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9 v6-sts - invoice-management/src/main/java/com/verizon/learning/controllers/InvoiceRestController.java - Spring Tool Suite 4
                       Q B W #
             Package Explor 🕱 Ju JUnit 🗀 🔲 InvoiceRestController.java 🛱 🚺 CustomerRestController.java
                                                                                 E & 8
                                                                                                                       1 package com.verizon.learning.controllers;
  0
                          3=import java.util.Arrays;
4 import java.util.List;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ▼ ∰ com.verizon.learning.value
► ☑ Customer.java
► ☑ CustomerAddress.java
                                                                                                                        6 import org.springframework.http.MediaType;
7 import org.springframework.web.bind.annotation.GetMapping;
                    ► ② CustomerAddress_java ▼ ② scrimain/resources ↓ ② scrimain/resources ↓ ③ application, properties ▶ ③ stripest_java → ⑤ stripest_java → ⑤ stripest_java → ⑥ stripest_java → 
                                                                                                                         8 import org.springframework.web.bind.annotation.PathVariable;
                                                                                                                         9 import org.springframework.web.bind.annotation.RestController;
                                                                                                                    10 import org.springframework.web.reactive.function.client.WebClient;
                                                                                                                    12 import com.verizon.learning.valueobjects.Customer;
                                                                                                                    13
                                                                                                                    14 import reactor.core.publisher.Flux;
                       spring-reactive-learning (boot) (v6 m
spring-reactive-learning toot) (v6 m
spring-reactive-learning controller
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                            > spring-reactive-learning [boot] [v6 π
                                                                                                                   15 import reactor.core.publisher.Mono;
                                                                                                                    16
                                                                                                                    17 @RestController
                                                                                                                    18 public class InvoiceRestController {
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                                                                                                                                                        WebClient webClient = WebClient.create("http://localhost:8080");
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                                                                                                                                                        @GetMapping(path = "/invoice-customers", produces = {MediaType.APPLICATI
public Flux<Customer> handleGetInvoiceCustomers() {
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                                                                                                                         10 import org.springframework.web.reactive.function.client.WebClient;
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                                                                                                                         12 import com.verizon.learning.valueobjects.Customer;
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                                                                                                                        14 import reactor.core.publisher.Flux:
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                                                                                                                         18 public class InvoiceRestController {
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                                                                                                                                                           private Mono<Customer> getCustomerById(String customerId) {
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                                                                                                                                                                                                                          .retrieve()
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                                                                                                                                                                                                                           .bodyToMono(Customer.class);
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                                                                                                                                                                                return customer;
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                                                                                                                                                             @GetMapping(path = "/invoice-customers", produces = {MediaType.APPLICAT
                                                                                                                                                            public Flux<Customer> handleGetInvoiceCustomers() {
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             🖺 Package Explor 🗯 Ju JUnit 🗀 🔲 Invoice
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                                                                                                                                                           @GetMapping(path = "/invoice-customers/{customerId}")
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                                                                                                                                                           public Mono<Customer> handleGetInvoiceCustomerById(@PathVariable String
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.uri("/customers/{customerId}", customerId)
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.bodyToMono(Customer.class);
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                                                                                                                                                           @GetMapping (path = "/select-customers")
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76
                                                                                                                                                           public Flux<Customer> handleGetSelectCustomers() {
                                                                                                                                                                              List<String> ids = Arrays.asList("101", "103", "105");
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79
                                                                                                                                                                              Flux<Customer> customers =
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                                                                                                                                                                                                                     Flux.fromIterable(ids)
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                                                                                                                                                                                                                        return this.getCustomerById(|customerId|)|;
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► ⚠ Customer.java
► ⚠ CustomerAddress.java
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**P. E. Customer Address_lava

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                               ► □ DemoController, java

