Architecture of Enterprise Applications 5
WebSocket

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Contents and Objectives

- Contents
  - Introduction to WebSocket
  - WebSocket Programming Model
  - WebSocket Samples

- Objectives
  - 能够根据系统需求，分析前后端之间适用于异步通信机制的业务场景，并设计并实现基于 WebSocket 的实现方案

WebSocket

- WebSocket is an application protocol that provides full-duplex communications between two peers over the TCP protocol.
  - In the traditional request-response model used in HTTP, the client requests resources and the server provides responses.
  - The exchange is always initiated by the client; the server cannot send any data without the client requesting it first.
  - The WebSocket protocol provides a full-duplex communication channel between the client and the server.
  - Combined with other client technologies, such as JavaScript and HTML5, WebSocket enables web applications to deliver a richer user experience.

Introduction to WebSocket

- In a WebSocket application, the server publishes a WebSocket endpoint and the client uses the endpoint's URI to connect to the server.
  - The WebSocket protocol is symmetrical after the connection has been established:
    - The client and the server can send messages to each other at any time while the connection is open, and they can close the connection at any time.
    - Clients usually connect only to one server, and servers accept connections from multiple clients.

- The WebSocket protocol has two parts:
  - handshake and data transfer.

Introduction to WebSocket

- The client initiates the handshake by sending a request to a WebSocket endpoint using its URI.
  - The handshake is compatible with existing HTTP-based infrastructure:
    - web servers interpret it as an HTTP connection upgrade request.
  - An example handshake from a client looks like this:

```
GET /path/to/websocket/endpoint HTTP/1.1
Host: localhost
Upgrade: websocket
Connection: Upgrade
Sec-WebSocket-Key: xqBt3ImNzJbYqRINxEFlkg==
Origin: http://localhost
Sec-WebSocket-Version: 13
```

Introduction to WebSocket

- The client initiates the handshake by sending a request to a WebSocket endpoint using its URI.
  - The handshake is compatible with existing HTTP-based infrastructure:
    - web servers interpret it as an HTTP connection upgrade request.
  - An example handshake from the server in response to the client looks like this:

```
HTTP/1.1 101 Switching Protocols
Upgrade: websocket
Connection: Upgrade
Sec-WebSocket-Accept: K7DJLdLooIwIG/MOpvWFB3y3FE8=
```

- The server applies a known operation to
  - the value of the `Sec-WebSocket-Key` header to generate the value of the `Sec-WebSocket-Accept` header.
- The client applies the same operation to
  - the value of the `Sec-WebSocket-Key` header, and the connection is established successfully if the result matches the value received from the server.
- The client and the server can send messages to each other after a successful handshake.

- WebSocket endpoints are represented by URIs that have the following form:
  - `ws://host:port/path?query`
  - `wss://host:port/path?query`

  - The `ws` scheme represents an unencrypted WebSocket connection, and
  - the `wss` scheme represents an encrypted connection.
  - The `port` component is optional;
    - the default port number is 80 for unencrypted connections and
    - 443 for encrypted connections.
  - The `path` component indicates the location of an endpoint within a server.
  - The `query` component is optional.

Creating WebSocket Applications

- The Java API for WebSocket consists of the following packages:
  - The `javax.websocket.server` package contains annotations, classes, and interfaces to create and configure server endpoints.
  - The `javax.websocket` package contains annotations, classes, interfaces, and exceptions that are common to client and server endpoints.

- WebSocket endpoints are instances of the `javax.websocket.Endpoint` class.
  - The Java API for WebSocket enables you to create two kinds of endpoints: programmatic endpoints and annotated endpoints.
    - To create a programmatic endpoint, you extend the Endpoint class and override its lifecycle methods.
    - To create an annotated endpoint, you decorate a Java class and some of its methods with the annotations provided by the packages above.
  - After you have created an endpoint, you deploy it to an specific URI in the application so remote clients can connect to it.

Creating and Deploying a WebSocket Endpoint

- The process for creating and deploying a WebSocket endpoint:
  1. Create an endpoint class.
  2. Implement the lifecycle methods of the endpoint.
  3. Add your business logic to the endpoint.
  4. Deploy the endpoint inside a web application.

- The process is slightly different for programmatic endpoints and annotated endpoints

Programmatic Endpoints

- EchoEndpoint

```
public class EchoEndpoint extends Endpoint {
 @Override
 public void onOpen(final Session session, EndpointConfig config)
 {
    session.addMessageHandler(
      new MessageHandler.Whole<String>() {
        @Override
        public void onMessage(String msg) {
          try {
            session.getBasicRemote().sendText(msg);
          } catch (IOException e) { ... }
        }
      });
 }
}
```

Programmatic Endpoints

- To deploy this programmatic endpoint, use the following code in your Java EE application:

```
ServerEndpointConfig.Builder.create(EchoEndpoint.class, "/echo").build();
```

- When you deploy your application, the endpoint is available at `ws://<host>:<port>/<application>/echo`;
  - for example, `ws://localhost:8080/echoapp/echo`.

Annotated Endpoints

- EchoEndpoint

```
@ServerEndpoint("/echo")
public class EchoEndpoint {
 @OnMessage
 public void onMessage(Session session, String msg) {
   try {
     session.getBasicRemote().sendText(msg);
   } catch (IOException e) { ... }
 }
}
```

Annotated Endpoints

Annotation	Event	Example
OnOpen	Connection opened.	@OnOpen public void open(Session session, EndpointConfig conf) { }
OnMessage	Message received.	@OnMessage public void message (Session session, String msg) { }
OnError	Connection error.	@OnError public void error(Session session, Throwable error) { }
OnClose	Connection closed.	@OnClose public void close(Session session, CloseReason reason) { }

Sending Messages to All Peers Connected to an Endpoint

- Send messages

```
@ServerEndpoint("/echoall")
public class EchoAllEndpoint {
  @OnMessage
  public void onMessage(Session session, String msg)
  {
    try {
      for (Session sess : session.getOpenSessions()) {
         if (sess.isOpen())
           sess.getBasicRemote().sendText(msg);
      }
    } catch (IOException e) { ... }
  }
}
```

Receiving Messages

- Receive messages

```
@ServerEndpoint("/receive")
public class ReceiveEndpoint {
 @OnMessage
 public void textMessage(Session session, String msg)
 { System.out.println("Text message: " + msg); }

 @OnMessage
 public void binaryMessage(Session session, ByteBuffer msg)
 { System.out.println("Binary message: " + msg.toString()); }

 @OnMessage
 public void pongMessage(Session session, PongMessage msg)
 {
    System.out.println("Pong message: " +
              msg.getApplicationData().toString());
 }
}
```

