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## Performance vs TCP Socket

- Performance Evaluation
- WebSocket TCP

# Performance Evaluation of WebSocket Protocol for Implementation of Full-Duplex Web Streams

Oleg Bilovus

Università degli Studi di Salerno

1st Scalability Research Forum

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- ▶ *Historically*, creating web applications that need bidirectional communication between a client and a server has required an abuse of HTTP to poll the server for updates while sending upstream notifications as distinct HTTP calls.

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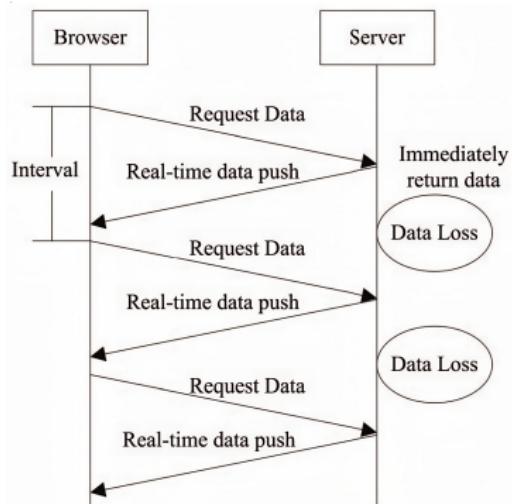
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# HTTP polling

Check whether the server is changed in a while, thereby performing incremental updates.



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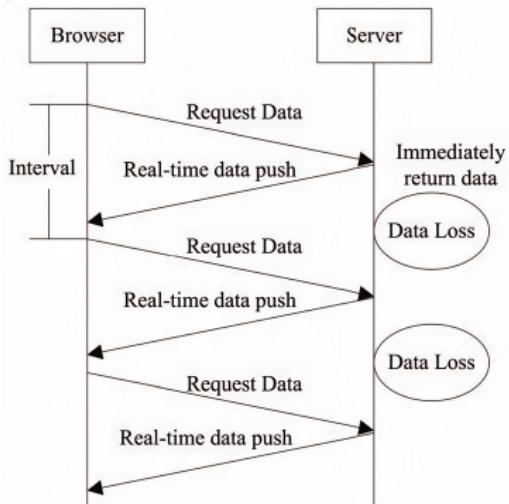
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# HTTP polling

Check whether the server is changed in a while, thereby performing incremental updates.

▶ How often to query?



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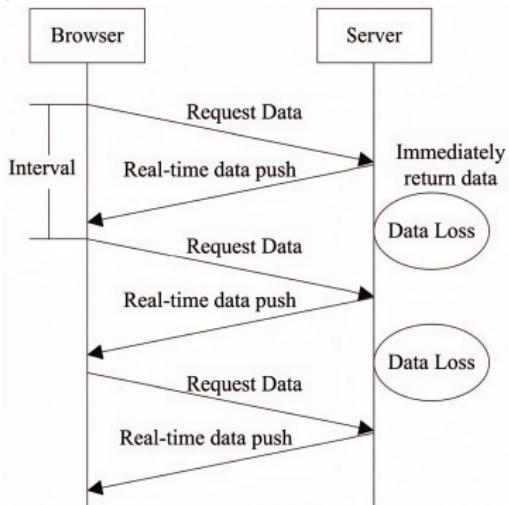
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# HTTP polling

Check whether the server is changed in a while, thereby performing incremental updates.



- ▶ How often to query?
- ▶ Continuously short interval requests will be washed away the server.

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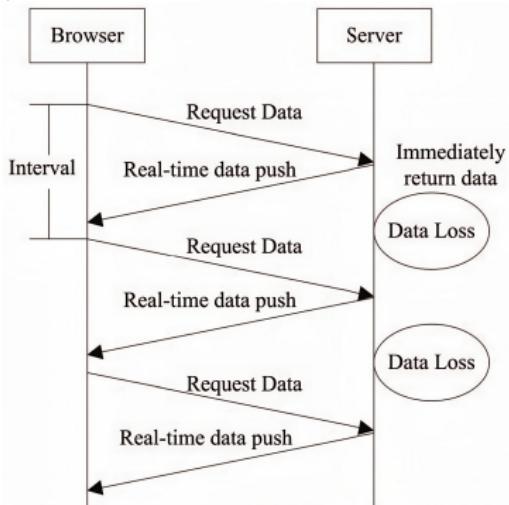
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# HTTP polling

Check whether the server is changed in a while, thereby performing incremental updates.



