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Don’t Wait!

Develop responsive applications with Java EE7 instead!

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IBM

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MGM Grand & Mandalay Bay
Las Vegas, Nevada

Focus on the server side

- “Responsive” application
- Maximize resource utilization
- Technologies in EE7 can help

JAX-RS 2.0 async processing

Concurrency Utilities (JSR-236)

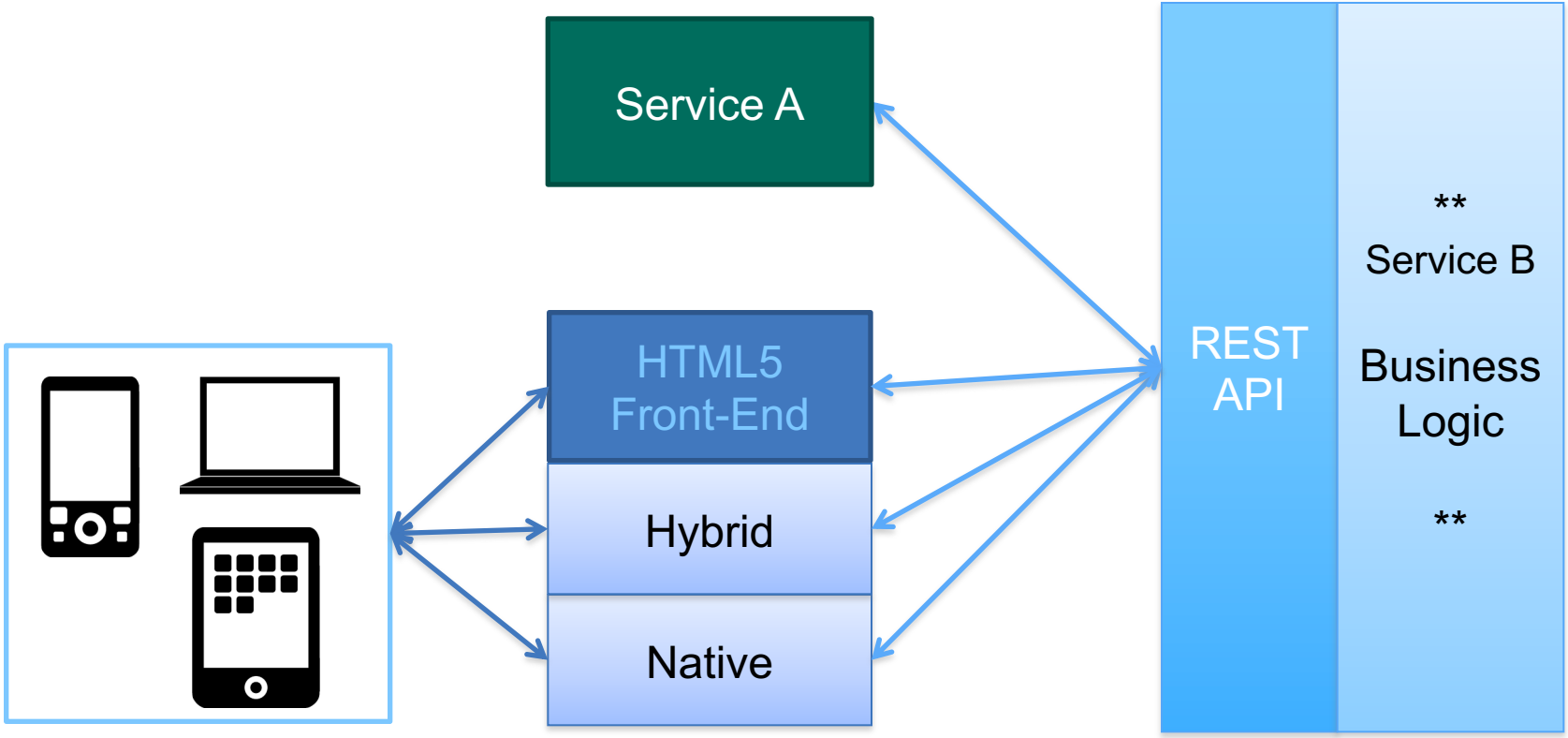
WebSocket API (JSR-356)

