU - Spring Cloud Gateway Recipes
- https://youtu.be/UyxUkAagLFs - Spring Cloud Gateway MVC

- API Gateway to aggregate microservices into one API
- Cross cutting concerns: security, resiliency, fault tolerance
- Compatible with Spring WebFlux and Spring MVC (new last year)
- Focus on developer experience
- Integration with other Spring Cloud projects:
  - Service Discovery, Load Balancer, Config, Circuit Breaker
- Commercial managed version on Cloud Foundry and Kubernetes

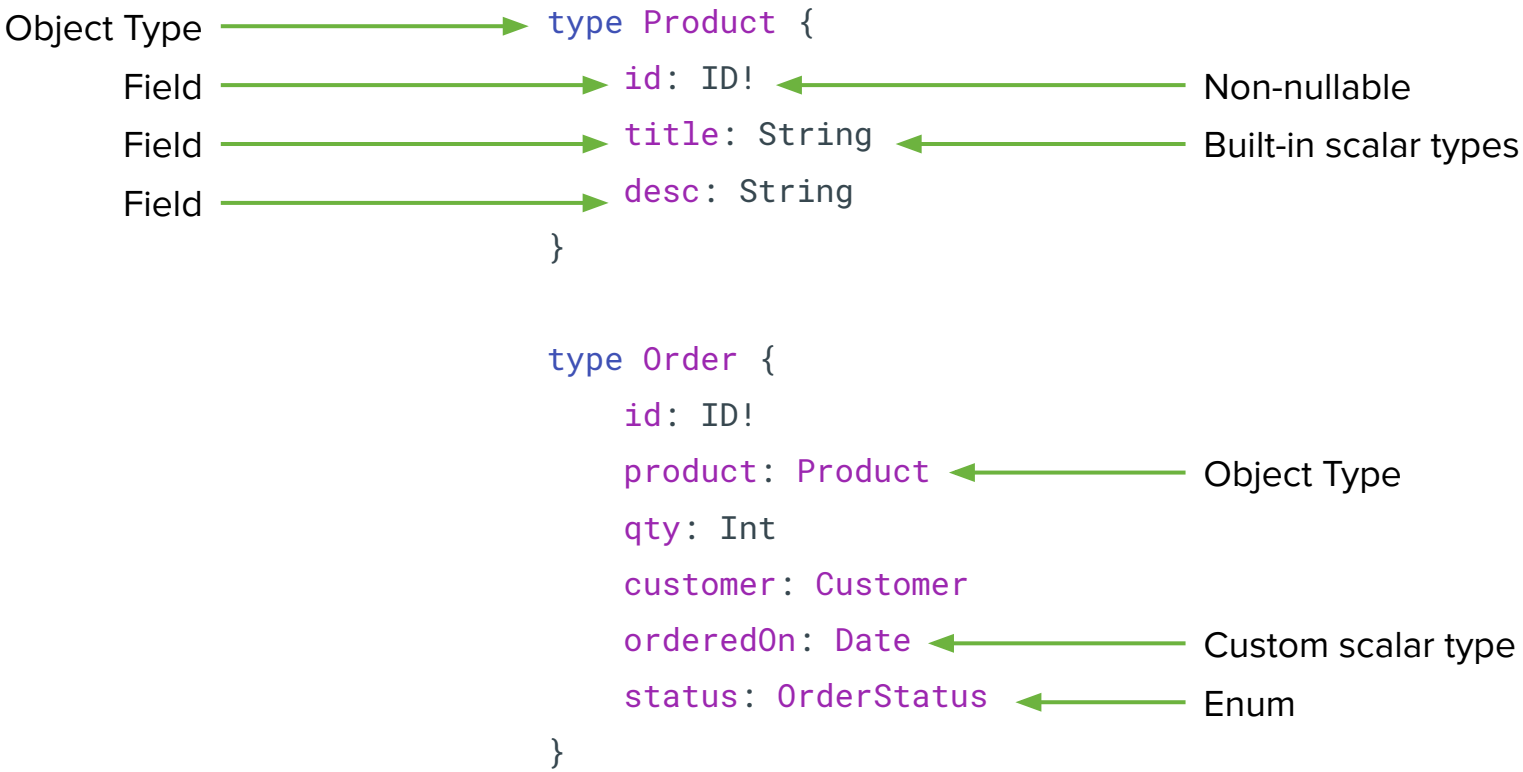


GraphQL

GraphQL

GraphQL is a **query language** for your API and a server-side runtime for executing queries and mutations using a type system you **model** for your data. GraphQL isn't tied to any specific database or storage engine and is instead backed by your existing code and data.

