

Background

HTTP polling  
HTTP long polling  
Streaming

WebSocket  
protocol

Definition  
Handshake  
Upgrade Request  
Upgrade Response  
Frame  
API

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

Oleg Bilovus

Università degli Studi di Salerno

1st Scalability Research Forum

# Outline

WebSocket

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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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- ▶ *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**.

# HTTP polling

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

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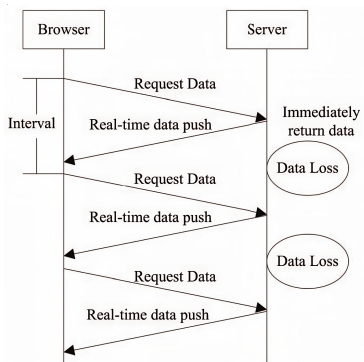
#### Handshake

##### Upgrade Request

##### Upgrade Response

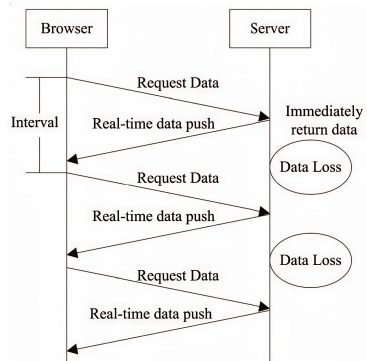
#### Frame

#### API



# HTTP polling

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



► How often to query?

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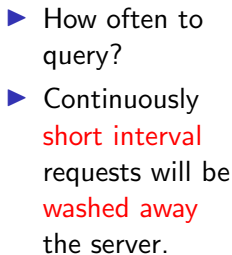
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# HTTP polling

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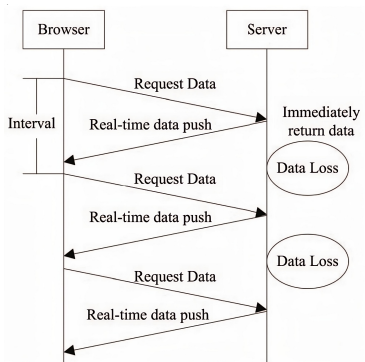
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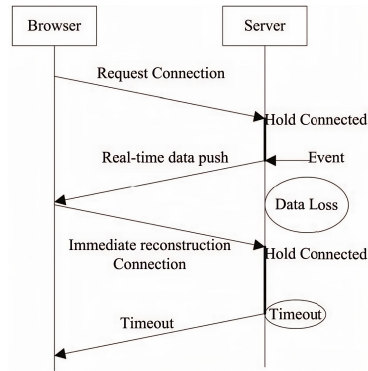
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- ▶ How often to query?
- ▶ Continuously **short interval** requests will be **washed away** the server.
- ▶ **Long interval** will require more time to reach the client, **no real-time** data.

# HTTP long polling

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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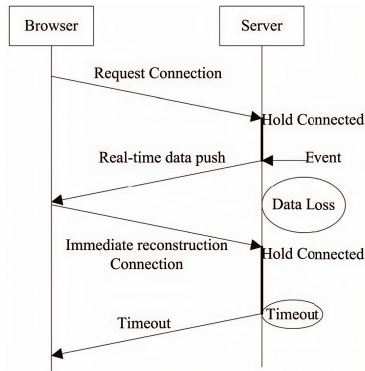
Upgrade Response

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# HTTP long polling

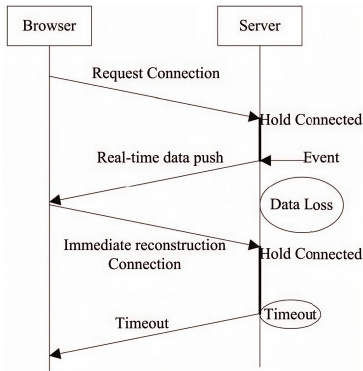
When a client sends a data request, the server will block the request until there is data transfer or timeout before returning.



► Solve the short polling frequency to access the server.

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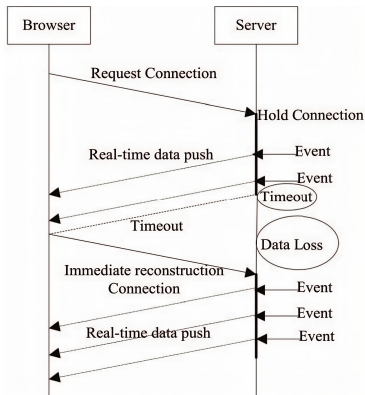
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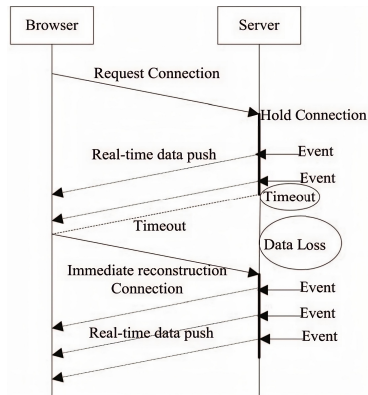
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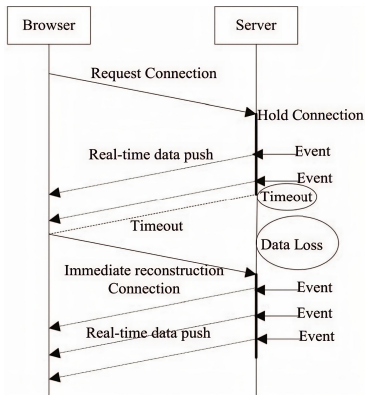
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- It can send multiple events from a single request.