Non-blocking I/O added in Servlet 3.1

JAX-RS 2.0 Async Support

Concurrency Utilities

REST application (client-server or server-server)



A (very) simple JAX-RS example

```
@Path(”items")
public class ItemResource {

     // various ways to get this guy, play nice and assume we have one
     protected ItemService itemService;

     @GET
     @Produces(MediaType.APPLICATION_JSON)
     public Collection<Item> listItems() {
          return itemService.listItems();
     }

     @POST
     @Consumes(MediaType.APPLICATION_JSON)
     public void addItem(Item item) {
          itemService.addItem(item);
     }

    ...
}
```

A (very) simple JAX-RS example

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          itemService.addItem(item);
     }

    ...
}
```

What if this is an encapsulation of a remote service?

JAX-RS 2.0 Asynchronous processing

```
@GET
@Produces(MediaType.APPLICATION_JSON)
public void getItems(@Suspended final AsyncResponse ar) {

    Collection<Item> result = itemService.listItems();
    ar.resume(result );
}
```

- @Suspended annotation with AsyncResponse parameter
- void return type (to allow this method to return immediately)
    - “suspend” the connection -- NOT DISCONNECTED!
- AsyncResponse.resume(…) to send the response to the client.

JAX-RS 2.0 Asynchronous processing

```
@GET
@Produces(MediaType.APPLICATION_JSON)
public void getItems(@Suspended final AsyncResponse ar) {

    Collection<Item> result = itemService.listItems();
    ar.resume(result );
}
```

Hmm…I don't see any threading stuff. How is this asynchronous?

- @Suspended annotation
- void return type (to allow th y)
  - "suspend" the connection -- NOT DISCONNECTED!
- AsyncResponse.resume(…) to send the response to the client.

JAX-RS 2.0 and …

```
@GET
@Produces(MediaType.APPLICATION_JSON)
public void getItems(@Suspended final AsyncResponse ar) {
    Runnable r = () -> {
        Collection<Item> result = itemService.listItems();
        Response resp = Response.ok(result).build();
        ar.resume(resp);
    };
    Executors.newSingleThreadExecutor().submit(r);
}
```

This would totally work:
The long-running operation is definitely on a different thread.

Hopefully we also know that this is a horrible idea!

#notcontainerfriendly

JAX-RS 2.0 and EJB

- For a local EJB, use the @Asynchronous method annotation.

```
@Stateless
@Path("ejbitems")
public class ItemEJBResource {
    ...
    @GET
    @Asynchronous
    @Produces(MediaType.APPLICATION_JSON)
    public void getItems(@Suspended final AsyncResponse ar) {
        Collection<Item> result = itemService.listItems();
        Response resp = Response.ok(result).build();
        ar.resume(resp);
    }
    ...
}
```

The EJB Container will dispatch to a different thread before invoking the method.

JAX-RS 2.0 and Concurrency Utilities

```
@Path("execitems")
public class ItemsExecutorResource {

    private ExecutorService getExecutor() throws NamingException {
        return (ExecutorService) new InitialContext()
                .lookup("java:comp/DefaultManagedExecutorService");
    }

    @GET
    @Produces(MediaType.APPLICATION_JSON)
    public void getItems(@Suspended final AsyncResponse ar) {
        Runnable r = () -> {...};

        try {
            ExecutorService executor = getExecutor();
            executor.submit(r);
        } catch (NamingException e) {
            r.run();
        }
    }
    ...
}
```

JNDI lookup for managed executor #oldschool

JAX-RS 2.0, CDI, and Concurrency Utilities

- Enable CDI (beans.xml), and have an Executor provided

```
@Path("cdiexecitems")
public class ItemsCDIExecutorResource {
    ...
    @Resource
    ManagedExecutorService executor;

    @GET
    @Produces(MediaType.APPLICATION_JSON)
    public void getItems(@Suspended final AsyncResponse ar) {
        Runnable r = () -> {
            Collection<Item> result = itemService.listItems();
            Response resp = Response.ok(result).build();
            ar.resume(resp);
        };

        executor.submit(r);
    }
}
```

JAX-RS 2.0: Time out!