GraphQL Object Types



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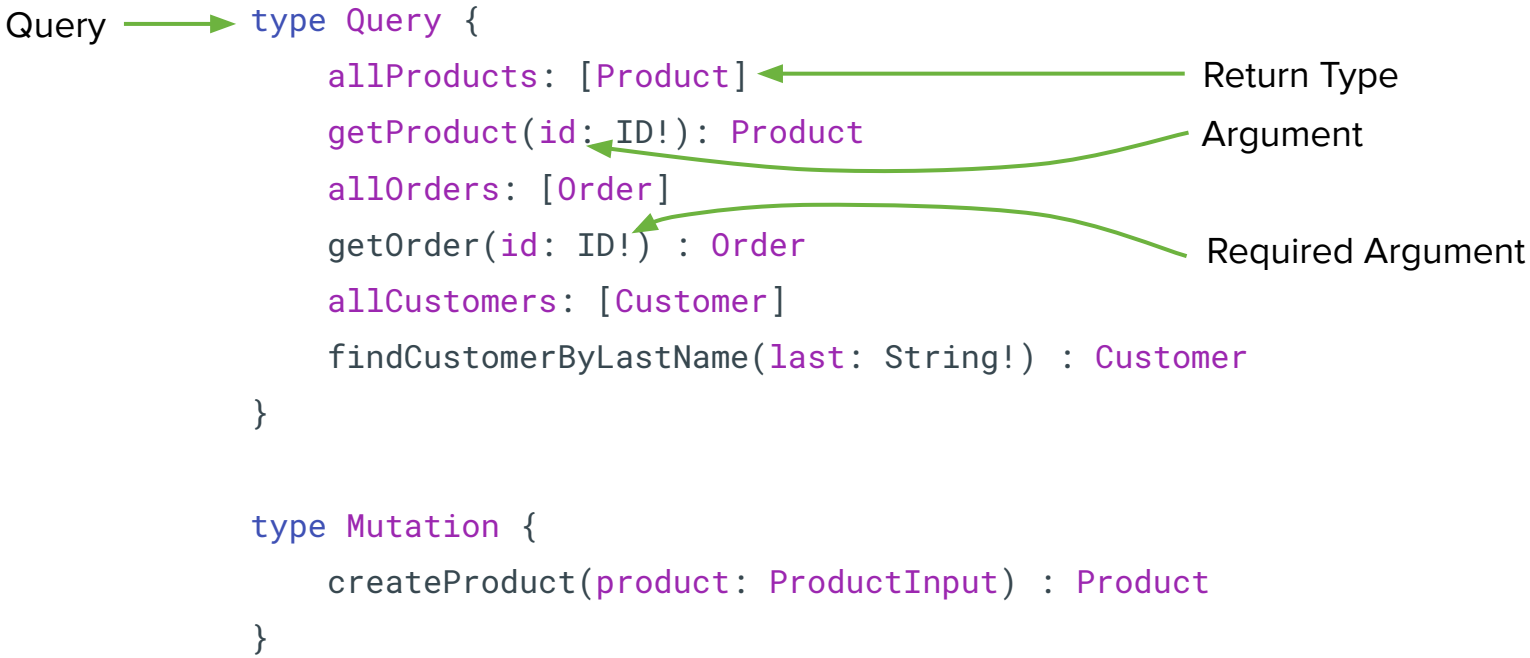
GraphQL Object Types



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GraphQL Libraries and Frameworks

GraphQL Java

https://www.graphql-java.com

Spring for GraphQL

https://docs.spring.io/spring-graphql/reference/

DGS

https://netflix.github.io/dgs/

spring

Spring for GraphQL

```
@Controller
public class BookController {
    @QueryMapping
    public Book bookById(@Argument Long id) {
        // ...
    }
    @MutationMapping
    public Book addBook(@Argument BookInput bookInput) {
        // ...
    }
    @SubscriptionMapping
    public Flux<Book> newPublications() {
        // ...
    }
}
```

Dan Vega

Does Your API Need a REST?

Check Out GraphQL

Wed Feb 21 @ 10:00

ST-Laurent 1 (English)

spring

Messaging

Stopwatch by M. Oki Orlando from NounProject.com

Java Message Service (JMS)


https://docs.spring.io/spring-framework/reference/integration/jms.html


https://docs.spring.io/spring-boot/docs/current/reference/html/messaging.html#messaging.jms

- Provides a similar simplification for using JMS API, similar to Spring's JDBC integration
- Classic Spring Template type class: **`JmsTemplate`**.
- Spring Boot provides auto-configuration for ActiveMQ "Classic" and ActiveMQ Artemis

Spring Cloud Function and Stream

https://docs.spring.io/spring-cloud-function/reference/index.html

https://docs.spring.io/spring-cloud-stream/reference/index.html

- Embraces core functional interfaces in Java defines as **`@Bean`**:
  - **`Supplier<O>`**, **`Function<I, O>`**, **`Consumer<I>`**
- Integration with IaaS serverless platforms and Spring Cloud Stream.
- Spring Cloud Stream is for building message-driven applications.
- Binders provide abstraction to popular middleware:
  - Kafka, RabbitMQ, Pulsar, AWS Kinesis, and others provided by the community

WebSockets


https://docs.spring.io/spring-framework/reference/web/websocket.html


https://docs.spring.io/spring-boot/docs/current/reference/html/messaging.html#messaging.websockets

- RFC 6455, Provides a standardized way to establish a full-duplex, two-way communication channel between client and server over a single TCP connection
- Designed to work over HTTP on ports 80 and 443 for firewalls
- For Spring MVC, use **`spring-boot-starter-websocket`**
- It is included in **`spring-boot-starter-webflux`**

RSocket


https://docs.spring.io/spring-framework/reference/rsocket.html


https://docs.spring.io/spring-boot/docs/current/reference/html/messaging.html#messaging.rsocket

- RSocket is an application protocol for multiplexed, duplex communication over TCP, WebSocket, & other byte stream transports.
- 4 interaction models: RR, RS, Channel, and F&F
- After initial connection, both sides can initiate interaction.
- Reactive Streams semantics across network boundary including back pressure.
- Much more, see https://rsocket.io/about/protocol

Testing

MockMVC


https://docs.spring.io/spring-framework/reference/testing/spring-mvc-test-framework.html


https://docs.spring.io/spring-boot/docs/current/reference/html/features.html#features.testing.spring-boot-applications.with-mock-environment

- Testing support for Spring MVC applications
- Full Spring MVC request/response handling with mock implementations rather than a running server
- Integration with **`WebTestClient`**, which provides higher level abstractions instead of raw data as well as the option to switch to integration testing and running a server.