An example

- ETFEndPoint.java

```
@ServerEndpoint("/dukeetf")
public class ETFEndpoint {
    private static final Logger logger =
                         Logger.getLogger("ETFEndpoint");
    static Queue<Session> queue = new ConcurrentLinkedQueue<>();

    public static void send(double price, int volume) {
        String msg = String.format("%.2f, %d", price, volume);
        try {
            for (Session session : queue) {
                session.getBasicRemote().sendText(msg);
                logger.log(Level.INFO, "Sent: {0}", msg);
            }
        } catch (IOException e) {
            logger.log(Level.INFO, e.toString());
        }
    }
```

An example

- ETFEndPoint.java

```
    @OnOpen
    public void openConnection(Session session) {
        queue.add(session);
        logger.log(Level.INFO, "Connection opened.");
    }
    @OnClose
    public void closedConnection(Session session) {
        queue.remove(session);
        logger.log(Level.INFO, "Connection closed.");
    }
    @OnError
    public void error(Session session, Throwable t) {
        queue.remove(session);
        logger.log(Level.INFO, t.toString());
        logger.log(Level.INFO, "Connection error.");
    }
}
```

An example

- ETFListener.java

```
@WebListener
public class ETFListener implements ServletContextListener {
   private Timer timer = null;

   public void contextInitialized(ServletContextEvent event) {
   timer = new Timer(true);
   event.getServletContext().log("The Timer is started");
   timer.schedule(new ReportBean(event.getServletContext()), 0, 1000);
   event.getServletContext().log("The task is added");
   }

}
```

An example

- ReportBean.java

```
public class ReportBean extends TimerTask {

  private ServletContext context = null;
  private Random random = new Random();
  private double price = 100.0;
  private int volume = 300000;

 public ReportBean(ServletContext context)
 { this.context = context; }

 public void run() {
  context.log("Task started");
  price += 1.0*(random.nextInt(100)-50)/100.0;
  volume += random.nextInt(5000) - 2500;
  ETFEndpoint.send(price, volume);
  context.log("Task ended");
 }
}
```

An example

- Index.html

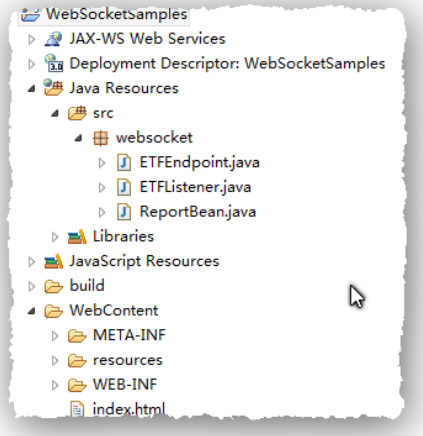
```
<html>
<head>
  <title>Duke's WebSocket ETF</title>
  <script type="text/javascript">
      var wsocket;
      function connect() {
          wsocket = new WebSocket
                   ("ws://localhost:8080/WebSocketSamples/dukeetf");
          wsocket.onmessage = onMessage;
      }
      function onMessage(evt) {
          var arraypv = evt.data.split(",");
          document.getElementById("price").innerHTML = arraypv[0];
          document.getElementById("volume").innerHTML = arraypv[1];
      }
      window.addEventListener("load", connect, false);
  </script>
</head>
```

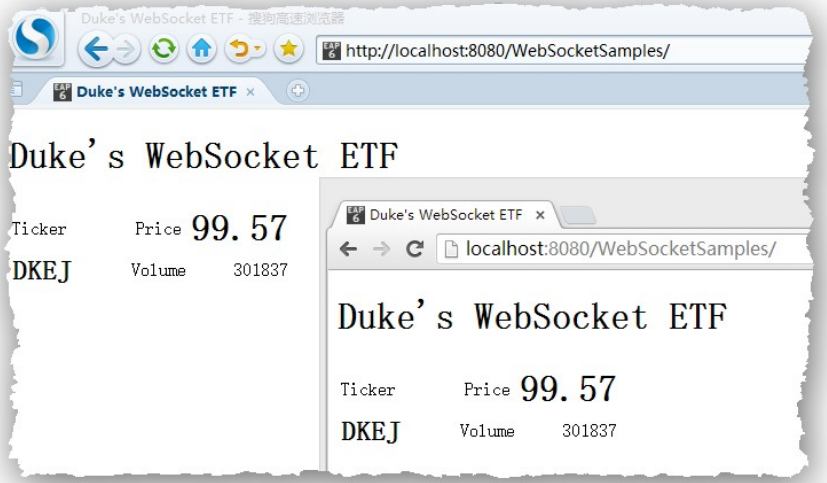
An example

- Index.html

```
<body>
    <h1>Duke's WebSocket ETF</h1>
    <table>
        <tr>
            <td width="100">Ticker</td>
            <td align="center">Price</td>
            <td id="price"
                style="font-size:24pt;font-weight:bold;">--.--</td>
        </tr>
        <tr>
            <td style="font-size:18pt;font-weight:bold;"
                width="100">DKEJ</td>
            <td align="center">Volume</td>
            <td id="volume" align="right">--</td>
        </tr>
    </table>
</body>
</html>
```

An example


WebSocketSamples
JAX-WS Web Services
Deployment Descriptor: WebSocketSamples
Java Resources
src
websocket
ETFEndpoint.java
ETFListener.java
ReportBean.java
Libraries
JavaScript Resources
build
WebContent
META-INF
resources
WEB-INF
index.html


Duke's WebSocket ETF - 搜狗高速浏览器
http://localhost:8080/WebSocketSamples/
Duke's WebSocket ETF
Duke's WebSocket ETF
Ticker Price 99.57
DKEJ Volume 301837
Duke's WebSocket ETF
localhost:8080/WebSocketSamples/
Duke's WebSocket ETF
Ticker Price 99.57
DKEJ Volume 301837

Using Encoders and Decoders

- The Java API for WebSocket provides
  - support for converting between WebSocket messages and custom Java types using encoders and decoders.
  - An encoder takes a Java object and produces a representation that can be transmitted as a WebSocket message;
    - for example, encoders typically produce JSON, XML, or binary representations.
  - A decoder performs the reverse function: it reads a WebSocket message and creates a Java object.
  - This mechanism simplifies WebSocket applications, because it decouples the business logic from the serialization and deserialization of objects.

