

Developing JAX-RS Web Application Utilizing SSE and WebSocket

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Agenda

- About This Lab
- Intro to the Used Technologies
- Lab Exercises
- Getting Started
- Resources
- Hands on ...

Bootstrapping The Lab

- Get the...
 - HOL content
 - <https://github.com/jersey/hol-sse-websocket>
 - Maven 3.0.4
 - GlassFish 4.0-b84
 - JDK 7u21
 - NetBeans 7.3

Once Bootstrapped...

- DO
 - Follow the lab guide – exercises are self-paced
 - Raise your hand if you get stuck – we are here to help
 - try to understand the code
- DON'T
 - just blindly copy-paste

Technologies Used...

- Jersey / JAX-RS 2.0
 - Server-sent events
- Tyrus / Java API for WebSocket
- JSON Processing

JAX-RS / Jersey



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JAX-RS

- Java API for RESTful Web Services
 - Annotation-based API for exposing RESTful web services
 - Maps HTTP requests to Java method invocations
 - Part of Java EE
- New in JAX-RS 2.0
 - Client API
 - Filters & Interceptors
 - Asynchronous processing
 - Server-side content negotiation, ...

JAX-RS Resources

```
public class OrderResource {  
  
    public List<Order> getOrders() { ... }  
  
    public Order getOrder(String orderId,  
                           String from) { ... }  
  
    public CustomerResource customer(...) { ... }  
  
    ...  
}
```

JAX-RS Resources

```
@Path("orders")
@Produces("application/xml")
@Consumes("application/xml")
public class OrderResource {
    @GET
    public List<Order> getOrders() { ... }

    @GET
    @Path("{id}")
    public Order getOrder(@PathParam("id") String orderId,
        @HeaderParam("From") @Default("unknown") String from) { ... }

    @Path("{id}/customer")
    public CustomerResource customer(...) { ... }

    ...
}
```

More in JAX-RS 1.x

- Injectable information
 - Request, HttpHeaders, UriInfo, ...
- Advanced HTTP response construction
 - Response, ResponseBuilder
- Message content handlers (a.k.a entity providers)
 - MessageBodyReader & MessageBodyWriter
- Error handlers
 - ExceptionMapper
- Other APIs aiding HTTP request/response processing

JAX-RS 2.0 Client API

- Accessing HTTP-based (RESTful) services from Java
- Low-level, fluent API
- Synchronous & Asynchronous (Future & callback) programming models
- Re-using server-side components and concepts
 - Response
 - Message content handlers
 - Reader/Writer Interceptors
 - Filters (conceptually)

Main Client API Components

- ClientFactory
 - Bootstrapping (analogy of RuntimeDeleate)
- Client
 - Main API entry point
 - Connection management, configurable
- Web Target
 - URI, URI template abstraction (“glorified URI”)
 - Configurable

JAX-RS 2.0 Client API

```
Client client = ClientFactory.newClient();

WebTarget ordersTarget = client.target("http://example.com/eshop/orders");

WebTarget orderTarget = ordersTarget.path("{id}");

Order order = orderTarget.resolveTemplate("id", "1234")
    .request("application/xml")
    .get(Order.class);
```

```
Order newOrder = new Order (...);
Response response = ordersTarget.request("text/plain")
                                .post(Entity.xml(newOrder));

if (response.getStatus() == 200) {
    String orderId = response.readEntity(String.class);
    Link paymentLink = response.getLink("payment");

    client.target(paymentLink).request()...
}
```

Server-Sent Events

: an example of a SSE event

id: 1

event: text-message

data: Hello, this is a

data: multi-line message.