MockMVC

```
@SpringBootTest
@AutoConfigureMockMvc
class MyMockMvcTests {
    @Test
    void testWithMockMvc(@Autowired MockMvc mvc) throws Exception {
      mvc.perform(get("/")).andExpect(status().isOk())
                .andExpect(content().string("Hello World"));
    }
    @Test
    void testWithWebTestClient(@Autowired WebTestClient webClient) {
        webClient.get().uri("/").exchange().expectStatus().isOk()
                .expectBody(String.class).isEqualTo("Hello World");
    }
}
```

spring

Wiremock


https://wiremock.org/


https://docs.spring.io/spring-cloud-contract/docs/current/reference/html/project-features.html#features-wiremock

- Wiremock allows mocking external APIs.
- Java or JSON configuration.
- Flexible request matching.
- Record/playback
- HTTP, gRPC, and GraphQL
- Add **`spring-cloud-starter-contract-stub-runner`** and **`@AutoConfigureWireMock`**.

Wiremock

```
@SpringBootTest(webEnvironment = WebEnvironment.RANDOM_PORT)
@AutoConfigureWireMock(port = 0)
public class WiremockForDocsTests {
    @Autowired private Service service; // A service that calls out over HTTP
    @BeforeEach
    public void setup() {
        this.service.setBase("http://localhost:"
                + this.environment.getProperty("wiremock.server.port"));
    }
    @Test
    public void contextLoads() throws Exception {
        stubFor(get(urlEqualTo("/resource")).willReturn(aResponse()
                .withHeader("Content-Type", "text/plain").withBody("Hello World!")));
        // We're asserting if WireMock responded properly
        assertThat(this.service.go()).isEqualTo("Hello World!");
    }
}
```

spring

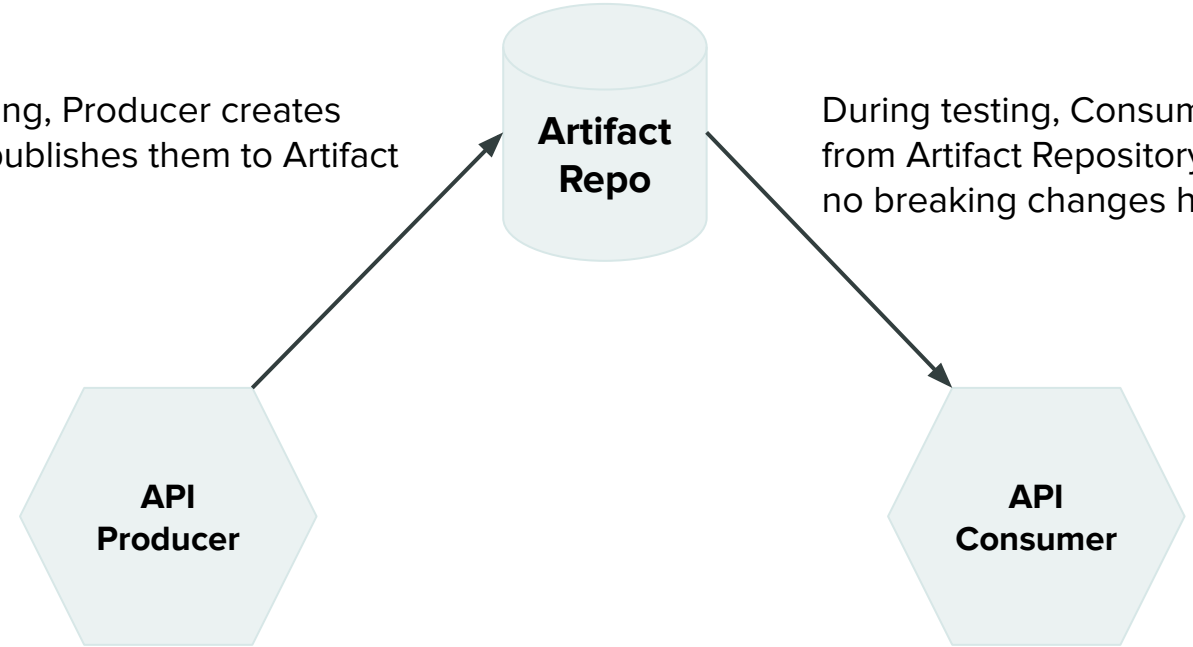
Spring Cloud Contract

https://docs.spring.io/spring-cloud-contract/docs/current/reference/html/getting-started.html

- Moves TDD to the level of Software Architecture.
- Provides consumer-driven and producer-driven contract testing.
- Various overloaded methods for combinations of HTTP method, return type, and parameters
- Ensures that HTTP and messaging stubs (used when developing the client) do exactly what the actual server-side implementation does.
- Provides the ability to publish contract changes for two way visibility (producer and consumer)

Spring Cloud Contract

During testing, Producer creates stubs and publishes them to Artifact Repository



During testing, Consumer pulls stubs from Artifact Repository and verifies no breaking changes have occurred

Testcontainers

https://docs.spring.io/spring-boot/docs/current/reference/html/features.html#features.testing.testcontainers

https://testcontainers.com/

- The Testcontainers library provides a way to manage services running inside Docker containers during testing.
- Supports native **`@Testcontainers`** & **`@Container`** annotations.
- The Spring Boot **`@ServiceConnection`** annotation bridges metadata (host, ports, etc.) from Testcontainers to Spring Boot configuration.
- Support for many technologies by default, including: databases, message brokers, cloud services, WireMock, and more.

Consuming APIs

RestTemplate


https://docs.spring.io/spring-framework/reference/integration/rest-clients.html#rest-resttemplate


https://docs.spring.io/spring-boot/docs/current/reference/html/io.html#io.rest-client.resttemplate

- The classic HTTP Client offered by Spring Framework.
- Classic Spring Template type class.
- Various overloaded methods for combinations of HTTP method, return type, and parameters

RestTemplate

```
@Service
public class MyService {
    private final RestTemplate restTemplate;

    public MyService(RestTemplateBuilder restTemplateBuilder) {
       restTemplate = restTemplateBuilder.build();
    }

    public Details someRestCall(String name) {
        return restTemplate.getForObject("/{name}/details",
               Details.class, name);
    }
}
```

spring

WebClient


https://docs.spring.io/spring-framework/reference/integration/rest-clients.html#rest-webclient


https://docs.spring.io/spring-boot/docs/current/reference/html/io.html#io.rest-client.webclient

- Non-blocking, reactive HTTP Client introduced in Framework 5.0.
- Reactive Streams back pressure.
- Functional-style fluent API.
- Requires WebFlux (even in a Spring MVC app).