Encoders

- Implement one of the following interfaces:
  - `Encoder.Text<T>` for text messages
  - `Encoder.Binary<T>` for binary messages

```
public class MessageATextEncoder implements Encoder.Text<MessageA> {
 @Override
 public void init(EndpointConfig ec) { }

 @Override
 public void destroy() { }

 @Override
 public String encode(MessageA msgA) throws EncodeException {
   // Access msgA's properties and convert to JSON text...
   return msgAJsonString;
 }
}
```

Encoders

- Then, add the encoders parameter to the `ServerEndpoint` annotation as follows:

```
@ServerEndpoint(
    value = "/myendpoint",
    encoders = {
          MessageATextEncoder.class,
          MessageBTextEncoder.class } )
public class EncEndpoint { ... }
```

- Now you can send `MessageA` and `MessageB` objects as `WebSocket` messages using the `sendObject` method as follows:

```
MessageA msgA = new MessageA(...);
MessageB msgB = new MessageB(...);
session.getBasicRemote.sendObject(msgA);
session.getBasicRemote.sendObject(msgB);
```

Decoders

- Implement one of the following interfaces:
  - `Decoder.Text<T>` for text messages
  - `Decoder.Binary<T>` for binary messages

```
public class MessageTextDecoder implements Decoder.Text<Message> {
 @Override
 public void init(EndpointConfig ec) { }
 @Override
 public void destroy() { }
 @Override
 public Message decode(String string) throws DecodeException {
   // Read message...
   if ( /* message is an A message */ ) return new MessageA(...);
   else if ( /* message is a B message */ ) return new MessageB(...);
 }
 @Override
 public boolean willDecode(String string) {
  // Determine if the message can be converted into either a
  // MessageA object or a MessageB object...
  return canDecode;
 }
}
```

Decoders

- Then, add the decoders parameter to the `ServerEndpoint` annotation as follows:

```
@ServerEndpoint(
   value = "/myendpoint",
   encoders = {
         MessageATextEncoder.class,
         MessageBTextEncoder.class }
   decoders = { MessageTextDecoder.class }
)
public class EncEndpoint { ... }
```

- Now define a method in the endpoint class that receives MessageA and MessageB objects as follows:

```
@OnMessage public void message(Session session, Message msg) {
 if (msg instanceof MessageA) {
   // We received a MessageA object...
 else if (msg instanceof MessageB) {
   // We received a MessageB object... }
}
```

Handling Errors

- To designate a method that handles errors in an annotated WebSocket endpoint, decorate it with @OnError:

```
@ServerEndpoint("/testendpoint")
public class TestEndpoint {
 ...
 @OnError
 public void error(Session session, Throwable t)
 {
     t.printStackTrace();
     ...
 }
}
```

Using WebSocket in Spring Application

- pom.xml

```
<dependency>
  <groupId>org.webjars</groupId>
  <artifactId>webjars-locator-core</artifactId>
</dependency>
<dependency>
  <groupId>org.webjars</groupId>
  <artifactId>sockjs-client</artifactId>
  <version>1.0.2</version>
</dependency>
<dependency>
  <groupId>org.webjars</groupId>
  <artifactId>stomp-websocket</artifactId>
  <version>2.3.3</version>
</dependency>
<dependency>
  <groupId>org.webjars</groupId>
  <artifactId>bootstrap</artifactId>
  <version>3.3.7</version>
</dependency>
<dependency>
  <groupId>org.webjars</groupId>
  <artifactId>jquery</artifactId>
  <version>3.1.1-1</version>
</dependency>
```

Using WebSocket in Spring Application

- HelloMessage.java

```
package com.example.messagingstompwebsocket;

public class HelloMessage {

  private String name;

  public HelloMessage() {
  }

  public HelloMessage(String name) {
    this.name = name;
  }

  public String getName() {
    return name;
  }

  public void setName(String name) {
    this.name = name;
  }
}
```

- The service will accept messages that contain a name in a STOMP message whose body is a JSON object.

```
{
   "name": "Fred"
}
```

Using WebSocket in Spring Application

- Greeting.java

```
package com.example.messagingstompwebsocket;

public class Greeting {

  private String content;

  public Greeting() {
  }

  public Greeting(String content) {
    this.content = content;
  }

  public String getContent() {
    return content;
  }

}
```

- Upon receiving the message and extracting the name, the service will process it by creating a greeting and publishing that greeting on a separate queue to which the client is subscribed.

```
{
    "content": "Hello, Fred!"
}
```

Using WebSocket in Spring Application

- GreetingController.java

```
package com.example.messagingstompwebsocket;

import org.springframework.messaging.handler.annotation.MessageMapping;
import org.springframework.messaging.handler.annotation.SendTo;
import org.springframework.stereotype.Controller;
import org.springframework.web.util.HtmlUtils;

@Controller
public class GreetingController {


  @MessageMapping("/hello")
  @SendTo("/topic/greetings")
  public Greeting greeting(HelloMessage message) throws Exception {
    Thread.sleep(1000); // simulated delay
    return new Greeting("Hello, " + HtmlUtils.htmlEscape(message.getName()) + "!");
  }

}
```

- In Spring's approach to working with STOMP messaging, STOMP messages can be routed to @Controller classes.

Using WebSocket in Spring Application

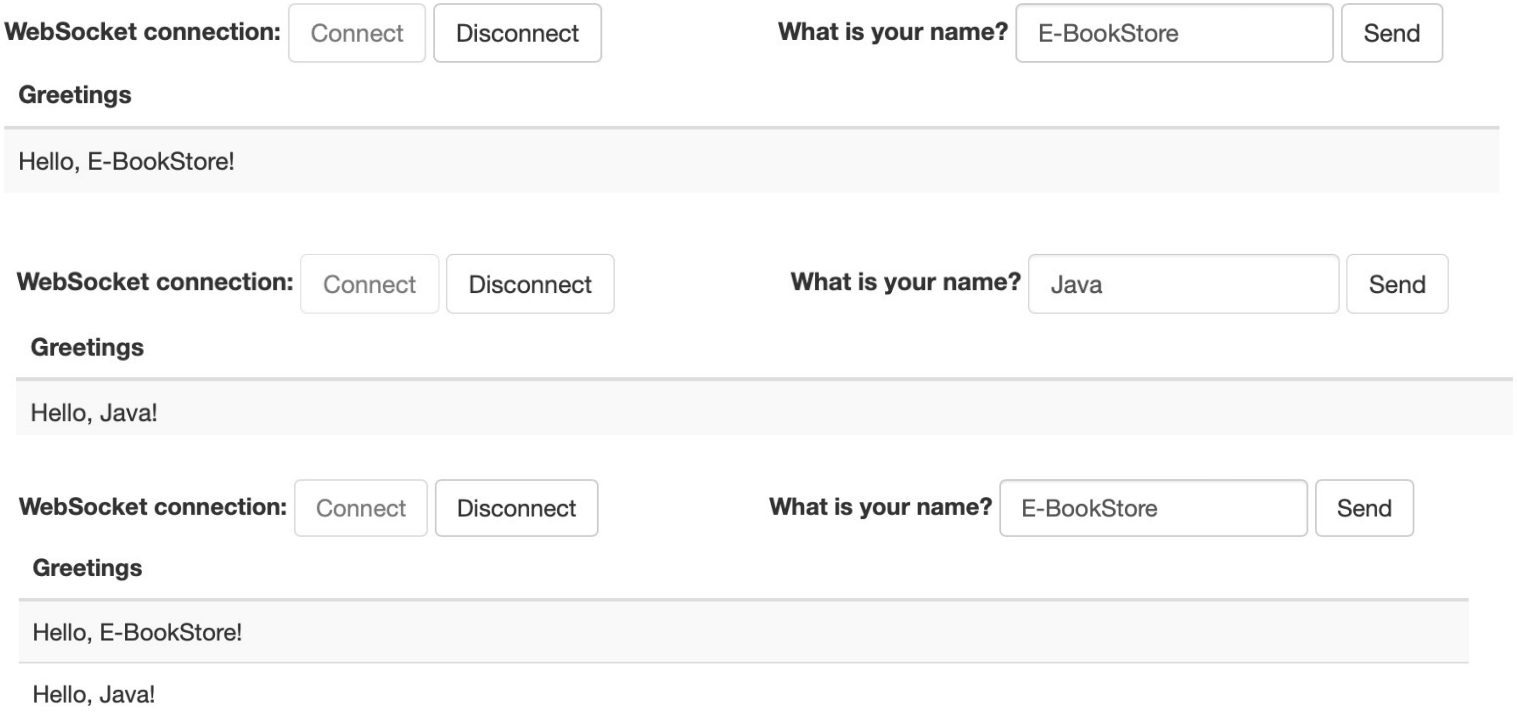
- WebSocketConfig.java

```
package com.example.messagingstompwebsocket;

import org.springframework.context.annotation.Configuration;
import org.springframework.messaging.simp.config.MessageBrokerRegistry;
import org.springframework.web.socket.config.annotation.EnableWebSocketMessageBroker;
import org.springframework.web.socket.config.annotation.StompEndpointRegistry;
import org.springframework.web.socket.config.annotation.WebSocketMessageBrokerConfigurer;

@Configuration
@EnableWebSocketMessageBroker
public class WebSocketConfig implements WebSocketMessageBrokerConfigurer {

  @Override
  public void configureMessageBroker(MessageBrokerRegistry config) {
    config.enableSimpleBroker("/topic");
    config.setApplicationDestinationPrefixes("/app");
  }

  @Override
  public void registerStompEndpoints(StompEndpointRegistry registry) {
    registry.addEndpoint("/gs-guide-websocket").withSockJS();
  }

}
```