<blank line>

Server-sent Events in Jersey

- Server side
 - OutboundEvent
 - EventOutput
 - SseBroadcaster
- Client side
 - InboundEvent
 - EventSource
 - EventListener

SSE Server-side

```
@Path("message/stream")
public class MessageStreamResource {
    private static SseBroadcaster broadcaster = new SseBroadcaster();

    @GET
    @Produces(SseFeature.SERVER_SENT_EVENTS)
    public EventOutput getMessageStream() {
        final EventOutput eventOutput = new EventOutput();
        broadcaster.add(eventOutput);
        return eventOutput;
    }
    ...
}
```

SSE Server-side

```
...

private static AtomicLong nextMessageId = new AtomicLong(0);

@PUT
@Consumes(MediaType.APPLICATION_JSON)
public void putMessage(Message message) {
    OutboundEvent event = new OutboundEvent.Builder()
        .id(String.valueOf(nextMessageId.getAndIncrement()))
        .mediaType(MediaType.APPLICATION_JSON_TYPE)
        .data(Message.class, message)
        .build();

    broadcaster.broadcast(event);
}
}
```

SSE Client-side

```
EventSource events = new EventSource(target.path("message/stream")) {  
    @Override  
    public void onEvent(InboundEvent event) {  
        String name = event.getName();  
        Message message = event.getData(Message.class);  
        display(name, message);  
    }  
};  
  
...  
  
events.close();
```

JAX-RS / Jersey

- More at Devovx
 - The Present and the Future of JAX-RS and Jersey (Thu 16:40, Room 8)
 - JAX-RS 2.0 Status & Directions (Thu 19:00, BOF 2)
- On the Web
 - Specification project: <http://jax-rs-spec.java.net>
 - Implementation project: <http://jersey.java.net>
 - Twitter: @gf_jersey

