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

Oleg Bilovus

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1st Scalability Research Forum

Outline

Background
HTTP polling
HTTP long polling
Streaming

WebSocket
protocol
Definition
Handshake
  Upgrade Request
  Upgrade Response
Frame

Background

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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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HTTP polling

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

HTTP polling

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

▶ How often to query?

HTTP polling

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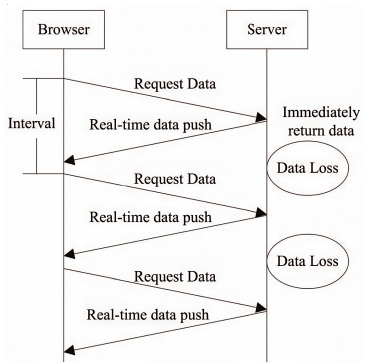
Definition

Handshake

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performing incremental updates.

▶ How often to
query?

▶ Continuously
short interval
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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.

HTTP long polling

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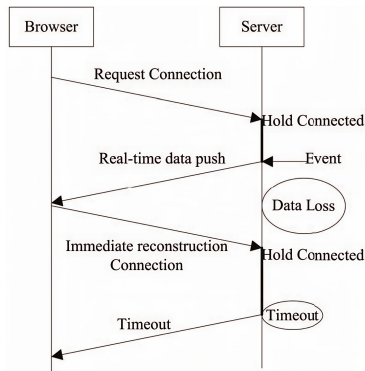
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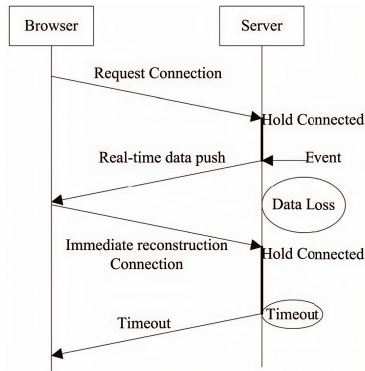
▶ Solve the short polling frequency to access the server.
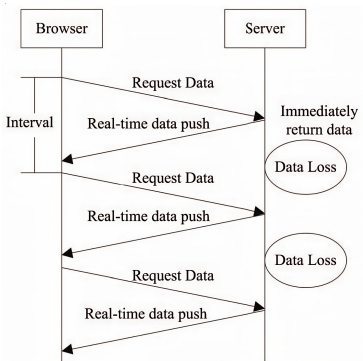
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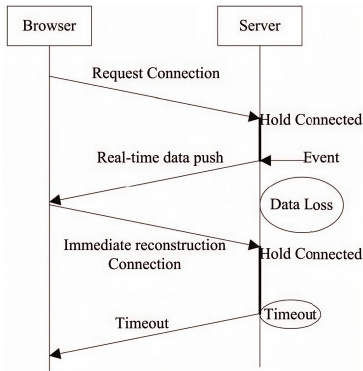
▶ Solve the short polling frequency to access the server.
▶ No bidirectional communication, server push data.

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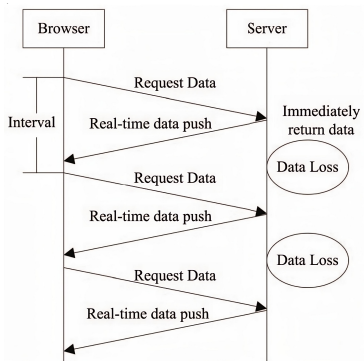
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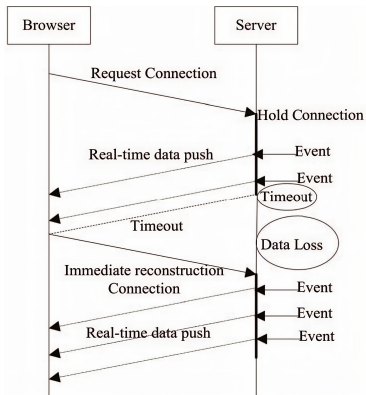
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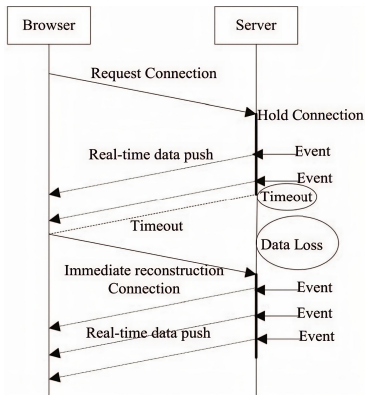
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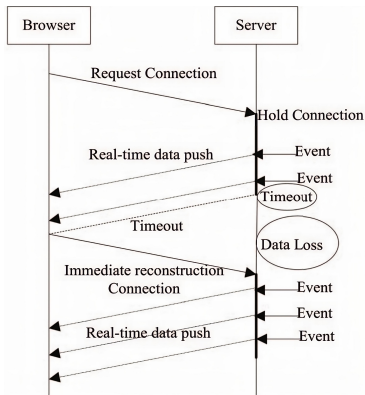
▶ It can send multiple events from a single request.