- Now that the essential components of the service are created, you can configure Spring to enable WebSocket and STOMP messaging.

Using WebSocket in Spring Application

- index.html



Using WebSocket in Spring Application

- app.js

```
var stompClient = null;

function setConnected(connected) {
    $("#connect").prop("disabled", connected);
    $("#disconnect").prop("disabled", !connected);
    if (connected) {
        $("#conversation").show();
    }
    else {
        $("#conversation").hide();
    }
    $("#greetings").html("");
}

function connect() {
    var socket = new SockJS('/gs-guide-websocket');
    stompClient = Stomp.over(socket);
    stompClient.connect({}, function (frame) {
        setConnected(true);
        console.log('Connected: ' + frame);
        stompClient.subscribe('/topic/greetings', function (greeting) {
            showGreeting(JSON.parse(greeting.body).content);
        });
    });
}

function disconnect() {
    if (stompClient !== null) {
        stompClient.disconnect();
    }
    setConnected(false);
    console.log("Disconnected");
}

function sendName() {
    stompClient.send("/app/hello", {}, JSON.stringify({'name': $
("#name").val()}));
}

function showGreeting(message) {
    $("#greetings").append("<tr><td>" + message + "</td></tr>");
}

$(function () {
    $("form").on('submit', function (e) {
        e.preventDefault();
    });
    $( "#connect" ).click(function() { connect(); });
    $( "#disconnect" ).click(function() { disconnect(); });
    $( "#send" ).click(function() { sendName(); });
});
```

Transfer with WebSocket

- WebSocketConfig.java

```
@Configuration
public class WebSocketConfig {
    @Bean
    public ServerEndpointExporter serverEndpointExporter(){
        return new ServerEndpointExporter();
    }
}
```

Transfer with WebSocket

- WebSocketServer.java

```
@ServerEndpoint("/websocket/transfer/{userId}")
@Component
public class WebSocketServer {
    private static final ConcurrentHashMap<String, Session> SESSIONS
                                = new ConcurrentHashMap<>();

    public void sendMessage(Session toSession, String message) {
        if (toSession != null) {
            try {
                toSession.getBasicRemote().sendText(message);
            } catch (IOException e) {
                e.printStackTrace();
            }
        } else {
            System.out.println(" 对方不在线 ");
        }
    }

    public void sendMessageToUser(String user, String message) {
        System.out.println(user);
        Session toSession = SESSIONS.get(user);
        sendMessage(toSession, message);
        System.out.println(message);
    }

    @OnMessage
    public void onMessage(String message) {
        System.out.println(" 服务器收到消息： " + message);
    }

    @OnOpen
    public void onOpen(Session session, @PathParam("userId") String userId) {
        if (SESSIONS.get(userId) != null) {
            return;
        }
        SESSIONS.put(userId, session);
        System.out.println(userId + " 上线了，当前在线人数： " + COUNT);

    }

    @OnClose
    public void onClose(@PathParam("userId") String userId) {
        SESSIONS.remove(userId);
        System.out.println(userId + " 下线了，当前在线人数： " + COUNT);
    }

    @OnError
    public void onError(Session session, Throwable throwable) {
        System.out.println(" 发生错误 ");
        throwable.printStackTrace();
    }
}
```

Transfer with WebSocket

- BankListener.java

```
public class BankListener {

    @Autowired
    private WebSocketServer ws;

    @KafkaListener(topics = "topic1", groupId = "group_topic_test")
    public void topic1Listener(ConsumerRecord<String, String> record) {
        String[] value = record.value().split(",");
        bankService.transfer(value[0], value[1], Integer.valueOf(value[2]));
        kafkaTemplate.send("topic2",  "key", "Done");
    }

    @KafkaListener(topics = "topic2", groupId = "group_topic_test")
    public void topic2Listener(ConsumerRecord<String, String> record) {
        String value = record.value();
        System.out.println(value);
        ws.sendMessageToUser("Tom","Done");
    }
}
```

Transfer with WebSocket

- frontend-app.js

```
import './App.css';
import $ from 'jquery'

var socket;

function setConnected(connected) {
  $("#connect").prop("disabled", connected);
  $("#disconnect").prop("disabled", !connected);
  if (connected) {
    $("#conversation").show();
  }
  else {
    $("#conversation").hide();
  }
  $("#greetings").html("");
}

function showGreeting(message) {
  $("#greetings").append("<tr><td>" + message + "</td></tr>");
}
```