★ □ com.verizon.learning.model

► □ Customer, java

► □ CustomerAddress, java

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▼ Ø src/main/resources
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Mayen Dependencies
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               Package Explor ☎ Ju JUnit □ □ ☑ InvoiceRestController.java ☎ 🕡 Custon
             | Paccage capper 32 of Junit
| Paccage capper
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                                                                                                                                                                                                                        return this.getCustomerById(customerId);
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                                                                                                                                                                                              @GetMapping (path = "/select-customers")
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                                                                                                                                                                                                                        List<String> ids = Arrays.asList("101", "103", "105");
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                                                                                                                                                                                                                                                                        Flux.fromIterable(ids)
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                                                                                                                                                                                                                                                                                                                           return this.getCustomerById(x);
                                                                                                                                                   88
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                                                                                                                                                                                                                                                                                          });
                          ▶ ① DemoController java

▼ donnvertrol earning model

▶ ② Customer java

▶ ② Customer java

▶ ② Customer Address Java

▶ ③ Convertion Learning web utill

▼ ④ scromin/resources

⇒ static

→ templates
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                                                                                                                                                   93
                                                                                                                                                                                                                        return customers;
                                                                                                                                                   94
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                                                                                                                                                   96
                                                                                                                                                                                              }
```

```
v6-sts - reactor.core.publisher.Flux - Spring Tool Suite 4
                   Q B W *
       Package Explor 🛱 Ju JUnit 📅 🗖 📝 InvoiceRestController.java 📝 CustomerRestController.java 🚮 Flux.class 🛱
                                                                                                          * @reactor.errorMode This operator supports {@link #onErrorContinue(
                                                    E & 8
                                                                               4917
0
         ▼ Note invoice-management [boot] [v6 mast
                                                                                                             * in the mapper {@link Function}. Exceptions thrown by the mapper th
                                                                               4918
               * it had mapped the value to an empty publisher. If the mapper does
* publisher (an optimization in which the value can be resolved imme
                                                                               4919
                                                                               4920
                                                                                                             * subscribing to the publisher, e.g. a {@link Mono#fromCallable(Call * publisher throws, this can be resumed from in the same manner.
                                                                              4921
                  4922
                                                                               4923
               4924
                                                                                                              * @return a new {@link Flux}
                                                                               4925
                                                                               4926⊖
                                                                                                          public final <R> Flux<R> flatMap (Function<? super T, ? extends Publis</pre>
                                                                                                                         return flatMap(mapper, Queues.SMALL_BUFFER_SIZE, Queues
                                                                               4927
                                                                               4928
                                                                                                                                                     .XS_BUFFER_SIZE);
                                                                               4929
                                                                                                            }
             i java-demo
i jav
                                                                               4930
                                                                               4931
                                                                               4932
                                                                                                               * Transform the elements emitted by this {@link Flux} asynchronously
                                                                               4933
                                                                                                             * then flatten these inner publishers into a single {@link Flux} thr * which allow them to interleave.
                ► A > CustomerRestController.java
                                                                              4934
```

The flapMap() takes a Function that takes one parameter and returns a value back