WebClient

```
@Service
public class MyService {
    private final WebClient webClient;

    public MyService(WebClient.Builder webClientBuilder) {
        this.webClient = webClientBuilder.baseUrl("https://example.org").build();
    }

    public Mono<Details> someRestCall(String name) {
        return this.webClient.get().uri("/{name}/details", name)
                .retrieve().bodyToMono(Details.class);
    }
}
```

RestClient


https://docs.spring.io/spring-framework/reference/integration/rest-clients.html#rest-restclient


https://docs.spring.io/spring-boot/docs/current/reference/html/io.html#io.rest-client.restclient

- Synchronous HTTP Client introduced in Framework 6.1.
- Functional-style fluent API (similar to WebClient)
- WebFlux not required
- Same underlying configuration as RestTemplate

RestClient

```
@Service
public class MyService {
    private final RestClient restClient;

    public MyService(RestClient.Builder restClientBuilder) {
        this.restClient = restClientBuilder.baseUrl("https://example.org").build();
    }

    public Details someRestCall(String name) {
        return this.restClient.get().uri("/{name}/details", name)
               .retrieve().body(Details.class);
    }
}
```

Interface Clients


https://docs.spring.io/spring-framework/reference/integration/rest-clients.html#rest-http-interface


https://github.com/spring-projects/spring-boot/issues/31337

- Declarative web client
- Annotate a Java interface and the library provides the implementation
- Originally supported OpenFeign in Spring Cloud
- Added to Spring Framework in 6.0
- Auto-configuration still to come in Spring Boot
- **`@HttpExchange`** and **`@RSocketExchange`**.
- **`@HttpExchange`** can use **`WebClient`**, **`RestClient`**, or **`RestTemplate`** .

Interface Clients: @HttpExchange

```
public interface VerificationService {
    @PostExchange(url = "/verify") // meta-annotated @HttpExchange(method = "POST")
    VerifyResult verify(@RequestBody CustomerApplication customerApplication);
}
@Bean
public VerificationService vs(RestClient.Builder builder, ConversionService cs) {
    RestClient rc = builder.baseUrl(this.verificationServiceUrl).build();
    // in the future, this will be auto-configured by Spring Boot
    HttpServiceProxyFactory hspf = HttpServiceProxyFactory.builderFor(
        RestClientAdapter.create(rc)).conversionService(cs).build();
    return hspf.createClient(VerificationService.class);
}
// somewhere else in the application
VerifyResult result = verificationService.verify(customerApplication);
```

Interface Clients: @RSocketExchange

```
public interface RadarsService {
    @RSocketExchange("locate.radars.within")
    Flux<AirportLocation> radars(MapRequest request);
}

@Controller
public class RadarsController implements RadarsService {
    public Flux<AirportLocation> radars(MapRequest request) {
        // ...
    }
}
```

spring

Documenting APIs

Spring REST Docs


https://docs.spring.io/spring-restdocs/docs/current/reference/htmlsingle/


https://docs.spring.io/spring-boot/docs/current/reference/htmlsingle/#features.testing.spring-boot-applications.autoconfigured-spring-restdocs

- Uses Asciidoctor by default
- Produces snippets by testing with MockMVC, WebTestClient, or Rest Assured
- The snippets are accurate if the tests pass.
- Spring Cloud Contract integration

```
[[resources_index_access]]
=== Accessing the index

A `GET` request is used to access the index

operation::index-example[snippets='response-fields,http-response,links']
```

Questions

Thank you

https://gibb.tech/preso/conconfoo-2024-api-toolbox-with-spring/

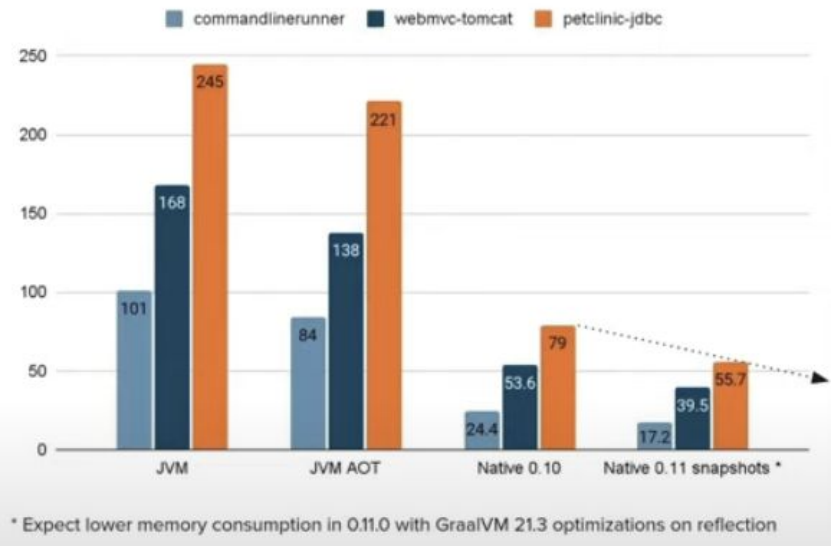
@spencerbgibb

social.sdf.org/@spencergibb

Question by Mani Cheng from NounProject.com
Tweet by James Smith from NounProject.com
Mastodon by Icon 54 from iconscout.com