- ▶ How often to query?
- ▶ Continuously **short interval** requests will be **washed away** the server.
- ▶ **Long interval** will require more time to reach the client, **no real-time data**.

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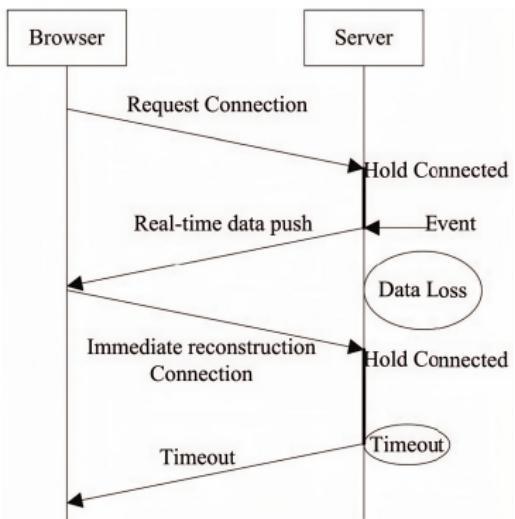
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# HTTP long polling

When a client sends a data request, the server will block the request until there is data transfer or timeout before returning.



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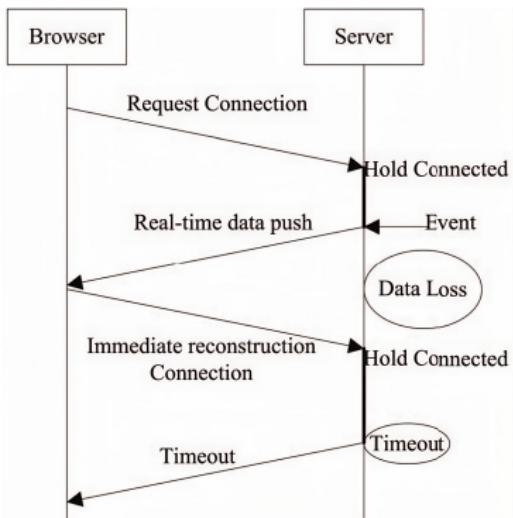
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# HTTP long polling

When a client sends a data request, the server will block the request until there is data transfer or timeout before returning.



- ▶ Solve the short polling frequency to access the server.

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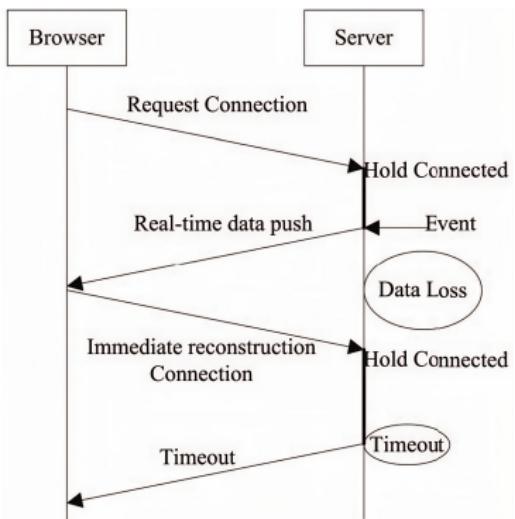
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# HTTP long polling

When a client sends a data request, the server will block the request until there is data transfer or timeout before returning.