```
v6-sts - java.util.function.Function - Spring Tool Suite 4
     Q B 4 4
   Package Explor 🛱 Ju JUnit 📅 🗖 📗 InvoiceRestController.java 🔑 CustomerRestController.java 🔐 Function.class 🛱
E & 8
                                 299/**
                                30 * Represents a function that accepts one argument and produces a result.
                                 31 *
                                     * This is a <a href="package-summary.html">functional interface</a>
                                                                                                                                           0
                                32
                                33
                                      * whose functional method is {@link #apply(Object)}.
        ▼ ∰ com.verizon.learning.value
▶ ☑ Customer.java
▶ ☑ CustomerAddress.java
                                34 *
                                35 * @param <T> the type of the input to the function 36 * @param <R> the type of the result of the function
      37
       ► @ src/test/java
                                38 * @since 1.8
        JRE System Library [JavaSE-1.8]
                                39 */
       Maven Dependencies
                                40 @FunctionalInterface
        target pom.xml
                                 41 public interface Function<T, R> {
      42
                                430
                                44
                                           * Applies this function to the given argument.
                                45
                                46
                                          * @param t the function argument
                                47
                                          * @return the function result
                                48
                           tory.j 49
                                     R apply(T t);
                              y6-sts - invoice-management/src/main/java/com/verizon/learning/controllers/invoiceRestController.java - Spring Tool Suite 4
      Q 18 8 4
   Package Explor 🛱 Ju Junit 📟 🗖 InvoiceRestController.java 🛱 🔝 CustomerRestController.java
                     B & 8
    ▼ "Eg" > invoice-management [boot] (vf mast
▼ "A" > src/main/java
▼ "B" > convertron.learning
▶ "B" myocieManagementApplicatio
▼ "B" > convertron.learning.controller
▶ "B" invoiceManagementApplicatio
▼ "B" > convertron.learning.valueobject
▼ "B" convertron.learning.valueobject
                                  6 import org.springframework.http.MediaType;
                                 7 import org.springframework.web.bind.annotation.GetMapping;
8 import org.springframework.web.bind.annotation.PathVariable;
                                                                                                                                           0
                                  9 import org.springframework.web.bind.annotation.RestController;
                                10 import org.springframework.web.reactive.function.client.WebClient;
        ▼ ∰ com.verizon.learning.value
▶ ☑ Customer.java
▶ ☑ CustomerAddress.java
                                11
                                12 import com.verizon.learning.valueobjects.Customer;
         src/main/resources

@application.properties
                                13
                                14 import reactor.core.publisher.Flux;
            est/java
       JRE System Library [JavaSE-1.8]
                                15 import reactor.core.publisher.Mono;
      Maven Dependencies
    16
      > Src
                                17 @RestController
                                18 public class InvoiceRestController {
                                19
                                20
                                          WebClient webClient = WebClient.create("http://localhost:8080");
                                21
                                22
                                23
                                 24
                                          private Mono<Customer> getCustomerById(String customerId) {
                                25
                                26
                                               Mono<Customer> customer =
                                27
                                                          webClient
                                28
                                                          .get()
                                29
                                                          .uri("/customers/{customerId}", customerId)
                                30
                                                           .retrieve()
                                                          .bodyToMono(Customer.class);
                                31
                                32
                                33
                                               return customer;
```

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🙀 v6-sts - invoice-management/src/main/java/com/verizon/learning/controllers/InvoiceRestController.java - Spring Tool Suite 4
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                                                                                                                                                                                 return this.getCustomerById(customerId);
                                                                                                                     72
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                     > src/main/java

> com.verizon.learning

| \( \int_{\text{in}} \) invoiceManagementApplicatio

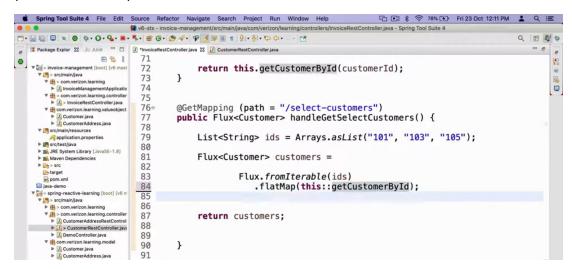
| \( \int_{\text{in}} \) com.verizon.learning.controller

| \( \int_{\text{in}} \) InvoiceRestController.java
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                                                                                                                                                          @GetMapping (path = "/select-customers")
public Flux<Customer> handleGetSelectCustomers() {
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                      com.verizon.learning.value

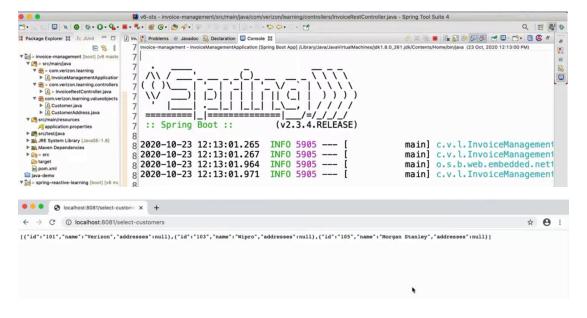
Customer.java

CustomerAddress.java
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                                                                                                                                                                                 List<String> ids = Arrays.asList("101", "103", "105");
                       Rapplication.properties
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                                                                                                                                                                                 Flux<Customer> customers =
                                                                                                                     81
               JRE System Library [JavaSE-1.8]
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                                                                                                                                                                                                                              Flux.fromIterable(ids)
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                                                                                                                                                                                                                                             .flatMap(x -> {
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            spring-reactive-learning (boot) [v6 m ] src/main(java spring-reactive-learning | w ] src/main(java spring-reactive-learning on-troller b ] customer/AddressRestControl b ] scom.verizon.learning.model b ] converizon.learning.model b ] converizon.learning.model b ] customer/AddressRespository.j b ] customer/AddressRessRespository.j b ] customer/AddressRespository.j b ] customer/Ad
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                                                                                                                                                                                                                                                                         return this.getCustomerById(x);
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                                                                                                                                                           }
```