```
@Path("cdiexecitemsTimeout")
public class ItemsCDIExecutorResourceTimeout {
    ...
    public void getItems(@Suspended final AsyncResponse ar) {

        ar.setTimeout(500, TimeUnit.MILLISECONDS);
        ar.setTimeoutHandler(new TimeoutHandler() {
            public void handleTimeout(AsyncResponse arg0) {
                ar.resume(Response.ok("Backup plan!").build());
            }
        });

        Runnable r = () -> {
            Collection<Item> result = itemService.listItems();
            Response resp = Response.ok(result).build();
            ar.resume(resp);
        };

        executor.submit(r);
    }
}
```

JAX-RS 2.0: Callbacks

- Register callbacks on AsyncResponse:

```
ar.register(new CompletionCallback() {
        @Override
        public void onComplete(Throwable t) {
            System.out.println("DONE! ");
            if ( t != null ) {
                t.printStackTrace();
            }
        }
    });

    ar.register(new ConnectionCallback() {
        @Override
        public void onDisconnect(AsyncResponse ar) {
            System.out.println("Disconnected: " + ar);
        }
    });
```

Support for ConnectionCallback is optional. #YMMV

Concurrency Utilities

- Extension of java.util.concurrent (familiar API)
  - ManagedExecutorService
    `java:comp/DefaultManagedExecutorService`
  - ManagedScheduledExecutorService
    `java:comp/DefaultManagedScheduledExecutorService`
  - ManagedThreadFactory
    `java:comp/DefaultManagedThreadFactory`
  - ContextService
    `java:comp/DefaultContextService`
- Container-friendly mechanisms to queue and manage work
  - Java EE Context propagation
    - JNDI, classloader, security, etc.
  - Allows container to manage async work, too!

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WebSocket APIs

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Server Endpoint: Annotated

- Simple POJO with `@ServerEndpoint` annotation
- Annotations for notifications: lifecycle and messages

```
@ServerEndpoint(value = "/SimpleAnnotated")
public class SimpleEndpoint {

    @OnOpen
    public void onOpen(Session session, EndpointConfig ec) {
    }

    @OnClose
    public void onClose(Session session, CloseReason reason) {
    }

    @OnMessage
    public void receiveMessage(String message, Session session) {
    }

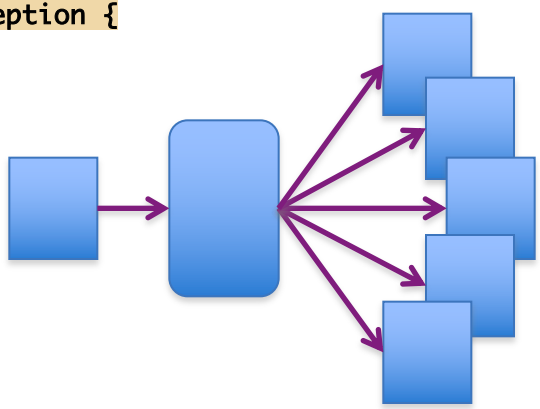
    @OnError
    public void onError(Throwable t) {
    }
}
```

Simple echo + server provided data (using annotations)

- `@OnMessage` method is called when a message is received
  - If message is ‘stop’: close the session
  - Otherwise, echo the message along with a hit count

```
int count = 0;

@OnMessage
public void receiveMessage(String message, Session session) throws IOException {
    if ( "stop".equals(message) ) {
        session.close();
    } else {
        int id = count++;
        for (Session s : session.getOpenSessions() ) {
            s.getBasicRemote().sendText("Echo " + id + ":  " + message);
        }
    }
}
```



- Broadcast – iterate over open sessions

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Non-blocking I/O

Servlet 3.1

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Non-blocking I/O in Servlet 3.1

- Builds on Asynchronous processing from Servlet 3.0
  - Only works for async-enabled apps
- Enables reading/writing data without blocking a thread
  - ReadListener on ServletInputStream
  - WriteListener on ServletOutputStream
- Best used with slow clients
  - For clients that are slow to read data, use a WriteListener
  - For clients that are slow to write data, use a ReadListener

Code Samples – Aync Servlet Listener