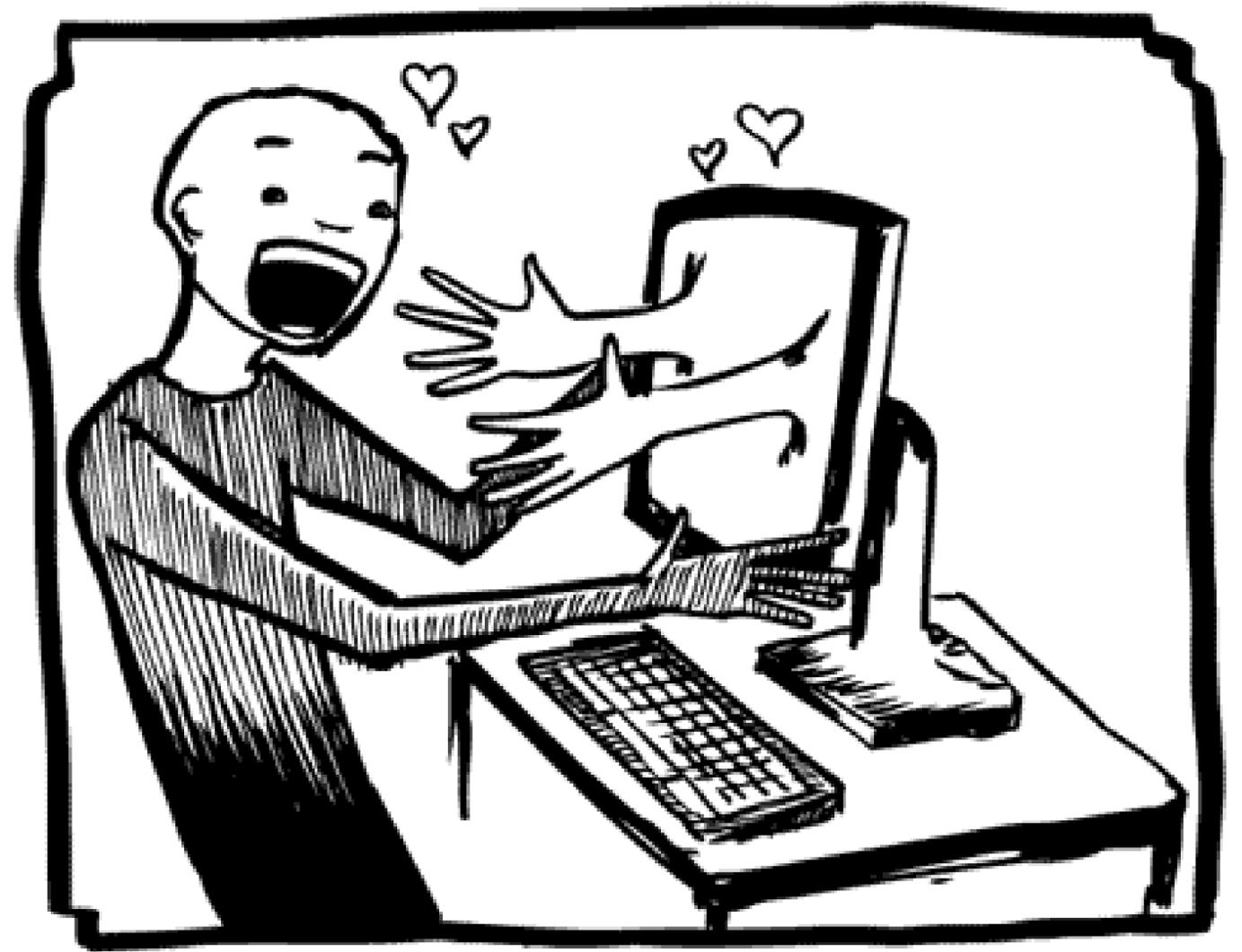
WebSocket / Tyrus



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Interactive Web Sites

- Chat, Streaming quotes, games, ...
- HTTP is request/response
- Forcing persistence on HTTP
 - Just to know server has data
 - Long Polling, Streaming, Comet/Ajax ..
- Complex, Inefficient, Wasteful



WebSocket to the Rescue



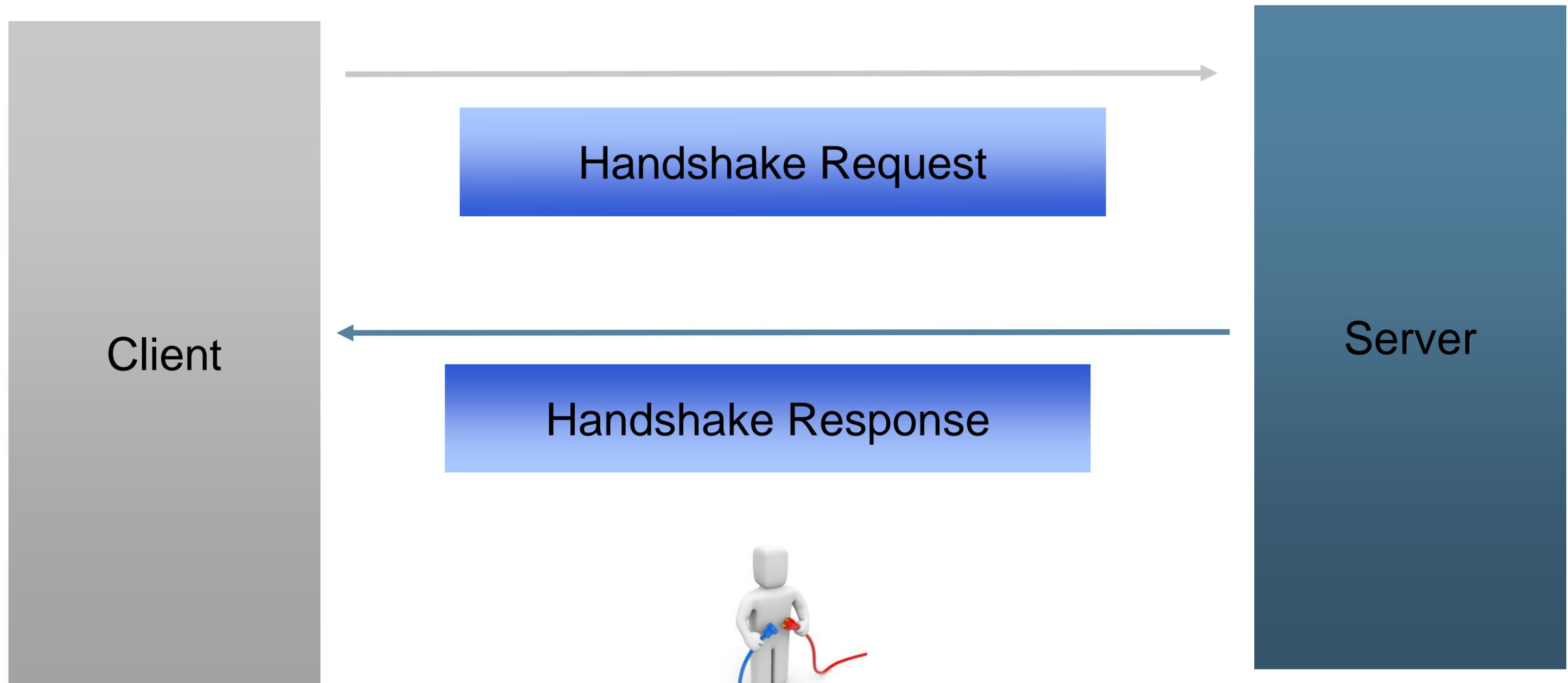
- TCP based, bi-directional, full-duplex messaging
- Originally proposed as part of HTML5
- IETF-defined **Protocol**: RFC 6455
 - Handshake
 - Data Transfer
- W3C defined **JavaScript API**
 - Candidate Recommendation