This is the lambda expression that represents that function, it takes in one parameter (String) and returns a value (Mono<Customer>) back.



We are using a function reference and it is now flatMap() that will internally call the getCustomerById() function as a higher-order function.



3. A Simple User Service

We're going to be using a simple *User* API in our examples. **This API has a GET method that exposes** one method *getUser* for retrieving a user using the id as a parameter.

Let's take a look at how to make a single call to retrieve a user for a given id:

In the next section, we'll learn how we can call this method concurrently.

4.1. Multiple Calls to the Same Service

Let's now imagine that we want to fetch data about five users simultaneously and return the result as a list of users:

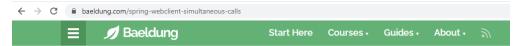
Let's decompose the steps to understand what we've done:

We begin by creating a Flux from our list of userIds using the static from Iterable method.

Next, we invoke *flatMap* to run the getUser method we created previously. This reactive operator has a concurrency level of 256 by default, meaning it executes at most 256 *getUser* calls simultaneously. This number is configurable via method parameter using an overloaded version of *flatMap*.

It's worth noting, that since operations are happening in parallel, we don't know the resulting order. If we need to maintain the input order, we can use <code>flatMapSequential</code> operator instead.

As Spring WebClient uses a non-blocking HTTP client under the hood, there is no need to define any Scheduler by the user. *WebClient* takes care of scheduling calls and publishing their results on appropriate threads internally, without blocking.



4.2. Multiple Calls to Different Services Returning the Same Type

Let's now take a look at how we can call multiple services simultaneously.

In this example, we're going to create another endpoint which returns the same *User* type:

```
public Mono<User> getOtherUser(int id) {
    return webClient.get()
    .uri("/otheruser/{id}", id)
    .retrieve()
    .bodyToMono(User.class);
}
```

Now, the method to perform two or more calls in parallel becomes:

```
public Flux fetchUserAndOtherUser(int id) {
    return Flux.merge(getUser(id), getOtherUser(id));
}
```

The main difference in this example is that we've used the static method *merge* instead of the *fromIterable* method. Using the merge method, we can combine two or more *Flux*es into one result.

4.3. Multiple Calls to Different Services Different Types

The probability of having two services returning the same thing is rather low. More typically we'll have another service providing a different response type and our goal is to merge two (or more) responses.

The Mono class provides the static zip method which lets us combine two or more results:

```
public Mono fetchUserAndItem(int userId, int itemId) {
   Mono user = getUser(userId);
   Mono item = getItem(itemId);
   return Mono.zip(user, item, UserWithItem::new);
}
```

The zip method combines the given user and item Monos into a new Mono with the type UserWithItem. This is a simple POJO object which wraps a user and item.