Transfer with WebSocket

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- frontend-app.js

```
function openSocket() {
  if (typeof (WebSocket) == “undefined”) {
    alert(“ 您的浏览器不支持 WebSocket”);
  } else {

    if (socket != null) {
      return;
    }


    var userId = document.getElementById('name').value;
    var socketUrl = "ws://localhost:8080/websocket/transfer/" + userId;
    console.log(socketUrl);
    setConnected(true);

    socket = new WebSocket(socketUrl);
    // 打开事件
  socket.onopen = function () {
      console.log("websocket 已打开 ");
      //socket.send(" 这是来自客户端的消息 " + location.href + new Date());
    };

    // 获得消息事件
    socket.onmessage = function (msg) {
      var serverMsg = " 收到服务端信息： " +
msg.data;
      console.log(serverMsg);
      // 发现消息进入    开始处理前端触发逻辑
     showGreeting(msg.data);
    };
    // 关闭事件
    socket.onclose = function () {
      console.log("websocket 已关闭 ");
    };
    // 发生了错误事件
    socket.onerror = function () {
      console.log("websocket 发生了错误 ");
    }
  }
}
```

Transfer with WebSocket

- frontend-app.js

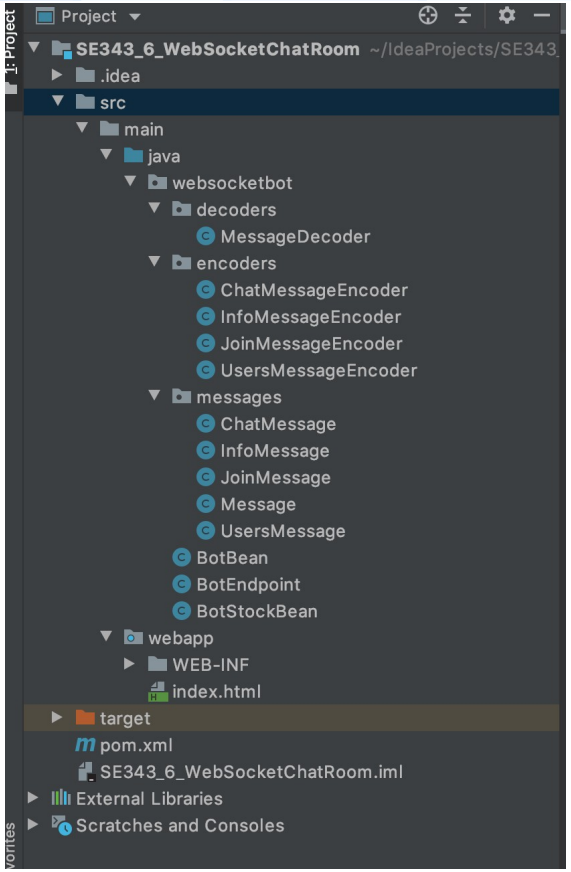
```
function closeSocket() {
  if (socket === undefined || socket === null) {
    alert("请先连接");
    return;
  }
  socket.close();
  socket = null;
  setConnected(false);
}

function sendMessage() {
  if (socket === undefined || socket === null) {
    alert("请先连接");
    return;
  }
  if (typeof (WebSocket) == "undefined") {
    console.log("您的浏览器不支持WebSocket");
  } else {
    console.log("您的浏览器支持WebSocket");
    var msg = JSON.stringify({'userId': $("#name").val()});
    console.log(msg);
    // socket.send(msg);
    $.ajax({
      type: "get",
      url: "http://localhost:8080/send",
      dataType: 'jsonp' // 【jsonp 进行跨域请求 只支持 get】
    });
  }
}

$(function () {
  $("form").on('submit', function (e) {
    e.preventDefault();
  });
  $( "#connect" ).click(function() { openSocket(); });
  $( "#disconnect" ).click(function() { closeSocket(); });
  $( "#send" ).click(function() { sendMessage(); });
});
```

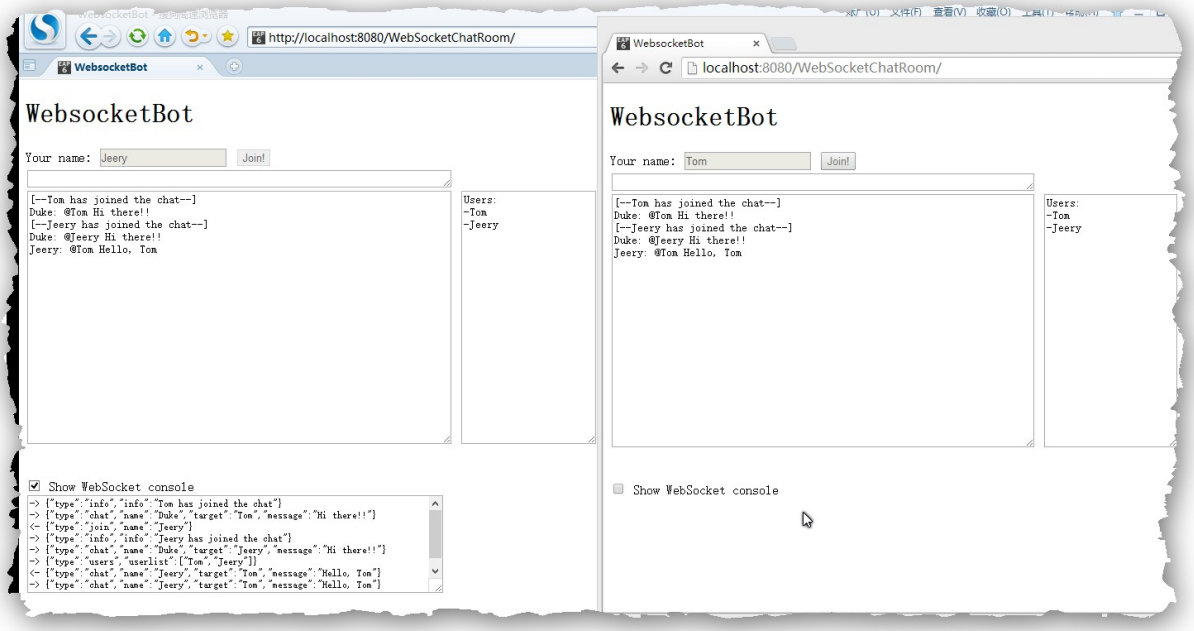
Transfer with WebSocket

- frontend-app.js

```
function App() {
  return (
    <div className="App">
      <div id="main-content" className="container">
        <div className="row">
          <div className="col-md-6">
            <form className="form-inline">
              <div className="form-group">
                <label htmlFor="connect">WebSocket connection:</label>
                <button id="connect" className="btn btn-default"
                        type="submit">Connect</button>
                <button id="disconnect" className="btn btn-default"
                        type="submit" disabled="disabled">Disconnect
                </button>
              </div>
            </form>
          </div>
          <div className="col-md-6">
            <form className="form-inline">
              <div className="form-group">
                <label htmlFor="name">What is your name?</label>
                <input type="text" id="name" className="form-control"
                       placeholder="Your name here..."/>
              </div>
              <button id="send" className="btn btn-default" type="submit">Send</button>
            </form>
          </div>
        </div>
        <div className="row">
          <div className="col-md-12">
            <table id="conversation"
                   className="table table-striped">
              <thead>
              <tr>
                <th>Greetings</th>
              </tr>
              </thead>
              <tbody id="greetings">
              </tbody>
            </table>
          </div>
        </div>
      </div>
    </div>
  );
}

export default App;
```