What's the basic idea ?

- Establish a connection (Single TCP connection)
- Send messages in both directions (Bi-directional)
- Send message independent of each other (Full Duplex)
- End the connection

Establish a connection



Handshake Request



GET /chat HTTP/1.1
Host: server.example.com
Upgrade: websocket
Connection: Upgrade
Sec-WebSocket-Key: dGhllHNhbXBsZSBub25jZQ==
Origin: http://example.com
Sec-WebSocket-Protocol: chat, superchat
Sec-WebSocket-Version: 13

Handshake Response



HTTP/1.1 101 Switching Protocols

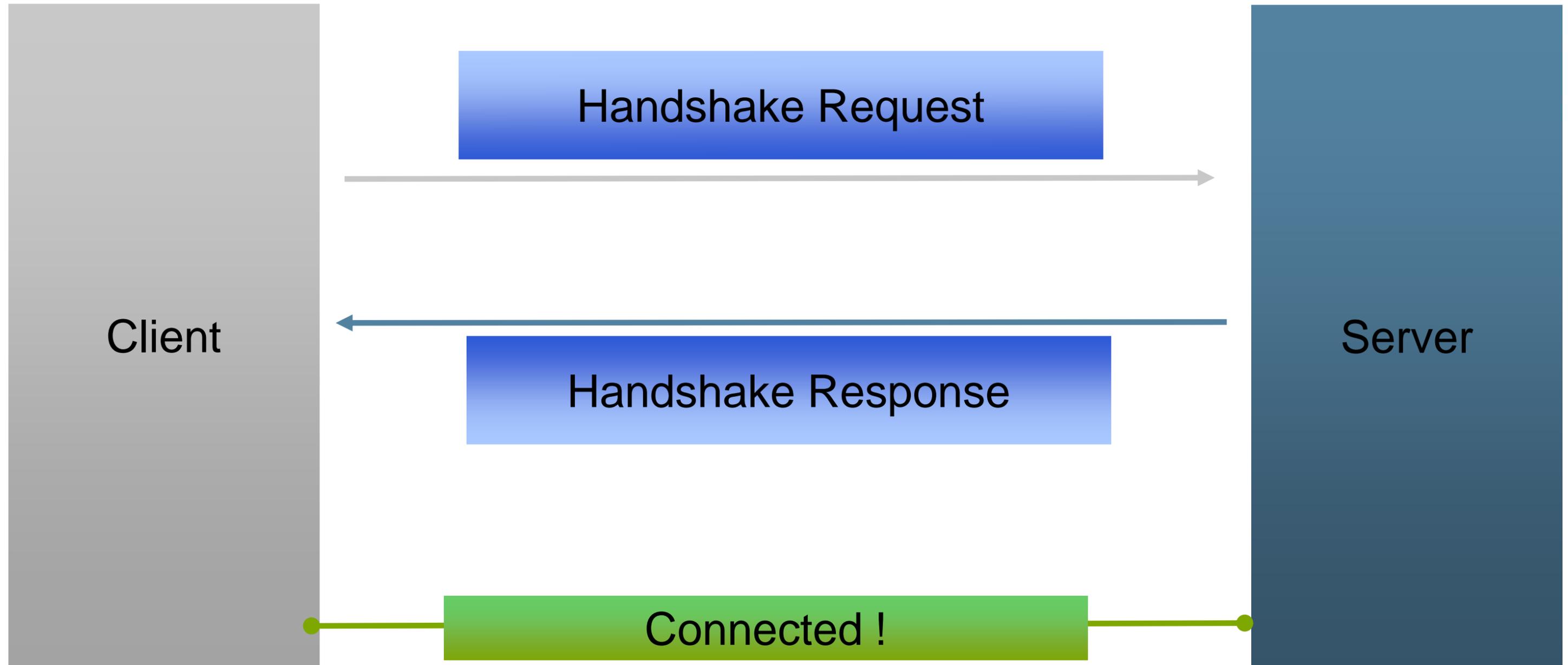
Upgrade: websocket

Connection: Upgrade

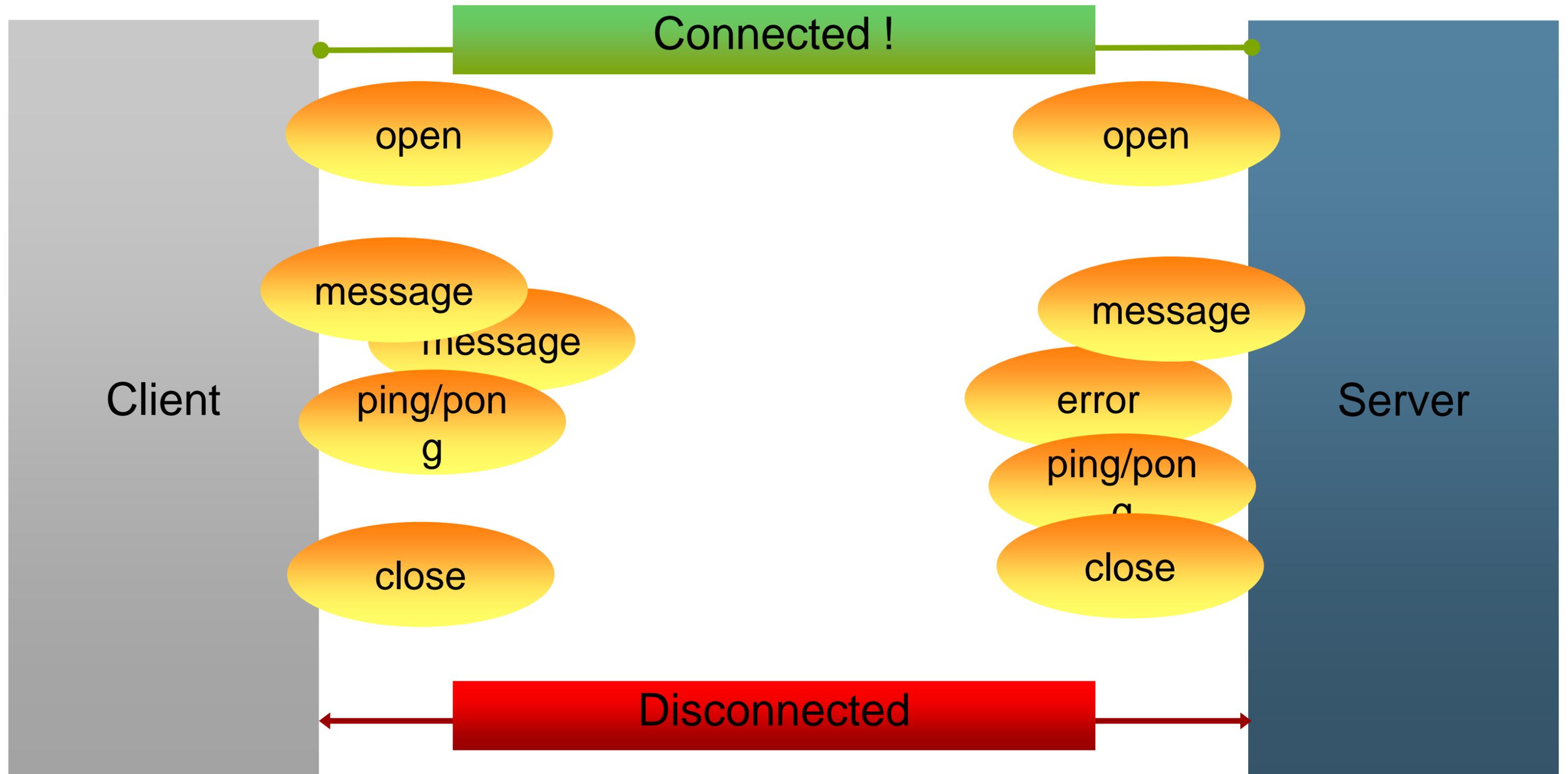
Sec-WebSocket-Accept: s3pPLMBiTxaQ9kYGzzhZRbK+xOo=

