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WebSocket API.NEXT

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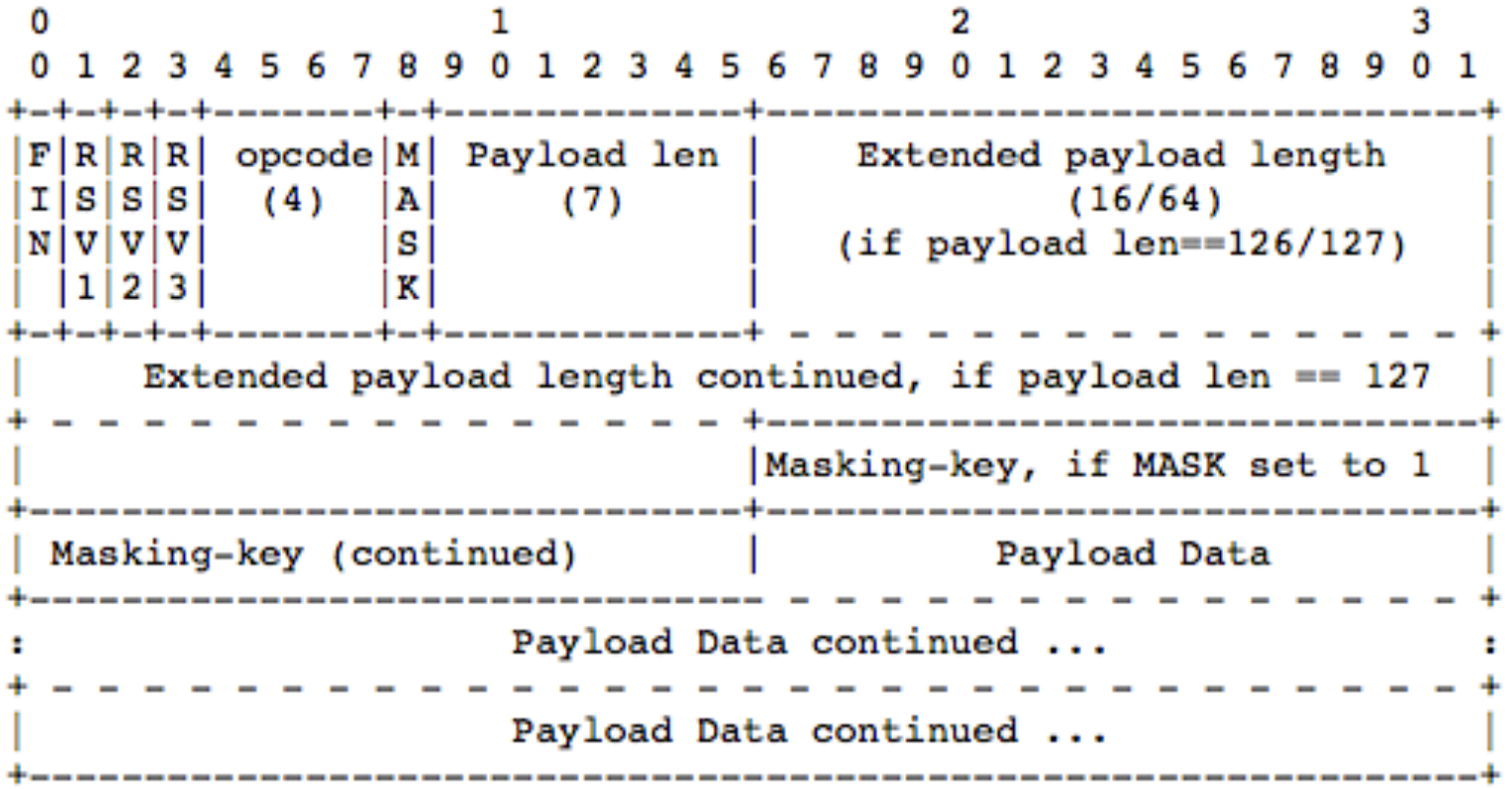
Program Agenda

1. Short intro about JSR 356 – Java API for WebSocket
2. WebSocket API 1.1
3. WebSocket.NEXT
4. CDI, Frame API, Extensions, SubProtocols, Java EE integration, Client API enhancements, smaller issues (broadcast, clustering, security, …)