An example - Chatroom





An example - Chatroom

- index.html

```
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
  <title>WebsocketBot</title>
  <script type="text/javascript">
      var wsocket;    // Websocket connection
      var userName;   // User's name
      var textarea;   // Chat area
      var wsconsole;  // Websocket console area
      var userlist;   // User list area

      function connect() {
          textarea = document.getElementById("textarea");
          wsconsole = document.getElementById("wsconsole");
          userlist = document.getElementById("userlist");
          wsocket = new WebSocket(

"ws://localhost:8080/WebSocketChatRoom/websocketbot");
          wsocket.onmessage = onMessage;
          document.getElementById("name").focus();
          document.getElementById("consolediv").style.visibility
='hidden';
      }
```

An example - Chatroom

- index.html

```
function onMessage(evt) {
    var line = "";
    var msg = JSON.parse(evt.data);
    if (msg.type === "chat") {
        line = msg.name + ": ";
        if (msg.target.length > 0)
            line += "@" + msg.target + " ";
        line += msg.message + "\n";
        textarea.value += "" + line;
    } else if (msg.type === "info") {
        line = "[--" + msg.info + "--]\n";
        textarea.value += "" + line;
    } else if (msg.type === "users") {
        line = "Users:\n";
        for (var i=0; i < msg.userlist.length; i++)
            line += "-" + msg.userlist[i] + "\n";
        userlist.value = line;
    }
    textarea.scrollTop = 999999;
    wsconsole.value += "-> " +  evt.data + "\n";
    wsconsole.scrollTop = 999999;
}
```

An example - Chatroom

- index.html

```
function sendJoin() {
    var input = document.getElementById("input");
    var name = document.getElementById("name");
    var join = document.getElementById("join");
    var jsonstr;
    if (name.value.length > 0) {
        var joinMsg = {};
        joinMsg.type = "join";
        joinMsg.name = name.value;
        jsonstr = JSON.stringify(joinMsg);
        wsocket.send(jsonstr);
        name.disabled = true;
        join.disabled = true;
        input.disabled = false;
        userName = name.value;
        wsconsole.value += "<- " + jsonstr + "\n";
        wsconsole.scrollTop = 999999;
    }
}
```

An example - Chatroom

- index.html

```
function sendMessage(evt) {
    var input = document.getElementById("input");
    var jsonstr;
    var msgstr;
    if (evt.keyCode === 13 && input.value.length > 0) {
        var chatMsg = {};
        chatMsg.type = "chat";
        chatMsg.name = userName;
        msgstr = input.value;
        chatMsg.target = getTarget(msgstr.replace(/,/g, ""));
        chatMsg.message = cleanTarget(msgstr);
        chatMsg.message =
               chatMsg.message.replace(/(\r\n|\n|\r)/gm,"");
        jsonstr = JSON.stringify(chatMsg);
        wsocket.send(jsonstr);
        input.value = "";
        wsconsole.value += "<- " + jsonstr + "\n";
        wsconsole.scrollTop = 999999;
    }
}
```

An example - Chatroom

- index.html

```
function checkJoin(evt) {
    var name = document.getElementById("name");
    var input = document.getElementById("input");
    if (evt.keyCode === 13 && name.value.length > 0) {
        sendJoin();
        input.focus();
    }
}

function getTarget(str) {
    var arr = str.split(" ");
    var target = "";
    for (var i=0; i<arr.length; i++) {
        if (arr[i].charAt(0) === '@') {
            target = arr[i].substring(1,arr[i].length);
            target = target.replace(/(\r\n|\n|\r)/gm,"");
        }
    }
    return target;
}
```

An example - Chatroom

- index.html

```
        function cleanTarget(str) {
            var arr = str.split(" ");
            var cleanstr = "";
            for (var i=0; i<arr.length; i++) {
                if (arr[i].charAt(0) !== '@')
                    cleanstr += arr[i] + " ";
            }
            return cleanstr.substring(0,cleanstr.length-1);
        }
        function showHideConsole() {
            var chkbox = document.getElementById("showhideconsole");
            var consolediv = document.getElementById("consolediv");
            if (chkbox.checked)
                consolediv.style.visibility = 'visible';
            else
                consolediv.style.visibility = 'hidden';
        }
        window.addEventListener("load", connect, false);
    </script>
</head>
```

An example - Chatroom

- index.html

```
<body>
    <h1>WebsocketBot</h1>
    Your name: <input id="name" type="text" size="20" maxlength="20"
                onkeyup="checkJoin(event);"/>
    <input type="submit" id="join" value="Join!"
           onclick="sendJoin();"/><br/>
    <textarea id="input" cols="70" rows="1" disabled="true"
              onkeyup="sendMessage(event);"></textarea><br/>
    <textarea id="textarea" cols="70" rows="20"
              readonly="true"></textarea>
    <textarea id="userlist" cols="20" rows="20"
              readonly="true"></textarea>
    <br/><br/><br/>
    <input id="showhideconsole" type="checkbox"
           onclick="showHideConsole();"/>
    Show WebSocket console<br/>
    <div id="consolediv"><textarea id="wsconsole" cols="80" rows="8"
         readonly="true" style="font-size:8pt;"></textarea></div>
</body>
</html>
```

An example - Chatroom

- BotEndPoint.java

```
@ServerEndpoint(
        value = "/websocketbot",
        decoders = { MessageDecoder.class },
        encoders = { JoinMessageEncoder.class, ChatMessageEncoder.class,
                     InfoMessageEncoder.class, UsersMessageEncoder.class }
        )
public class BotEndpoint {
    private static final Logger logger = Logger.getLogger("BotEndpoint");
    private static Queue<Session> mySession = new ConcurrentLinkedQueue<>();


    @OnOpen
    public void openConnection(Session session) {
             mySession.add(session);
         logger.log(Level.INFO, "Connection opened.");
    }
```

An example - Chatroom

- BotEndPoint.java

```
    @OnMessage
    public void message(final Session session, Message msg) {
        if (msg instanceof JoinMessage) {
            JoinMessage jmsg = (JoinMessage) msg;
            session.getUserProperties().put("name", jmsg.getName());
            session.getUserProperties().put("active", true);
            logger.log(Level.INFO, "Received: {0}",
jmsg.toString());
            sendAll(session, new InfoMessage(jmsg.getName() + " has
                    joined the chat"));
            sendAll(session, new ChatMessage("Duke", jmsg.getName(),
                    "Hi there!!"));
            sendAll(session, new
UsersMessage(this.getUserList(session)));

        } else if (msg instanceof ChatMessage) {
            final ChatMessage cmsg = (ChatMessage) msg;
            logger.log(Level.INFO, "Received: {0}",
cmsg.toString());
            sendAll(session, cmsg);
        }
```