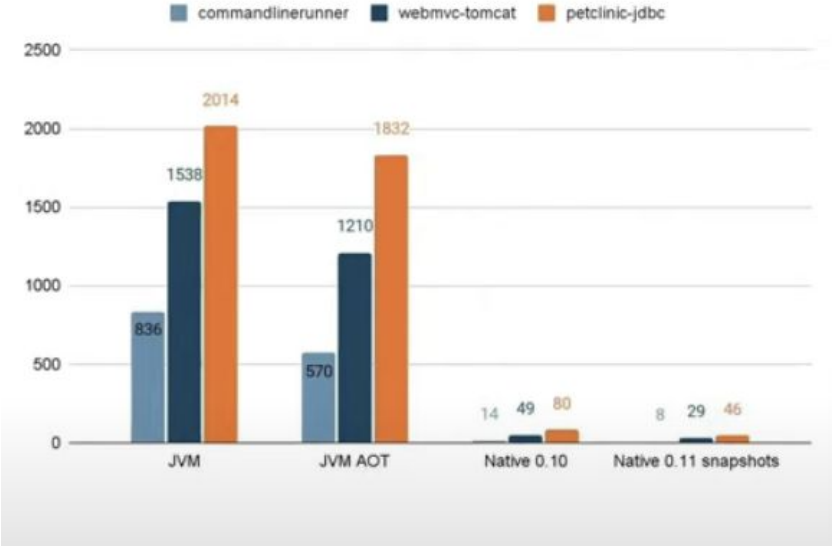
Benefits of Native Image

Memory Footprint



* Expect lower memory consumption in 0.11.0 with GraalVM 21.3 optimizations on reflection

Startup Time



spring

What Changes in Spring Framework 6 and Spring Boot 3?

Spring Native was an experimental project

- AOT metadata processing moves to Framework. All can benefit, not just native applications.
- Build time plugins will move to Spring Boot
- Type and Resource hints will move out of the spring-native monorepo to individual Spring projects or upstream projects

Observability: From Sleuth to Micrometer

Sleuth introduced distributed tracing via Zipkin and May 2016

- All instrumentation lived in Sleuth repo.
- 2021.0 will be the last release train to support Sleuth

Introducing Micrometer Tracing

- Supports Zipkin Brave and OpenTelemetry
    - Plans to migrate upstream
- new `Observation` API
- Instrumentation will move to individual Spring projects
- Spring Boot with auto configure needed infrastructure
- Continues Java 8 baseline for broader compatibility

Divider Slide Title

Single column of content

When allocating resources for a critical application they were delivering, the company set aside a large team.

- Which virtualization technologies are in use for application deployment?
- Are any additional virtualization technologies being explored? Public cloud?
- What tools & automation are used for application operations?
- What is the process for maintaining, patching and upgrading environments today?
- Are you using/exploring Continuous Integration and Continuous Delivery pipelines?
- Which app servers and databases are used e.g. Tomcat, Weblogic, Websphere etc?
- How is Business success measured? Key metrics?

Content with sidebar

When allocating resources for a critical application they were delivering.

- Which virtualization technologies are in use for application deployment?
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Which virtualization technologies are in use for application deployment?

Are any additional virtualization technologies being explored? Public cloud?

What tools & automation are used for application operations?

What is the process for maintaining, patching and upgrading environments today?

Two columns of content

Headline for column 1

- Which virtualization technologies are in use for application deployment?
- Are any additional virtualization technologies being explored? Public cloud?
- What tools & automation are used for application operations?
- What is the process for maintaining, patching and upgrading environments today?
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Headline for column 2

- Which virtualization technologies are in use for application deployment?
- Are any additional virtualization technologies being explored? Public cloud?
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Three columns of content

Headline for column 1

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Headline for column 3

- Which virtualization technologies are in use for application deployment?
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Centered Text Template