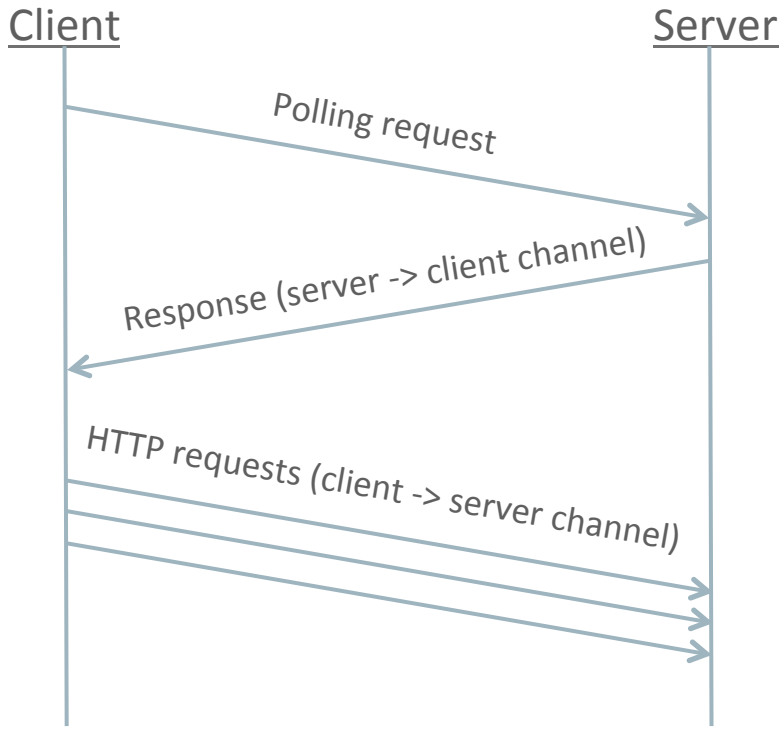
WebSocket protocol

- RFC 6455 (December 2011)
- Two-way communication, replacement for Long-polling
  - Better resource utilization
- Extensions, SubProtocol
- WebSocket handshake uses HTTP, connection is then **UPGRADE**d to “websocket” protocol
  - No HTTP since this point, only WebSocket frame are allowed to be sent or received
  - Connection can be closed using Close frame or just closing underlying TCP connection