An example - Chatroom

- BotEndPoint.java

```
    @OnClose
    public void closedConnection(Session session) {
        session.getUserProperties().put("active", false);
        if (session.getUserProperties().containsKey("name")) {
            String name =
                session.getUserProperties().get("name").toString();
            sendAll(session, new InfoMessage(name +
                    " has left the chat"));
            sendAll(session, new
UsersMessage(this.getUserList(session)));
        }
        logger.log(Level.INFO, "Connection closed.");
    }

    @OnError
    public void error(Session session, Throwable t) {
        logger.log(Level.INFO, "Connection error ({0})",
t.toString());
    }
```

An example - Chatroom

- BotEndPoint.java

```
    public synchronized void sendAll(Session session, Object msg) {
        try {
            for (Session s : session.getOpenSessions()) {
                if (s.isOpen()) {
                    s.getBasicRemote().sendObject(msg);
                    logger.log(Level.INFO, "Sent: {0}",
msg.toString());
                }
            }
        } catch (IOException | EncodeException e) {
            logger.log(Level.INFO, e.toString());
        }
    }
    public List<String> getUserList(Session session) {
        List<String> users = new ArrayList<>();
        for (Session s : session.getOpenSessions()) {
            if (s.isOpen()&&(boolean)
s.getUserProperties().get("active"))

users.add(s.getUserProperties().get("name").toString());
        }
        return users;
```

An example - Chatroom

- Message.java

```
public class Message {}
```

- ChatMessage.java

```
public class ChatMessage extends Message {
    private String name;
    private String target;
    private String message;

    public ChatMessage(String name, String target, String message) {
        this.name = name;
        this.target = target;
        this.message = message;
    }

    ……
    public String getMessage() { return message;  }
    public void setMessage(String message) { this.message = message; }
    ……
}
```

An example - Chatroom

- UserMessage.java

```
public class Message {}
public class UsersMessage extends Message {
    private List<String> userlist;

    public UsersMessage(List<String> userlist) {
        this.userlist = userlist;
    }

    public List<String> getUserList() {  return userlist; }
  ……
}
```

- JoinMessage.java

```
public class JoinMessage extends Message {
    private String name;
    public JoinMessage(String name) { this.name = name;  }
    public String getName() { return name;  }
    ……
}
```

An example - Chatroom

- InfoMessage.java

```
public class InfoMessage extends Message {

    private String info;

    public InfoMessage(String info) {
        this.info = info;
    }

    public String getInfo() {
        return info;
    }

    /* For logging purposes */
    @Override
    public String toString() {
        return "[InfoMessage] " + info;
    }
}
```

An example - Chatroom

- ChatMessageEncoder.java

```
public class ChatMessageEncoder implements Encoder.Text<ChatMessage> {

    @Override
    public void init(EndpointConfig ec) { }

    @Override
    public void destroy() { }

    @Override
    public String encode(ChatMessage chatMessage) throws EncodeException
    {
        StringWriter swriter = new StringWriter();
        try (JsonGenerator jsonGen = Json.createGenerator(swriter)) {
            jsonGen.writeStartObject()
                .write("type", "chat")
                .write("name", chatMessage.getName())
                .write("target", chatMessage.getTarget())
                .write("message", chatMessage.getMessage())
            .writeEnd();
        }
        return swriter.toString();
    }
}
```

An example - Chatroom

- JoinMessageEncoder.java

```
public class JoinMessageEncoder implements Encoder.Text<JoinMessage> {
    @Override
    public void init(EndpointConfig ec) { }

    @Override
    public void destroy() { }

    @Override
    public String encode(JoinMessage joinMessage) throws EncodeException
    {
        StringWriter swriter = new StringWriter();
        try (JsonGenerator jsonGen = Json.createGenerator(swriter)) {
            jsonGen.writeStartObject()
                .write("type", "join")
                .write("name", joinMessage.getName())
            .writeEnd();
        }
        return swriter.toString();
    }
}
```

An example - Chatroom

- InfoMessageEncoder.java

```
public class InfoMessageEncoder implements Encoder.Text<InfoMessage> {
    @Override
    public void init(EndpointConfig ec) { }

    @Override
    public void destroy() { }

    @Override
    public String encode(InfoMessage joinMessage) throws EncodeException
    {
        StringWriter swriter = new StringWriter();
        try (JsonGenerator jsonGen = Json.createGenerator(swriter)) {
            jsonGen.writeStartObject()
                .write("type", "info")
                .write("info", joinMessage.getInfo())
            .writeEnd();
        }
        return swriter.toString();
    }
}
```

An example - Chatroom

- UsersMessageEncoder.java

```
public class UsersMessageEncoder implements Encoder.Text<UsersMessage> {
    @Override
    public void init(EndpointConfig ec) { }

    @Override
    public void destroy() { }

    @Override
    public String encode(UsersMessage usersMessage) throws
              EncodeException {
        StringWriter swriter = new StringWriter();
        try (JsonGenerator jsonGen = Json.createGenerator(swriter)) {
            jsonGen.writeStartObject()
                .write("type", "users")
                .writeStartArray("userlist");
            for (String user : usersMessage.getUserList())
                jsonGen.write(user);
            jsonGen.writeEnd().writeEnd();
        }
        return swriter.toString();
    }
}
```

An example - Chatroom

- MessageDecoder.java

```
public class MessageDecoder implements Decoder.Text<Message> {
    private Map<String,String> messageMap;

    @Override
    public void init(EndpointConfig ec) { }

    @Override
    public void destroy() { }

    /* Create a new Message object if the message can be decoded */
    @Override
    public Message decode(String string) throws DecodeException {
        Message msg = null;
        if (willDecode(string)) {
            switch (messageMap.get("type")) {
                case "join":
                    msg = new JoinMessage(messageMap.get("name"));
                    break;
                case "chat":
                    msg = new ChatMessage(messageMap.get("name"),
                                          messageMap.get("target"),
                                          messageMap.get("message"));
            }
        } else {
            throw new DecodeException(string, "[Message] Can't decode.");
        }
        return msg;
    }
```

An example - Chatroom

- MessageDecoder.java

```
    @Override
    public boolean willDecode(String string) {
        boolean decodes = false;
        messageMap = new HashMap<>();
        JsonParser parser = Json.createParser(new StringReader(string));
        while (parser.hasNext()) {
            if (parser.next() == JsonParser.Event.KEY_NAME) {
                String key = parser.getString();
                parser.next();
                String value = parser.getString();
                messageMap.put(key, value);
            }
        }

        Set keys = messageMap.keySet();
        if (keys.contains("type")) {
            switch (messageMap.get("type")) {
                case "join":
                    if (keys.contains("name"))
                        decodes = true;
                    break;
                case "chat":
                    String[] chatMsgKeys = {"name", "target", "message"};
                    if (keys.containsAll(Arrays.asList(chatMsgKeys)))
                        decodes = true;
                    break;
            }
        }
        return decodes;
    }
}
```