```
// start async
AsyncContext ac = request.startAsync();

// set up async listener
ac.addListener(new AsyncListener() {
    @Override
    public void onComplete(AsyncEvent event) throws IOException {
        System.out.println("AsyncServlet onComplete() called");
    }

    @Override
    public void onError(AsyncEvent event) {
        System.out.println("AsyncServlet onError() " + event.getThrowable());
    }

    @Override
    public void onStartAsync(AsyncEvent event) {
        System.out.println("AsyncServlet onStartAsync()");
    }

    @Override
    public void onTimeout(AsyncEvent event) {
        System.out.println("AsyncServlet onTimeout()");
    }
}, request, response);
```

Code Samples – Non-Blocking I/O: Input

```
final ServletInputStream is = request.getInputStream();

// Start NIO Mode!! May only be called once…
// Can not use regular servlet input stream read/write after this
is.setReadListener(new AsyncReadListener(...));


public class AsyncReadListener implements ReadListener {
    ...
    @Override
    public void onDataAvailable() throws IOException {
        System.out.println("AsyncReadListener: data available ");
    }

    @Override
    public void onAllDataRead() throws IOException {
        System.out.println("AsyncReadListener: All data read.. ");
    }

    @Override
    public void onError(Throwable t) {
        System.out.println("AsyncReadListener onError() " + t);
        t.printStackTrace();
        ac.complete();
    }
}
```

Code Samples – Non-Blocking I/O: Output

```
final ServletOutputStream os = response.getOutputStream();

// Start NIO Mode!! May only be called once…
// Can not use regular servlet input stream read/write after this
os.setWriteListener(new AsyncWriteListener(...));

public class AsyncWriteListener implements WriteListener {

    @Override
    public void onWritePossible() throws IOException {
        System.out.println("AsyncWriteListener: onWritePossible.. ");