- ▶ **Solve the short polling frequency to access the server.**
- ▶ **No bidirectional communication, server push data.**

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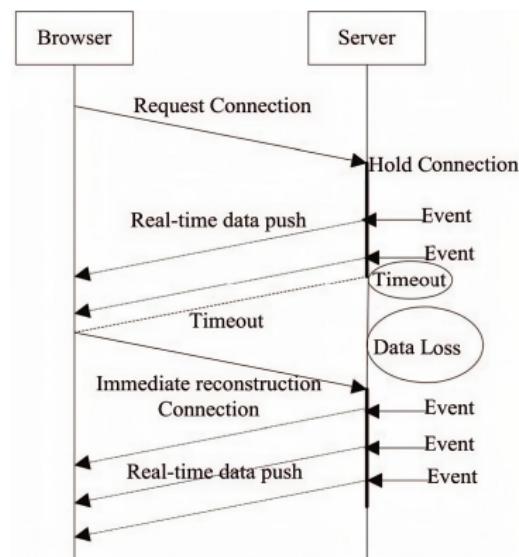
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# Streaming

Iframe embed a hidden frame in an HTML page, then set it as a long connection request, thus the server can send data to the clients constantly.

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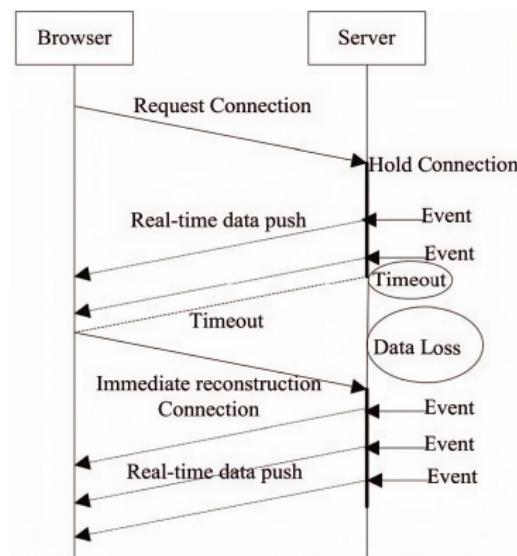
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- ▶ It can send multiple events from a single request.

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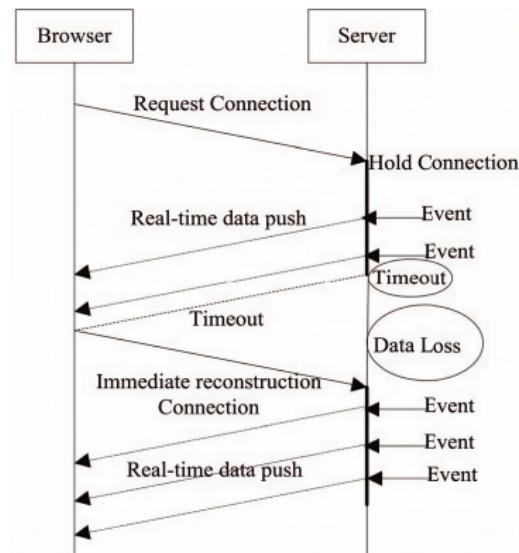
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- ▶ It can send multiple events from a single request.
- ▶ But, it increases the burden on the server, causing the server performance degradation, or even collapse.

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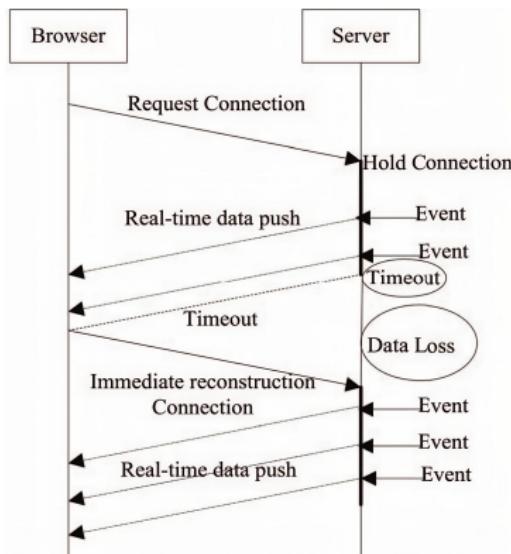
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- ▶ It can send multiple events from a single request.
- ▶ But, it increases the burden on the server, causing the server performance degradation, or even collapse.
- ▶ No bidirectional communication.

