WebSockets

AJAX Summary

- Retrieve/Send data from the server after the page loads without a page reload
- To get new data from the server:
  - polling
  - long-polling
- If the server has new data to send to the client
  - Must wait for a poll request

WebSockets

- Two-way communication between server and client
  - Server can "push" new data to each client without being prompted by an HTTP request
- Enables real-time [minus network delays] communication between users
  - Without long-polling
- **Works by keeping a TCP socket open**

WebSocket Overview

- WebSocket protocol:
  - Establish a TCP connection
  - Client sends an HTTP request to upgrade to the WebSocket protocol
  - Server responds confirming the upgrade request
  - Client and server keep the TCP connection open
  - Client and server send WebSocket messages/frames over the TCP connection until one side closes the connection

WebSocket Handshake

- When the server receives a WebSocket HTTP request
  - Take steps to keep this TCP socket open as a WebSocket connection
  - These steps ensure that both client and server are speaking the same protocol
- After the handshake, client/server can both send messages over the socket

WebSocket Handshake

- Client sends an HTTP GET request to the WebSocket path
- Client sets headers
  - Connection: Upgrade
  - Upgrade: websocket
  - Sec-WebSocket-Key: <random_key>
- Server responds with 101 Switching Protocols with headers
  - Connection: Upgrade
  - Upgrade: websocket
  - Sec-WebSocket-Accept: <accept_response>

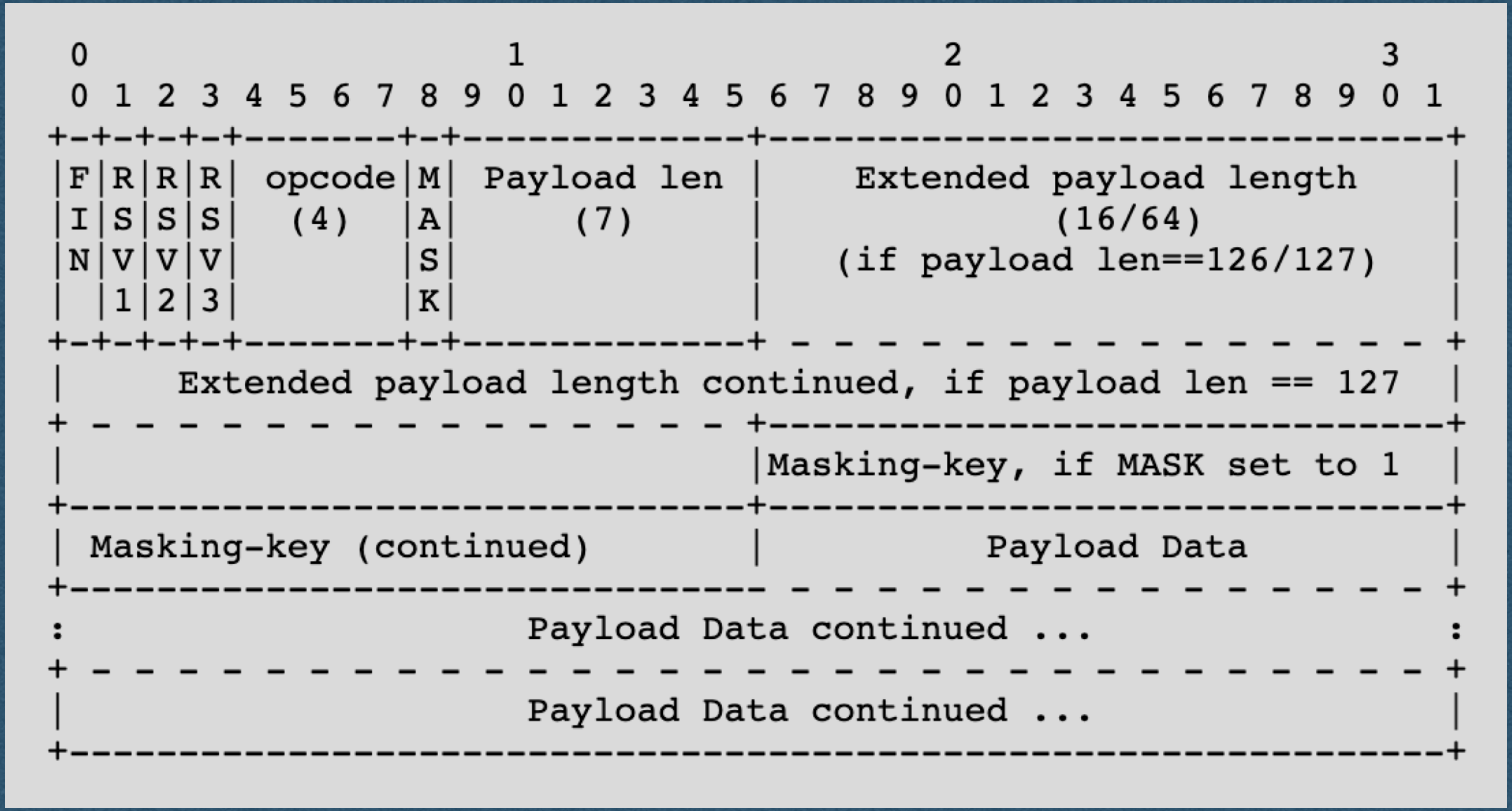
WebSocket Handshake

- The client generates a random "Sec-WebSocket-Key" for each new WebSocket connection
- The server appends a specific GUID to this key
  - "258EAFA5-E914-47DA-95CA-C5AB0DC85B11"
- Computes the SHA-1 hash
- "Sec-WebSocket-Accept" is the base64 encoding of the hash
- Why?
  - Ensure client and server both implement the protocol
    - Highly unlikely this value would be returned by accident
  - Avoid caching

WebSocket Frames

- Once the connection is established
  - Two-way communication via web socket frames
- A frame is a specifically formatted sequence of bits containing the message to be sent
  - Yes, bits! (And you thought bytes were fun!)
- Parse these bits to read the message

WebSocket Frame



```
 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 ...                |
+---------------------------------------------------------------+
```

https://tools.ietf.org/html/rfc6455#section-5.2

- We'll see how to parse through this on Wednesday

Web Sockets - Browser

- To setup a connection from the browser
- Create a new WebSocket object with the host/path to connect to
  - Choose a path and setup your server to accept WS requests on that path

```
let socket = new WebSocket('ws://' + window.location.host + '/socket');
socket.onmessage = renderMessages;

function sendMessage() {
    socket.send(JSON.stringify({'username': username, 'message': message}))
}

function renderMessages(message) {
    console.log(message.data);
}
```

Web Sockets - Browser

- Set onmessage to a function that will be called whenever a message is received
- The argument of the call will contain the message

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Web Sockets - Browser

- Call the send method to send a message to the server
- Can give it a String and the WebSocket object will convert it to a frame
    - We'll parse this frame on the server

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Examples

Concurrency