Sec-WebSocket-Protocol: chat

Establishing a Connection



WebSocket Lifecycle



WebSocket wire messages



- Capture traffic on loopback

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
11	9.489449000	:::1	:::1	HTTP	648	GET /HelloWebSocket/ HTTP/1.1
13	9.491601000	:::1	:::1	HTTP	2134	HTTP/1.1 200 OK (text/html)
18	9.669322000	:::1	:::1	HTTP	501	GET /HelloWebSocket/echo HTTP/1.1
20	9.669489000	:::1	:::1	HTTP	543	GET /favicon.ico HTTP/1.1
22	9.670298000	:::1	:::1	HTTP	205	HTTP/1.1 101 Switching Protocols
24	9.671010000	:::1	:::1	HTTP	1624	HTTP/1.1 404 Not Found (text/html)
26	12.411987000	:::1	:::1	WebSocket	98	WebSocket Text [FIN] [MASKED]
28	12.413161000	:::1	:::1	WebSocket	108	WebSocket Text [FIN]
30	13.011122000	:::1	:::1	WebSocket	98	WebSocket Text [FIN] [MASKED]
32	13.013172000	:::1	:::1	WebSocket	108	WebSocket Text [FIN]

WebSocket Protocol Summary

- Starts with HTTP handshake
- Data transfer
 - Text/Binary frames
 - Ping/Pong control frames for keep-alive
 - Data frames don't have HTTP overhead
 - No headers/cookies/security/metadata
 - Close frame
- Full duplex and bi-directional

The Web Sockets API



- Web Sockets API defines WebSocket javascript interface
- Event handlers for `onopen()`, `onmessage()`, `onclose()`, `onerror()`
- Send a String, Blob, ArrayBuffer using `send()`
- Supports sub protocols