▶ 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

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▶ 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 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.
- ▶ The protocol consists of an opening handshake followed by basic message framing, layered over TCP.
- ▶ 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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Handshake

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▶ To establish a session, client sends a WebSocket Upgrade Request to the server, upon which server responds with a WebSocket Upgrade Response.

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.

WebSocket Upgrade Request

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```
GET /chat HTTP/1.1
Host:  server.example.com
Upgrade:  WebSocket
Connection:  Upgrade
Sec-WebSocket-Key:
dGhlIHNhbXBsZSBub25jZQ==
Origin:  http://example.com
Sec-WebSocket-Protocol:
chat, superchat
Sec-WebSocket-Version:  13
```

WebSocket Upgrade Request

▶ HTTP GET request.

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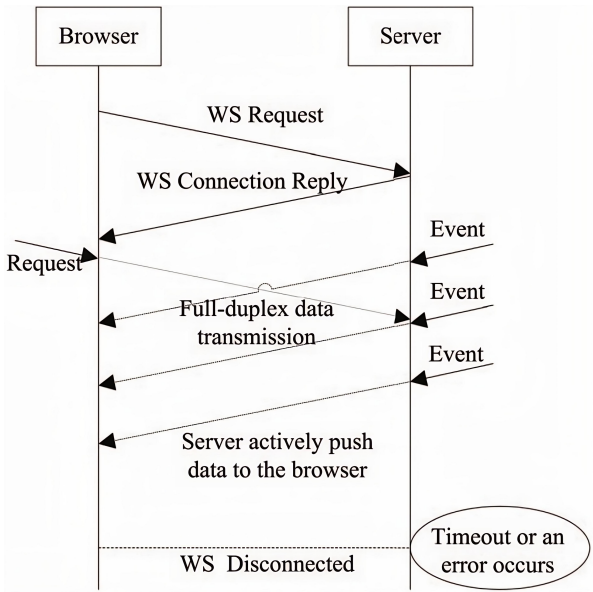
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► HTTP GET request.
► URI to identify endpoint.

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

WebSocket Upgrade Request

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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.

WebSocket Upgrade Request

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- ▶ WebSocket protocols.

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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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- ▶ WebSocket protocols.
- ▶ WebSocket version.

WebSocket Upgrade Response

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```
HTTP/1.1 101 Switching
protocols
Upgrade:  WebSocket
Connection:  Upgrade
Sec-WebSocket-Accept:
dGhlIHNhbXBsZSBub25jZQ==
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WebSocket Upgrade Response

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▶ Server confirms it supports WebSocket.

WebSocket Upgrade Response

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▶ Server confirms it supports WebSocket.

▶ Server proves that it can use WebSocket. Client checks it.

WebSocket Upgrade Response

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```

▶ Server confirms it supports WebSocket.

▶ Server proves that it can use WebSocket. Client checks it.

▶ Server tells which protocol it supports.

WebSocket Frame

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

WebSocket Frame

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▶ 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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▶ 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.

WebSocket Frame Structure

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-------+-+-------------+-------------------------------+
|F|R|R|R| opcode|M| Payload len |    Extended payload length    |
|I|S|S|S|  (4)  |A|     (7)     |             (16/64)           |
|N|V|V|V|       |S|             |   (if payload len==126/127)   |
| |1|2|3|       |K|             |                               |
+-+-+-+-+-------+-+-------------+ - - - - - - - - - - - - - - - +
|     Extended payload length continued, if payload len == 127  |
+ - - - - - - - - - - - - - - - +-------------------------------+
|                               |Masking-key, if MASK set to 1  |
+-------------------------------+-------------------------------+
| Masking-key (continued)       |          Payload Data         |
+-------------------------------- - - - - - - - - - - - - - - - +
:                     Payload Data continued ...                :
+ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - +
|                     Payload Data continued ...                |
+---------------------------------------------------------------+
```

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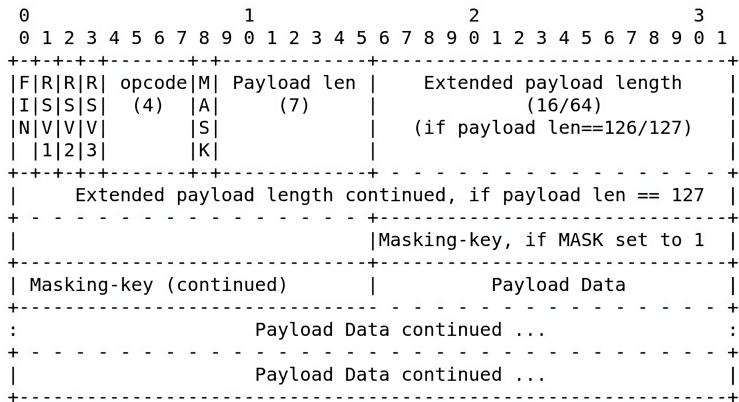
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