Spring Logo and Project Icons

Spring
Boot

Spring
Cloud

Spring
Framework

Spring Cloud
Data Flow

Spring Tool
Suite

Spring
LDAP

Spring
Cloud Gateway

Spring
Security

Spring
Data

Spring
Batch

Spring
Integration

Project
Reactor

Spring
Kafka

Spring
for GraphQL

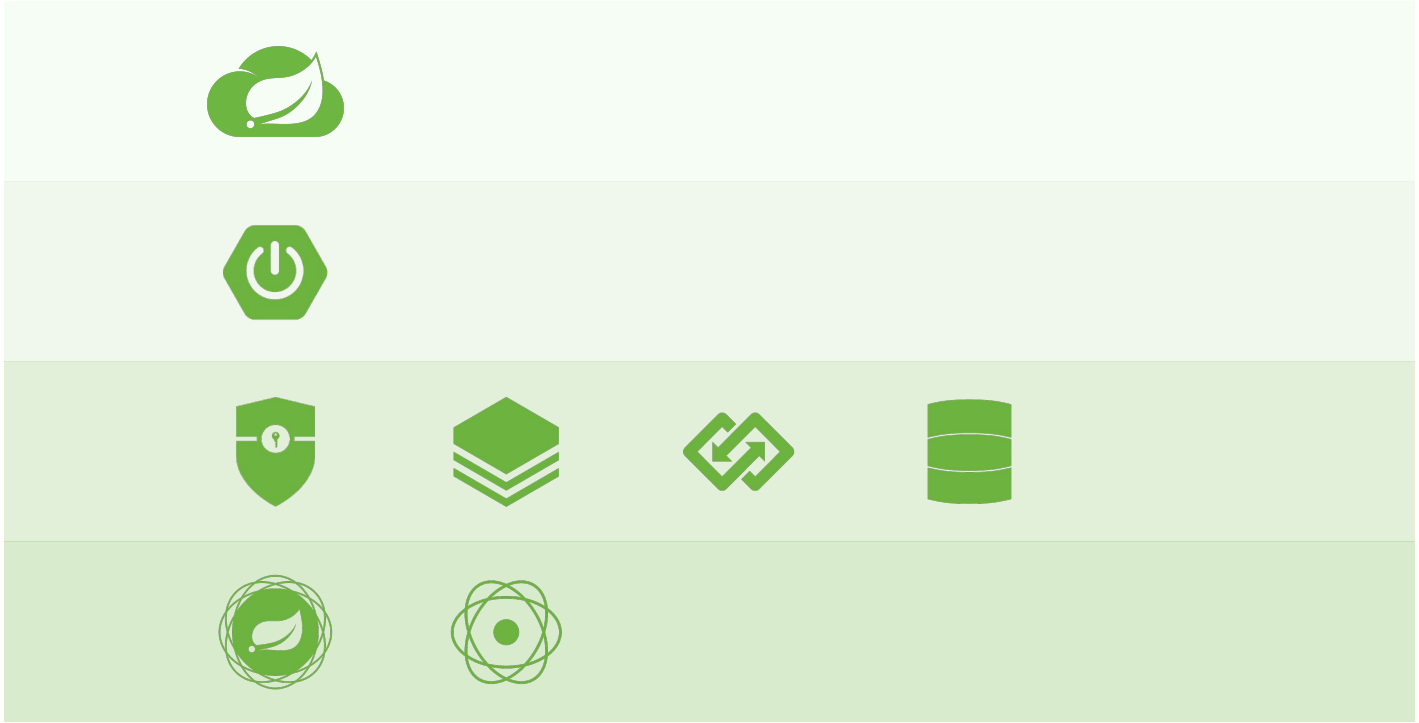
Spring
Web Services

Spring
Web Flow

Spring
Hateoas

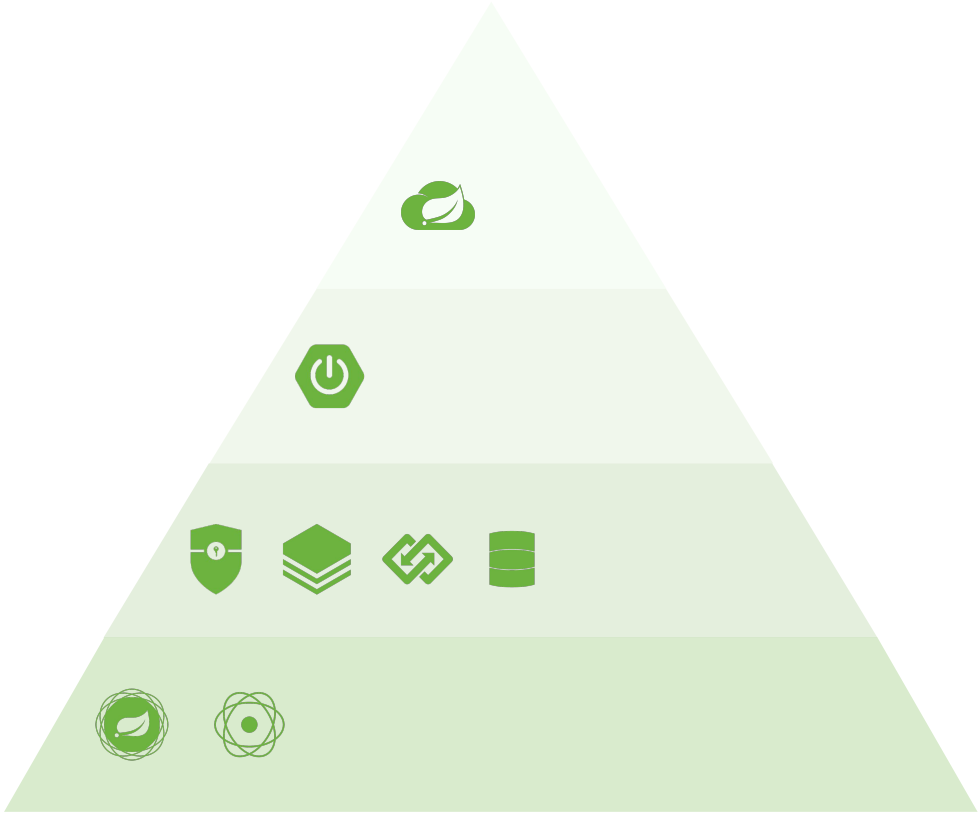
Spring
AMQP

Spring Project Icons Hierarchy Template #1



spring

Spring Project Icons Hierarchy Template #2



spring

Code Block Template #1

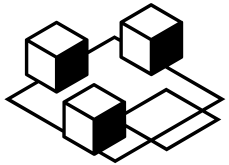
```
@SpringBootApplication
@RestController
public class DemoApplication {

@GetMapping("/helloworld")
public String hello() {
return "Hello World!";
```

Code Block Template #2

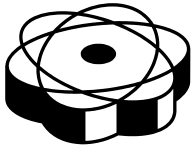
```
@SpringBootApplication
 @RestController
 public class DemoApplication {

 @GetMapping("/helloworld")
 public String hello() {
 return "Hello World!";
```