JSR 356 Specification

- Standard Java API for creating WebSocket Applications
- Transparent Expert Group
 - jcp.org/en/jsr/detail?id=356
 - java.net/projects/websocket-spec
- Now: Early Draft Review
- December: Public Draft Review
- Will be in Java EE 7

JSR 356: Reference Implementation

- Tyrus: java.net/projects/tyrus
- Originated from WebSocket SDK
 - java.net/projects/websocket-sdk
- Works in stand alone, Java EE deployments
- Integrated in GlassFish 4 Builds

API Features

- Create WebSocket Client- and Server Endpoints
 - Annotation-driven (@ServerEndpoint, @ClientEndpoint)
 - Interface-driven (Endpoint)
- Integration with Java EE Web container
 - CDI, Security, HttpSession etc.

Hello World

```
import javax.net.websocket.annotations.*;  
  
@ServerEndpoint("/hello")  
public class HelloBean {  
  
    @OnMessage  
    public void hello(String str) {  
        // Receiving a "Hello World"  
    }  
}
```

Hello World

```
@ServerEndpoint("/hello")
public class HelloBean {

    @OnMessage
    public String hello(String str) {
        // Echoing "Hello World"
        return str;
    }
}
```

Custom Objects

```
@ServerEndpoint(  
    value      = "/hello",  
    encoders  = {ServerHello.class},  
    decoders  = {ClientHello.class})  
public class HelloBean {  
    @OnMessage  
    public ServerHello hello(ClientHello str) {  
        ...  
    }  
}
```

Lifecycle Events

```
@ServerEndpoint("/chat")
public class ChatBean {

    @OnOpen
    public void xxx(Session peer) {
    }

    @OnClose
    public void yyy(Session peer) {
    }

    @OnError
    public void zzz(Session peer) {
    }
}
```

Custom Decoders

- Binary(ByteBuffer/InputStream), Text (String/Reader) messages

```
public class X implements Decoder.TextStream<JsonObject> {  
  
    public JsonObject decode(Reader io) {  
        return new JsonReader(io).readObject();  
    }  
  
    public boolean willDecode(String string) {  
        return true; // Only if can process the payload  
    }  
  
}
```

Custom Encoders

- Binary(ByteBuffer/OutputStream), Text (String/Writer) messages

```
public class X implements Encoder.TextStream<JsonObject> {  
    public void encode(JsonObject obj, Writer io) {  
        new JsonWriter(io).write(obj);  
    }  
}
```

Tyrus / WebSocket

- More at Devox
 - JSR 356 : Java API for WebSocket (Fri 10:45 am, Room 5)
- On The Web
 - Specification Project: <http://websocket-spec.java.net>
 - Implementation: <http://tyrus.java.net>

JSON Processing API



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Standard JSON API

- Parsing/Processing JSON
- Data binding : JSON text <-> Java Objects
- Two JSRs (similar to JAXP and JAXB)
 - Processing/Parsing – Java EE 7
 - Binding – Java EE 8

Java API for Processing JSON

- Streaming API to produce/consume JSON
 - Similar to StAX API in XML world
- Object model API to represent JSON
 - Similar to DOM API in XML world
- Aligns with Java EE 7 schedules
 - PR in Dec
- EG (Oracle, RedHat, Twitter, 3 individual members)
 - Also, user community !

JSR-353: Java API for Processing JSON

- JsonReader – reads JsonObject/JsonArray from i/o

```
try (JsonReader reader = new JsonReader(io)) {  
    JsonObject jsonObj = reader.readObject();  
}
```

- JsonWriter – writes JsonObject/JsonArray to i/o

```
try (JsonWriter writer = new JsonWriter(io)) {  
    writer.writeObject(jsonObj);  
}
```

JSR-353: Java API for Processing JSON

- JsonBuilder – builds JSON object/array from scratch

```
JSONArray arr = new JsonBuilder()

    .beginArray()
        .beginObject()
            .add("type", "home")
            .add("number", "212 555-1234")
        .endObject()
        .beginObject()
            .add("type", "fax")
            .add("number", "646 555-4567")
        .endObject()
    .endArray()

.build();
```

```
[
    {
        "type": "home",
        "number": "212 555-1234"
    },
    {
        "type": "fax",
        "number": "646 555-4567"
    }
]
```