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# RFC 6455

## Keywords

- ▶ The WebSocket Protocol enables two-way communication between a client running untrusted code in a controlled environment to a remote host that has opted-in to communications from that code.

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- ▶ The goal of this technology is to provide a mechanism for browser-based applications that need two-way communication with servers.

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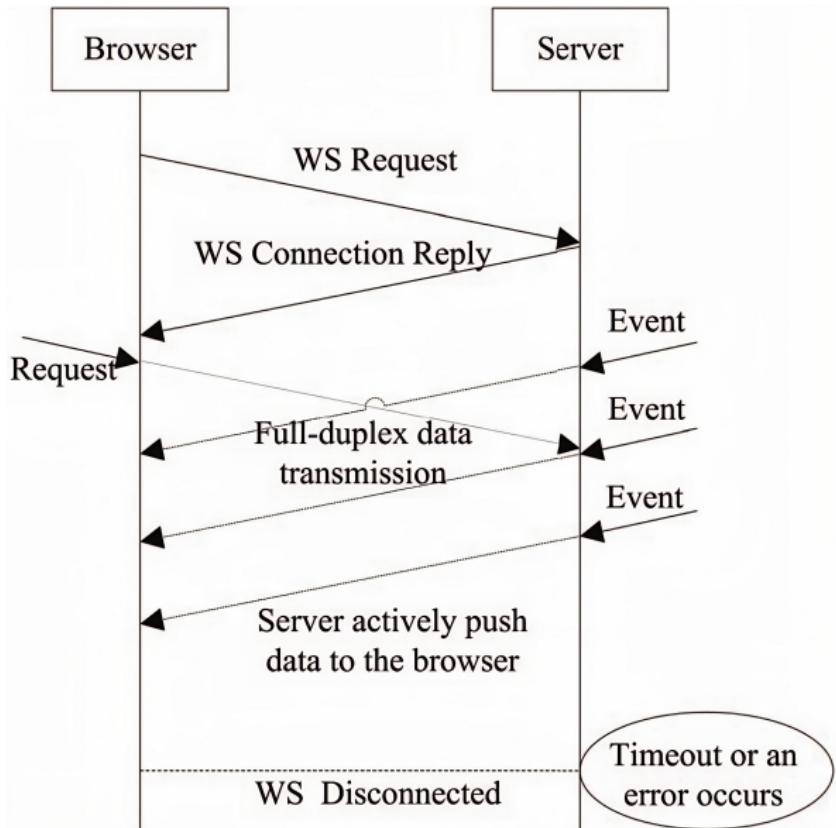
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- ▶ For WebSocket-based communication, a **WebSocket session** should be established first.

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# Handshake

- ▶ For WebSocket-based communication, a **WebSocket session** should be established first.
- ▶ To establish a session, client sends a WebSocket **Upgrade Request** to the server, upon which server responds with a WebSocket **Upgrade Response**.

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# Handshake

- ▶ For WebSocket-based communication, a **WebSocket session** should be established first.
- ▶ To establish a session, client sends a WebSocket **Upgrade Request** to the server, upon which server responds with a WebSocket **Upgrade Response**.
- ▶ From this point forward, the client and server can **send data back and forth in asynchronous full-duplex mode**.

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```
GET /chat HTTP/1.1
Host: server.example.com
Upgrade: WebSocket
Connection: Upgrade
Sec-WebSocket-Key:
dGh1IHNhbXBsZSBub25jZQ==
Origin: http://example.com
Sec-WebSocket-Protocol:
chat, superchat
Sec-WebSocket-Version: 13
```

# WebSocket Upgrade Request

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► HTTP GET request.

GET /chat HTTP/1.1

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Upgrade: WebSocket

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- ▶ HTTP GET request.
- ▶ URI to identify endpoint.

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- ▶ HTTP GET request.
- ▶ URI to identify endpoint.
- ▶ Headers indicating the will to switch from regular HTTP to WebSocket.

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- ▶ HTTP GET request.
- ▶ URI to identify endpoint.
- ▶ Headers indicating the will to switch from regular HTTP to WebSocket.
- ▶ A key the server has to use to prove that it can use WebSockets.

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- ▶ URI to identify endpoint.
- ▶ Headers indicating the will to switch from regular HTTP to WebSocket.
- ▶ A key the server has to use to prove that it can use WebSockets.
- ▶ **WebSocket protocols.**

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Sec-WebSocket-Version: 13
```