An example - Chatroom

- BotEndpoint.java

```
@ServerEndpoint(
        value = "/websocketbot",
        decoders = { MessageDecoder.class },
        encoders = { JoinMessageEncoder.class, ChatMessageEncoder.class,
                     InfoMessageEncoder.class, UsersMessageEncoder.class }
        )
public class BotEndpoint {

    @OnOpen
    public void openConnection(Session session) {
        logger.log(Level.INFO, "Connection opened.");
    }

    @OnMessage
    public void message(final Session session, Message msg) {
        logger.log(Level.INFO, "Received: {0}", msg.toString());

        if (msg instanceof JoinMessage) {
            JoinMessage jmsg = (JoinMessage) msg;
            session.getUserProperties().put("name", jmsg.getName());
            session.getUserProperties().put("active", true);
            logger.log(Level.INFO, "Received: {0}", jmsg.toString());
            sendAll(session, new InfoMessage(jmsg.getName() + " has joined the chat"));
            sendAll(session, new ChatMessage("Duke", jmsg.getName(), "Hi there!!"));
            sendAll(session, new UsersMessage(this.getUserList(session)));

        } else if (msg instanceof ChatMessage) {
            final ChatMessage cmsg = (ChatMessage) msg;
            logger.log(Level.INFO, "Received: {0}", cmsg.toString());
            sendAll(session, cmsg);

        }
    }
```

An example - Chatroom

- BotEndpoint.java

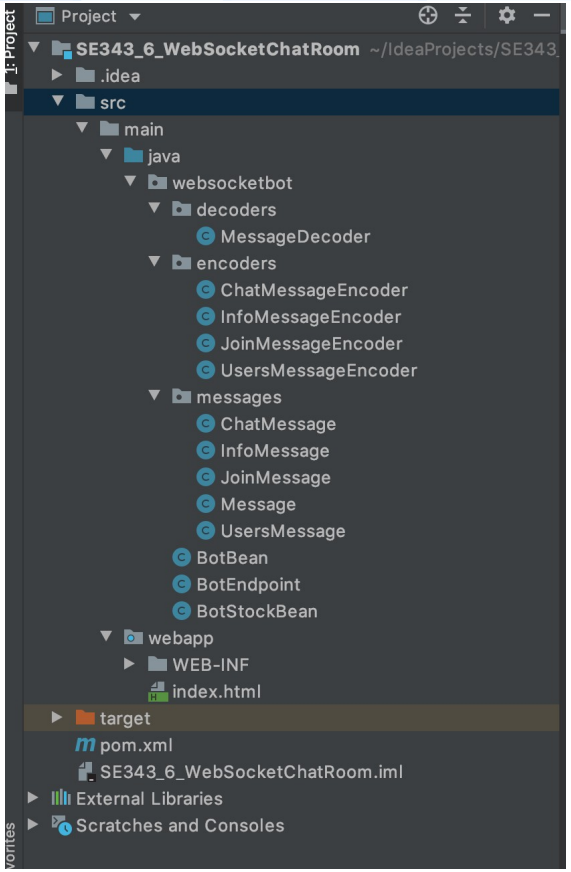
```
@OnClose
public void closedConnection(Session session) {
    session.getUserProperties().put("active", false);
    if (session.getUserProperties().containsKey("name")) {
        String name = session.getUserProperties().get("name").toString();
        sendAll(session, new InfoMessage(name + " has left the chat"));
        sendAll(session, new UsersMessage(this.getUserList(session)));
    }
    logger.log(Level.INFO, "Connection closed.");
}

@OnError
public void error(Session session, Throwable t) {
    logger.log(Level.INFO, "Connection error ({0})", t.toString());
}

public synchronized void sendAll(Session session, Object msg) {
    try {
        for (Session s : session.getOpenSessions()) {
            if (s.isOpen()) {
                s.getBasicRemote().sendObject(msg);
                logger.log(Level.INFO, "Sent: {0}", msg.toString());
            }
        }
    } catch (IOException | EncodeException e) {
        logger.log(Level.INFO, e.toString());
    }
}
```

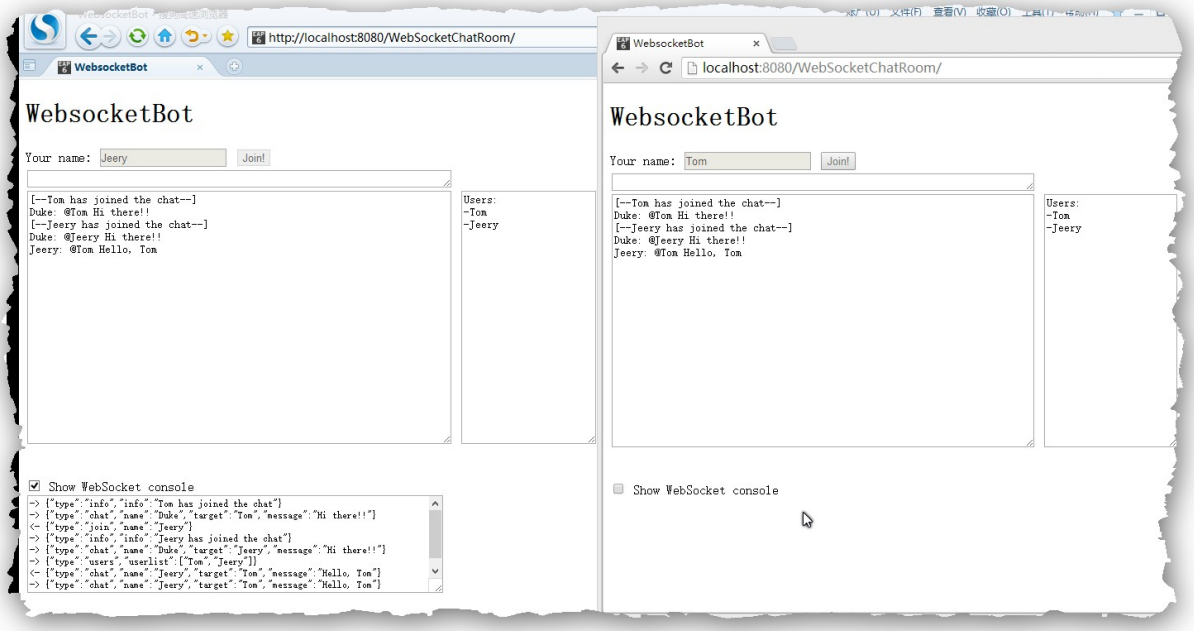
An example - Chatroom

- BotEndpoint.java

```
    public List<String> getUserList(Session session) {
         List<String> users = new ArrayList<>();
         for (Session s : session.getOpenSessions()) {
             if (s.isOpen() && (boolean) s.getUserProperties().get("active"))
                 users.add(s.getUserProperties().get("name").toString());
         }
         return users;
     }
  }
}
```

An example - Chatroom





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Thank You!