spring

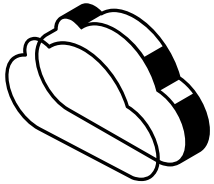
Icons



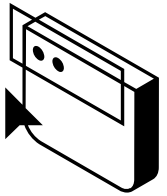
Microservices



Reactive

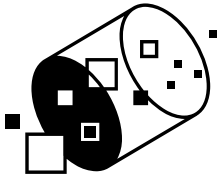


Cloud

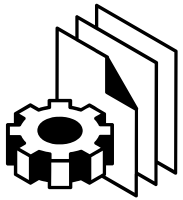


Web Apps

Serverless



Event Driven

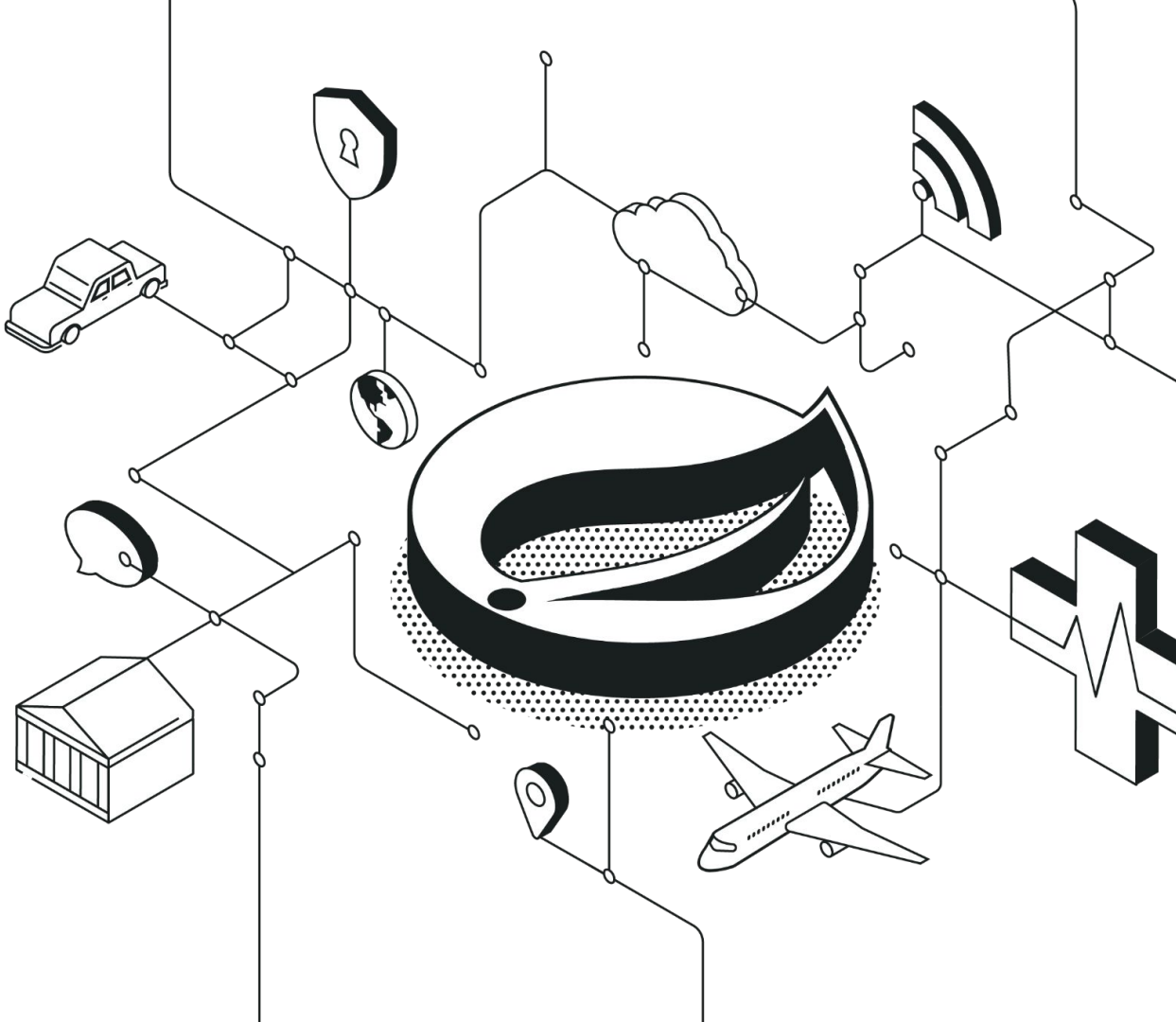


Batch

Abstract Icons

spring

Why Spring?