        // At some point, you know you're all done..
        ac.complete();
    }

    @Override
    public void onError(Throwable t) {
        System.out.println("AsyncWriteListener onError() " + t);
        t.printStackTrace();
        ac.complete();
    }
}
```

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RxJava + EE7

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Reactive Programming

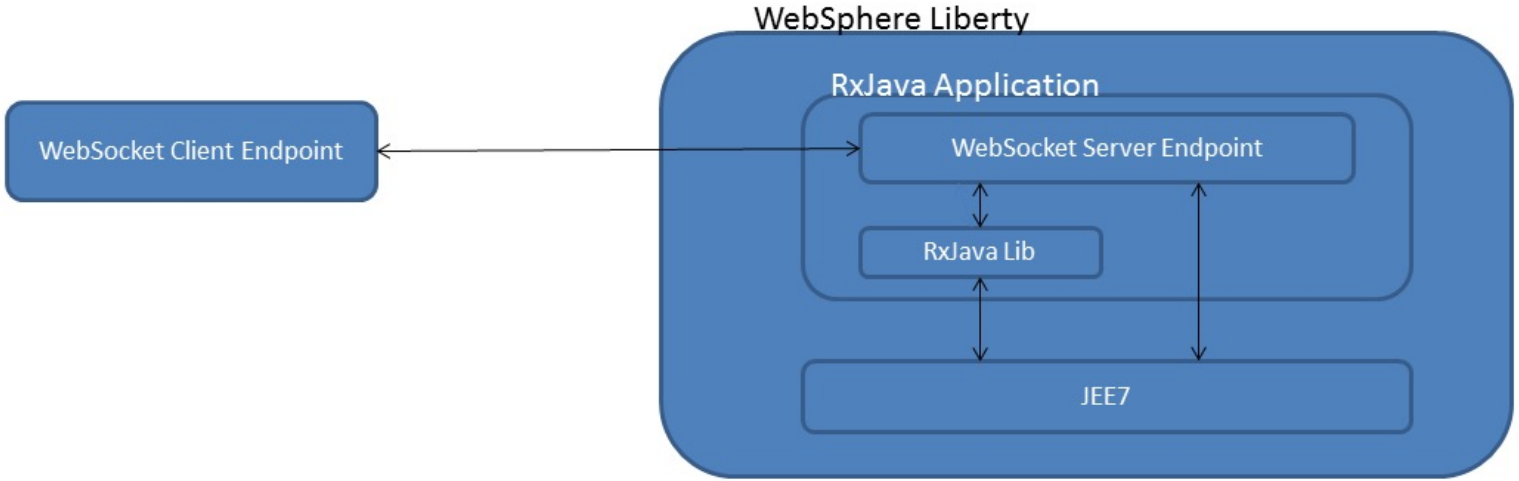
- Reactive programming focuses on data flows and propagation of change.
- Java 8 has introduced lambdas and a new *java.util.stream* package, which help reactive programmers get started.
- For highly concurrent stream processing and more advanced scenarios, ReactiveX is the library of choice.
- RxJava is the Java implementation of ReactiveX.