JSON Processing

- More at Devvxx
 - JSR 353: Java API for JSON Processing (Thu, 3:10 pm, Room 8)
- Projects
 - Specification Project - <http://json-processing-spec.java.net>
 - RI Project - <http://jsonp.java.net>
- Latest Javadoc
 - <http://json-processing-spec.java.net/nonav/releases/1.0/edr/javadocs/index.html>

Lab Overview

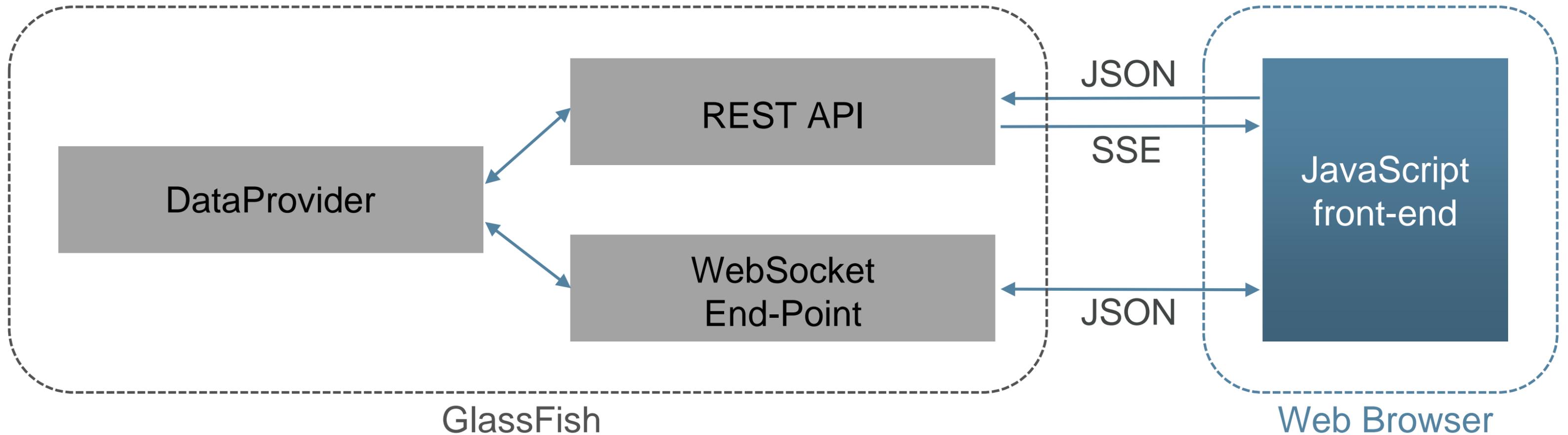


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Lab Exercises

- Drawing Board web application:
 - Exercise 1: Exposing RESTful API
 - Exercise 2: Adding Server-Sent Events
 - Exercise 3: Adding Web Sockets
- Simple Drawing Board client:
 - Exercise 4: Implementing a Simple Java SSE Client
- JavaFX Drawing Board client:
 - Exercise 5: Implementing a hybrid JavaFX Drawing Board Client

Drawing Board Application



Getting Started

- Get the HOL content from github:
 - <https://github.com/jersey/hol-sse-websocket>
- Open lab-guide.pdf
- Follow the instructions
 - If you get stuck, raise your hand

Additional Resources

- Follow [@gf_jersey](#) on Twitter
- Jersey – <http://jersey.java.net>
 - Mailing list: users@jersey.java.net
 - Fork Jersey on GitHub: <http://github.com/jersey>
- Tyrus – <http://tyrus.java.net>
- JSON Processing – <http://jsonp.java.net>