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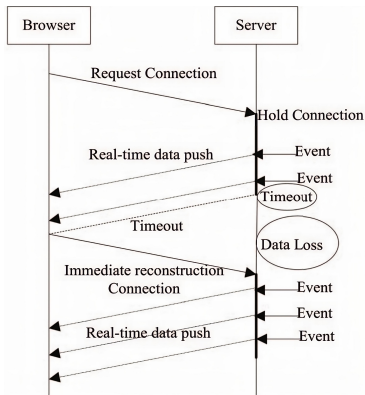
Iframe embed a hidden frame in an HTML page, then set it as a long connection request, thus the server can send data to the clients constantly.



- ▶ 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.

# 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.



- ▶ 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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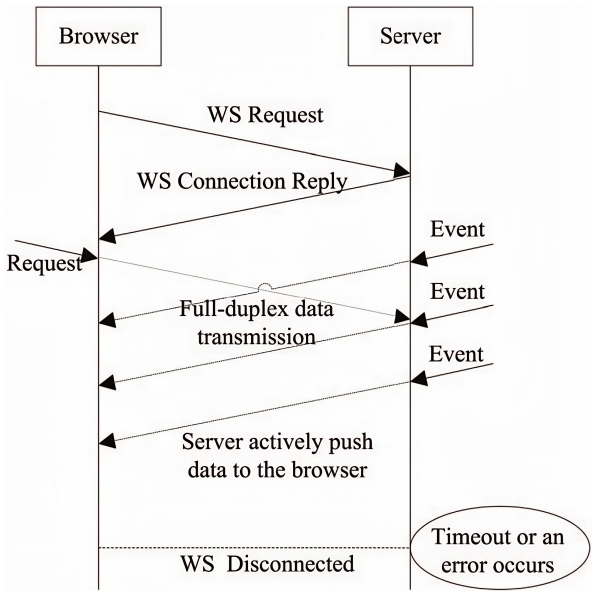
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# Handshake

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

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# Handshake

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- ▶ 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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- ▶ 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:
dGhlIHhnbXBsZSBub25jZQ==
Origin: http://example.com
Sec-WebSocket-Protocol:
chat, superchat
Sec-WebSocket-Version: 13
```

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► HTTP GET request.

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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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- ▶ HTTP GET request.
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- ▶ A key the server has to use to prove that it can use WebSockets.
- ▶ **WebSocket protocols.**

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chat, superchat
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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 protocols.
- ▶ **WebSocket version.**

# WebSocket Upgrade Response

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```
HTTP/1.1 101 Switching
protocols
Upgrade: WebSocket
Connection: Upgrade
Sec-WebSocket-Accept:
dGhlIHNBhbXBsZSBub25jZQ==
Origin: http://example.com
Sec-WebSocket-Protocol: chat
```

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► Server confirms it supports WebSocket.

HTTP/1.1 101 Switching  
protocols

Upgrade: WebSocket

Connection: Upgrade

Sec-WebSocket-Accept:

dGhlIHNBbXBsZSBub25jZQ==

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

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Upgrade: WebSocket

Connection: Upgrade

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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.

# WebSocket Frame

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



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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

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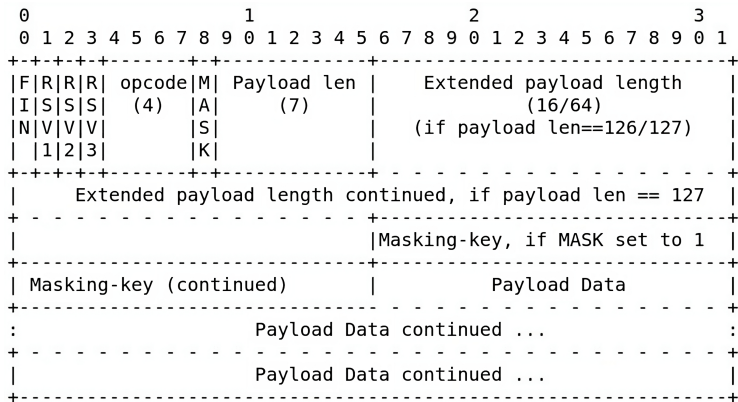
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# WebSocket API

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

Callback	textbfDescription
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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# References

-  Alexey Melnikov and Ian Fette, *The WebSocket Protocol*, RFC 6455, December 2011.
-  D. Skvorc, M. Horvat, and S. Srbljic, *Performance evaluation of websocket protocol for implementation of full-duplex web streams*, 2014 37th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO), 2014, pp. 1003–1008.
-  Lijing Zhang and Xiaoxiao Shen, *Research and development of real-time monitoring system based on websocket technology*, Proceedings 2013 International Conference on Mechatronic Sciences, Electric Engineering and Computer (MEC), 2013, pp. 1955–1958.

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