RxJava and JEE7

- RxJava and EE7 go hand-in-hand:
  - Inject (CDI) and ExecutorServices from Concurrency Utilities into your app
  - Encapsulate these concurrent artifacts with a RxJava Scheduler
  - Use Websockets to provide real-time updates as observables are completed

RxJava and Liberty

- Applications deployed in Liberty can include the RxJava library and seamlessly tap into its EE7 framework

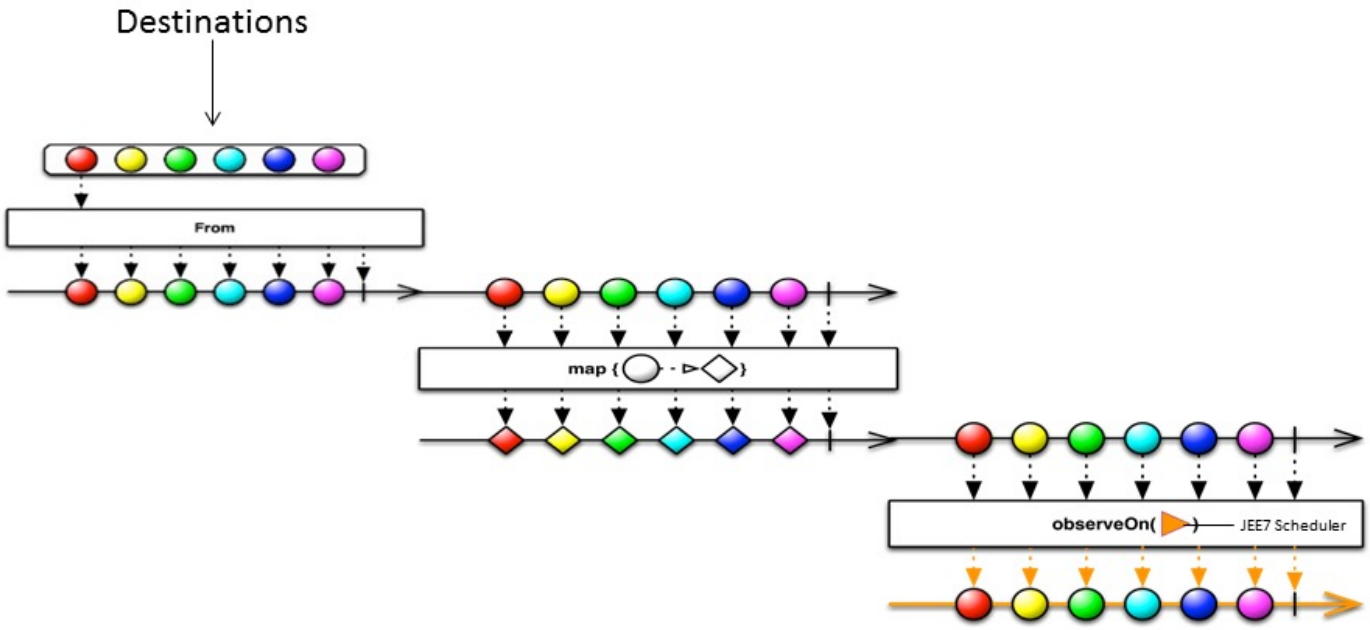


RxJava and Liberty

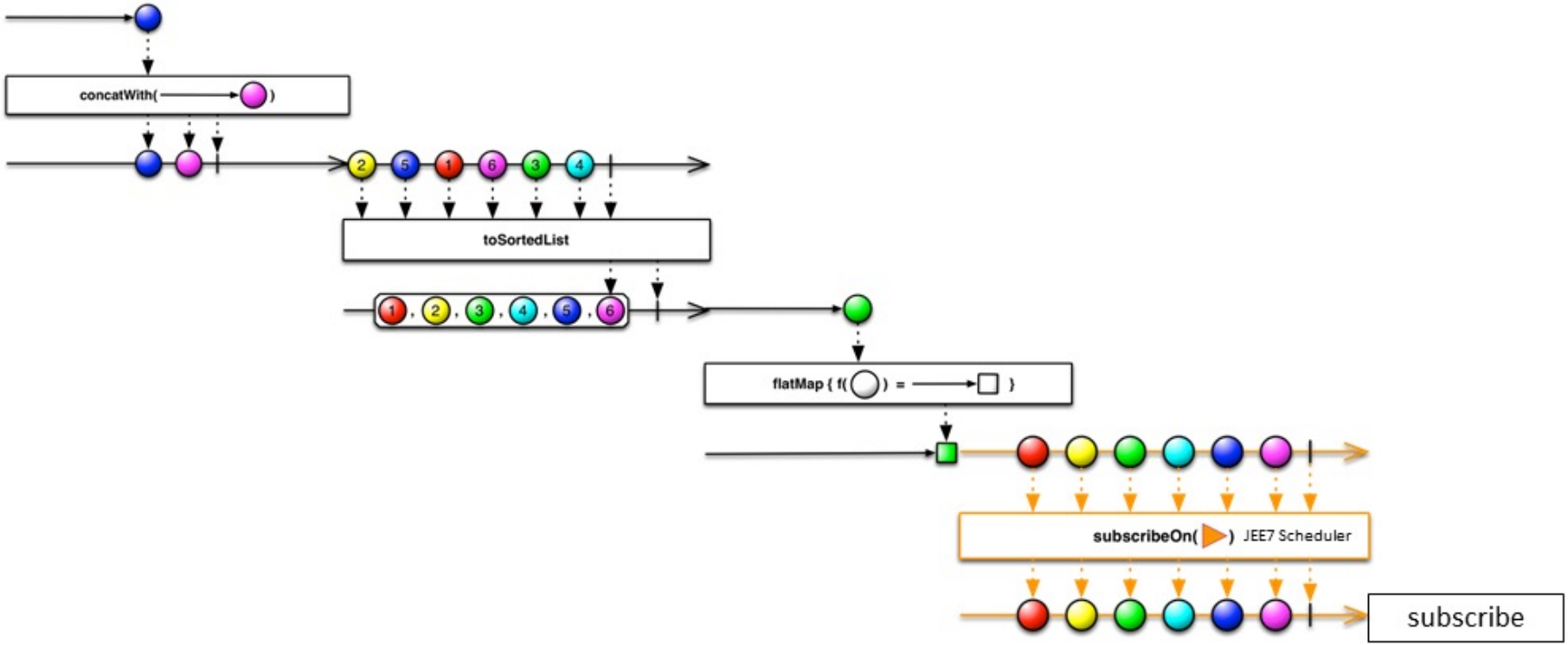
- GitHub sample: https://github.com/WASdev/sample.rxjava

- App provides reviews and weather information about vacation destinations
  - concurrent-1.0
  - websocket-1.1
  - cdi-1.2

RxJava and Liberty



RxJava and Liberty



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