- ▶ HTTP GET request.
- ▶ URI to identify endpoint.
- ▶ Headers indicating the will to switch from regular HTTP to WebSocket.
- ▶ A key the server has to use to prove that it can use WebSockets.
- ▶ WebSocket protocols.
- ▶ **WebSocket version.**

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HTTP/1.1 101 Switching  
protocols

Upgrade: WebSocket

Connection: Upgrade

Sec-WebSocket-Accept:

dGh1IHNhbXBsZSBub25jZQ==

Origin: http://example.com

Sec-WebSocket-Protocol: chat

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HTTP/1.1 101 Switching

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Upgrade: WebSocket

Connection: Upgrade

Sec-WebSocket-Accept:

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Origin: http://example.com

Sec-WebSocket-Protocol: chat

► Server confirms it supports WebSocket.

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Upgrade: WebSocket

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Sec-WebSocket-Accept:

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Origin: http://example.com

Sec-WebSocket-Protocol: chat

- ▶ Server confirms it supports WebSocket.
- ▶ Server proves that it can use WebSocket.  
Client checks it.

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Origin: http://example.com

Sec-WebSocket-Protocol: chat

- ▶ Server confirms it supports WebSocket.
- ▶ Server proves that it can use WebSocket. Client checks it.
- ▶ **Server tells which protocol it supports.**

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- ▶ After the handshake is successful, client and server can communicate in full-duplex by using frames.

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# WebSocket Frame

- ▶ After the handshake is successful, client and server can communicate in full-duplex by using frames.
- ▶ The added overhead to the payload data is minimal because it does not send all the HTTP headers for each frame.

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# WebSocket Frame

- ▶ After the handshake is successful, client and server can communicate in full-duplex by using frames.
- ▶ The added overhead to the payload data is minimal because it does not send all the HTTP headers for each frame.
- ▶ Each frame adds at least 2 bytes of overhead to the payload data. Depending on the length of the payload data and the direction of the communication, the length of the overhead may increase up to 14 bytes.

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HTTP polling

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**WebSocket protocol**

Definition

Handshake

Upgrade Request

Upgrade Response

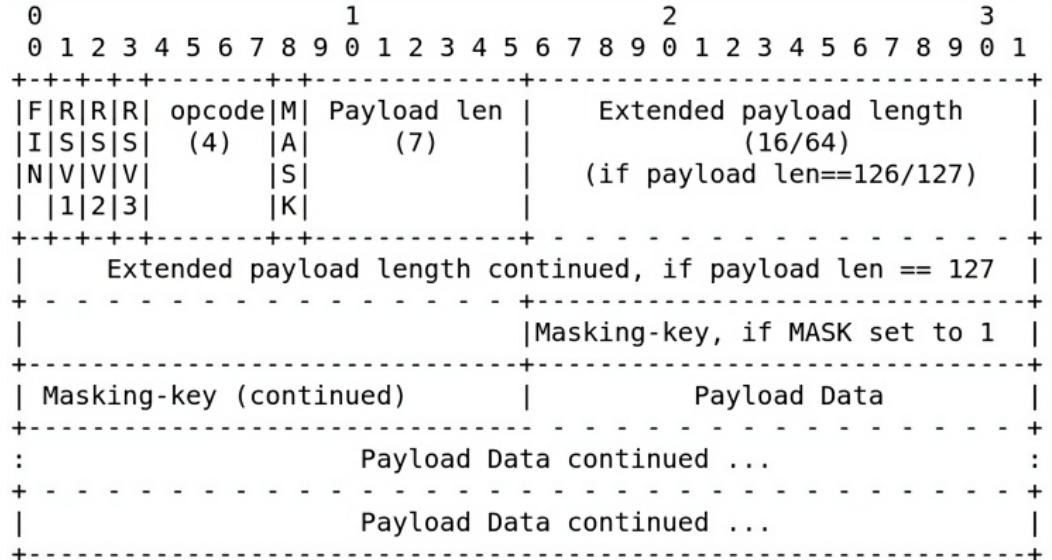
**Frame**

API

**Performance vs TCP Socket**

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# WebSocket API

The API is defined by its states of readiness, responses to a networking or messaging **event**.