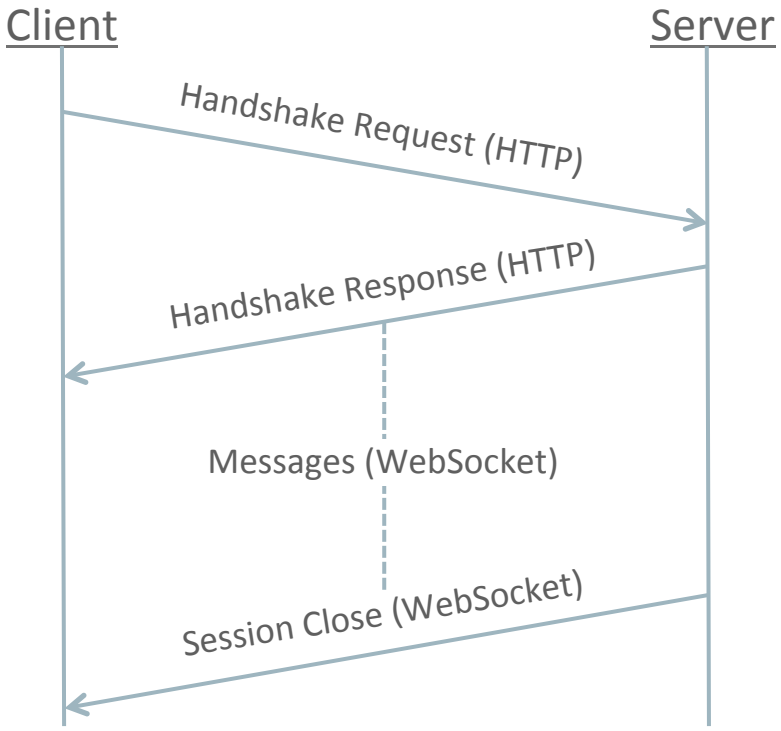
WebSocket protocol - Frame



WebSocket protocol



Long polling



WebSocket

Java API for WebSocket

- JSR 356 – Part of Java EE 7
  - 1.0 (May 2013)
  - 1.1 (August 2014)
- Annotated and programmatic way how to deploy and access WebSocket endpoints
- Event-driven model - @OnOpen, @OnMessage, @OnError, @OnClose
- Encoders/Decoders, Path/Query parameter handling, Handshake headers interceptors, CDI integration, …

Java API for WebSocket – Annotated Endpoint

```java
@ServerEndpoint("/echo")
public class EchoEndpoint {

    @OnOpen
    public void onOpen(Session session) throws IOException {
        session.getBasicRemote().sendText("onOpen");
    }

    @OnMessage
    public void echo(Session session, String message) throws IOException {
        session.getBasicRemote().sendText(message + " (from your server)");
        session.close();
    }

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

Java API for WebSocket – Programmatic Endpoint

```
public class EchoProgrammaticEndpoint extends Endpoint {
    @Override
    public void onOpen(final Session session, EndpointConfig config) {

        session.addMessageHandler(String.class, new MessageHandler.Whole<String>() {
            @Override
            public void onMessage(String message) {
                try {
                    session.getBasicRemote().sendText(message + " (from your server)");
                    session.close();
                } catch (IOException e) {
                    e.printStackTrace();
                }

            }
        });
    }

    @Override
    public void onError(Session session, Throwable thr) {
        thr.printStackTrace();
    }
}
```

WebSocket 1.1

- JSR 356 Maintenance release
  - August 2014
- WEBSOCKET_SPEC-226: Session.addMessageHandler(…) and lambdas
- Impact: JDK8, Nashorn, possibly any other JVM language

WebSocket 1.1

WEBSOCKET_SPEC-226

- `Javax.websocket.Session#addMessageHandler(MessageHandler)`
  - `MessageHandler` contains two sub interfaces, `Whole<T>` and `Partial<T>`
  - WebSocket implementation must know the generic type of added MessageHandler to be able to match appropriate javax.websocket.Decoder
- Solution: add methods which provide the type directly as a parameter
  - `Javax.websocket.Session#addMessageHandler(Class<T>, MessageHandler.Whole<T>)`
  - `Javax.websocket.Session#addMessageHandler(Class<T>, MessageHandler.Partial<T>)`

WebSocket 1.0

```
session.addMessageHandler(
        new MessageHandler.Whole<String>() {
            @Override
            public void onMessage(String message) {
                // process message.
            }
        }
);

// ===== Lambda expression =====

session.addMessageHandler(
        (MessageHandler.Whole<String>) message -> {
            // process message.
        }
);
```

WebSocket 1.1

```
session.addMessageHandler(String.class,
        new MessageHandler.Whole<String>() {
            @Override
            public void onMessage(String message) {
                // process message.
            }
        }
);