spring

Diagram Kit

Diagram Examples

Batch Stereotypes

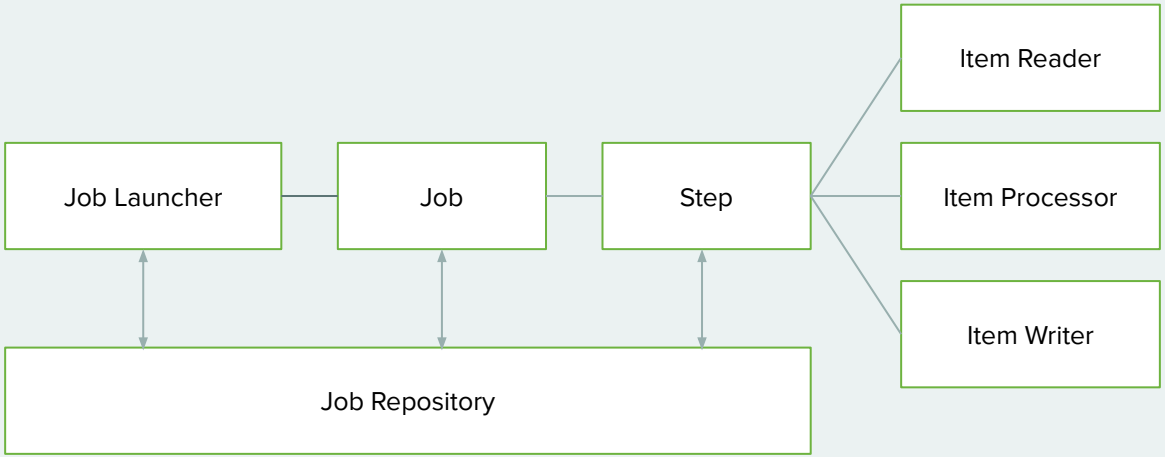
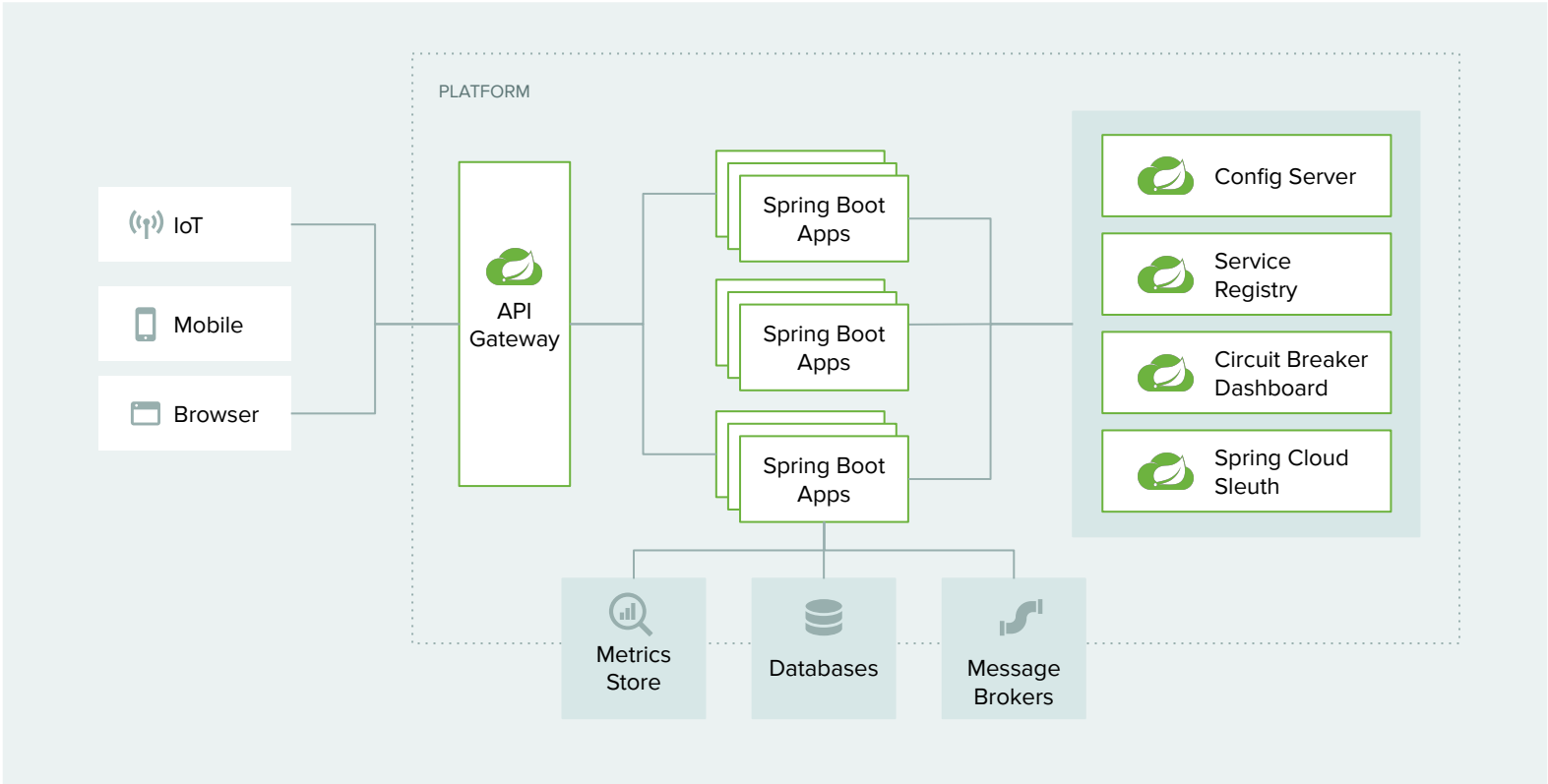
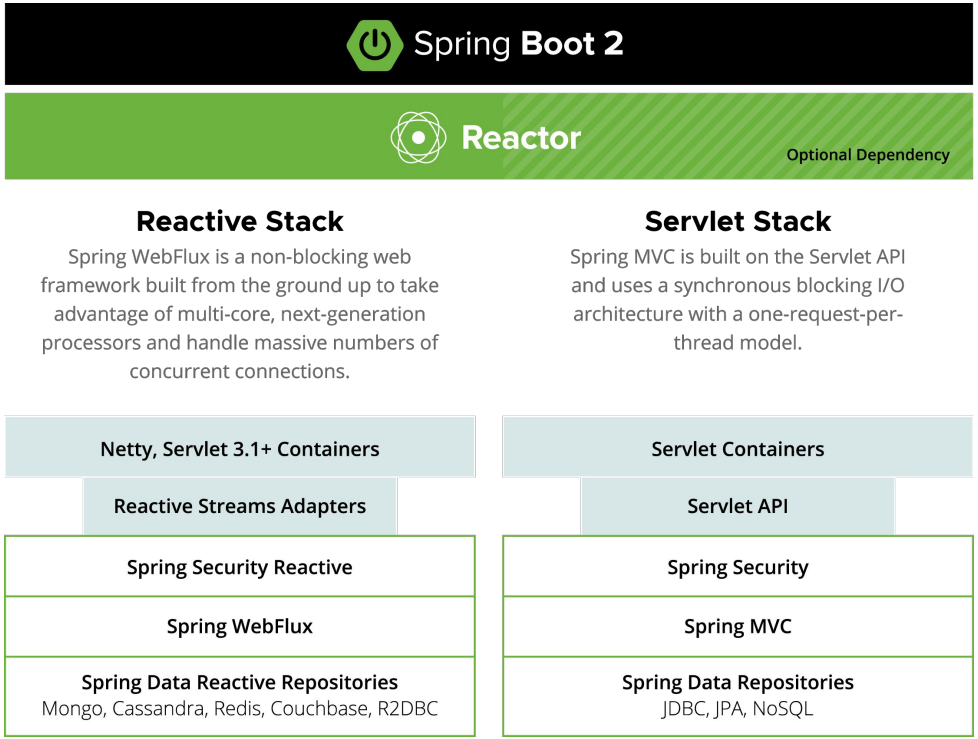


Diagram Examples



spring

Diagram Examples



spring