Callback	Description
onopen	invoked when WebSocket session is established, signalizes that the protocol is ready to transfer payload data
onerror	invoked whenever an error occurs
onclose	invoked when one of the peers has terminated the session
onmessage	invoked when an incoming message from another peer has arrived

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- ▶ Performance evaluation of the WebSocket and the TCP Socket protocol consists of:

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- ▶ Performance evaluation of the WebSocket and the TCP Socket protocol consists of:
  - ▶ Network traffic

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- ▶ Performance evaluation of the WebSocket and the TCP Socket protocol consists of:
  - ▶ Network traffic
  - ▶ Data transfer time

# Performance Evaluation

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- ▶ Performance evaluation of the WebSocket and the TCP Socket protocol consists of:
  - ▶ Network traffic
  - ▶ Data transfer time
- ▶ Network traffic is *evaluated analytically* using the protocol specifications.

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# Performance Evaluation

- ▶ Performance evaluation of the WebSocket and the TCP Socket protocol consists of:
  - ▶ Network traffic
  - ▶ Data transfer time
- ▶ Network traffic is *evaluated analytically* using the protocol specifications.
- ▶ Data transfer time is *evaluated experimentally* in a laboratory test bed.

# WebSocket TCP sequence diagram

WebSocket

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## Background

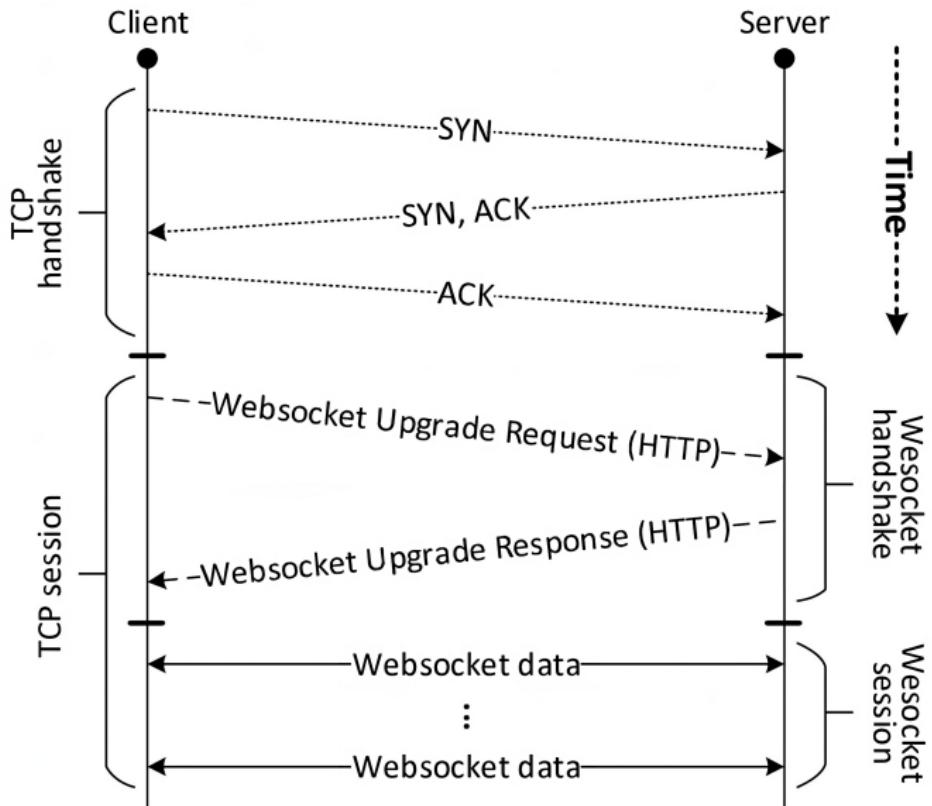
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