// ===== Lambda expression =====

session.addMessageHandler(String.class,
        (message) -> {
            // process message.
        }
);
```

WebSocket 1.1

- Lesson learned: There is no reliable way how to get the generic type (*)
  - Not until generics reification is introduced to the JDK

- (*) during the runtime.

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- Should be part of Java EE 8
- The scope is not clear yet

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CDI integration

- Present in the specification since 1.0
- WebSocket spec depends on Servlet (3.1)
- Issue with CDI scope
  - @RequestScope
  - @SessionScope
  - @ApplicationScope
  - @ConversationScope
- HttpUpgradeHandler (from Servlet 3.1) has CDI scope “undefined”

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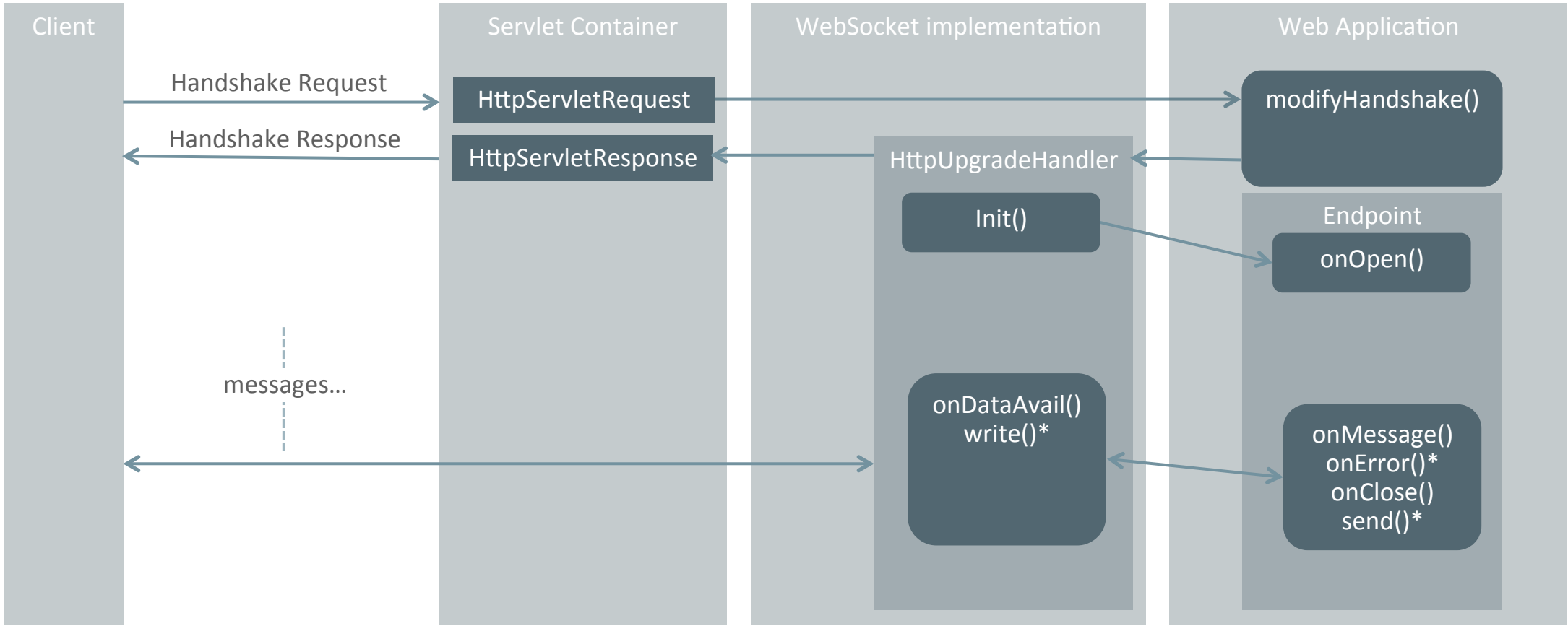
CDI integration



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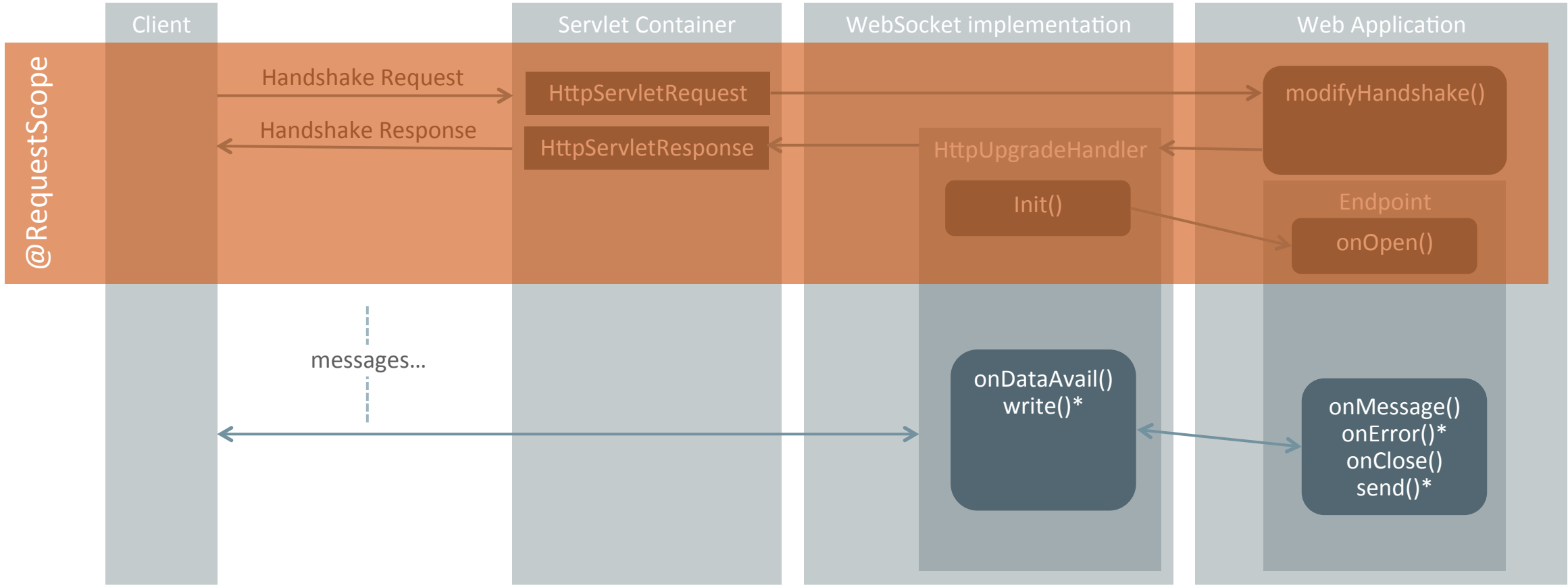
CDI integration



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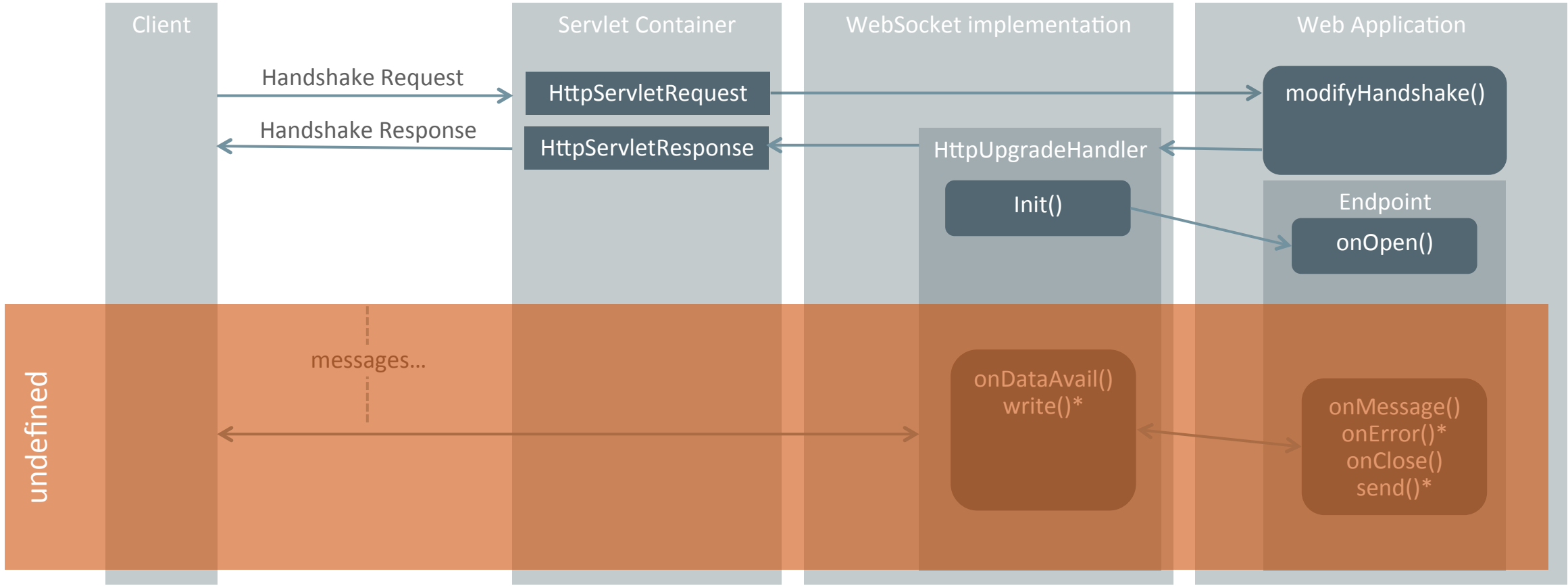
CDI integration



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Low level Frame API

- Support for direct handling of WebSocket Frames
  - Direct manipulation with payload or other frame properties
  - Custom encryption, encoding, compression, …
- WebSocket Extension support
  - Currently WebSocket API contains only negotiation-related bits
    - (and not very well executed – not able to negotiate extension parameters, …)
  - Extending current API is possible, but…

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Low level Frame API – WebSocket Extensions

- Existing WebSocket Extensions proposals:
  - "Compression Extensions for WebSocket" - Submitted to IESG for Publication
  - "A Multiplexing Extension for WebSockets" – expired
- Other option is just state that implementation must/can support some list of extensions
- Common API for Extensions might be hard to craft, since there are no exact rules about what WebSocket Extension might specify.
  - (this extension must be run as first when receiving frame and last when sending, …)

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Extensions/Message(*) processing

- WEBSOCKET_SPEC-199
  - "Add the ability to define filters and interceptor"
- API for filtering
  - Handshake requests?
    - It may be worth to have better control in handshake process – currently only response headers can be modified, no possibility to deny the request/return HTTP 5xx response
  - WebSocket Frames?
  - Decoded/extracted messages (Frame payload)?

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SubProtocol support

- Existing WebSocket SubProtocol proposals
  - The WebSocket Protocol as a Transport for the Session Initiation Protocol (SIP) – published – RFC 7118
  - An XMPP Sub-protocol for WebSocket – almost done – Submitted for publication
  - The WebSocket Protocol as a Transport for the Message Session Relay Protocol (MSRP)
  - Use of the WebSocket Protocol as a Transport for the Remote Framebuffer Protocol
  - CoAP over WebSockets

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SubProtocol support

- WebSocket API supports SubProtocols only for negotiation
  - Which might be OK
- It is not clear what everything might be needed for implementing other protocol (again, depends on the subprotocol specification)
- There seem to be common pattern
  - Using WebSocket as a Socket (or just stream) to send/receive messages/frames of the tunneled protocol
  - We could modify existing cases to suite those needs (Streamed MessageHandlers, RemoteEndpoint#getSendStream())

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Java EE integration

- JAX-P, JAX-B, JSON-P, JSON-B, …
  - Problem with missing metadata
- Bean validation
- Servlet 4.0 (HTTP/2)
- CDI – injectable managed Client/Session/RemoteEndpoint
- CDI – support external events (like CDI event which invokes broadcast)

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Client API improvements

- Asynchronous connectToServer method
- Security – HTTP Basic/Digest/custom authentication schemes
- Security – SSL related settings, ideally per client connection
  - Might be problematic to agree on single API, could be solved on different level and shared among all Java EE specification which do provide client API
- HTTP Proxy support
  - (at least state that setting Proxy in java-way should be picked up)

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Smaller issues (in terms of API changes)

- Broadcast support
  - Introduce something better than iterating over Set<Session>
- Security
  - @RolesAllowed, … - fine grain control for on endpoint level
- Clustering
  - Current API is not very friendly to clustered environment
  - Problematic parts: Session#getContainer(), Session#(add|get|del)MessageHandler, Session#getUserProperties, …
  - Enhancements like intercepting messages sent from other nodes, …

WebSocket.NEXT – Questions?

- WebSocket API 1.1.NEXT
- WebSocket-spec: https://java.net/projects/websocket-spec
  - https://java.net/jira/browse/WEBSOCKET_SPEC
- Reference Implementation: Tyrus https://tyrus.java.net
  - users@tyrus.java.net
  - https://java.net/jira/browse/TYRUS
- Pavel Bucek: pavel.bucek@oracle.com

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