Future of WebSockets?

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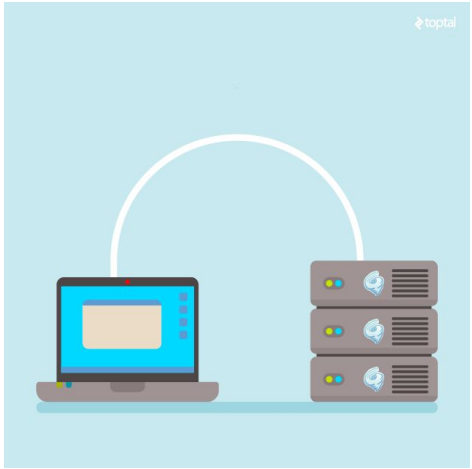
HTTP Workshop 2017

Outline

- Stats (Chrome, cloud)
- Solution space
- Discussion ...

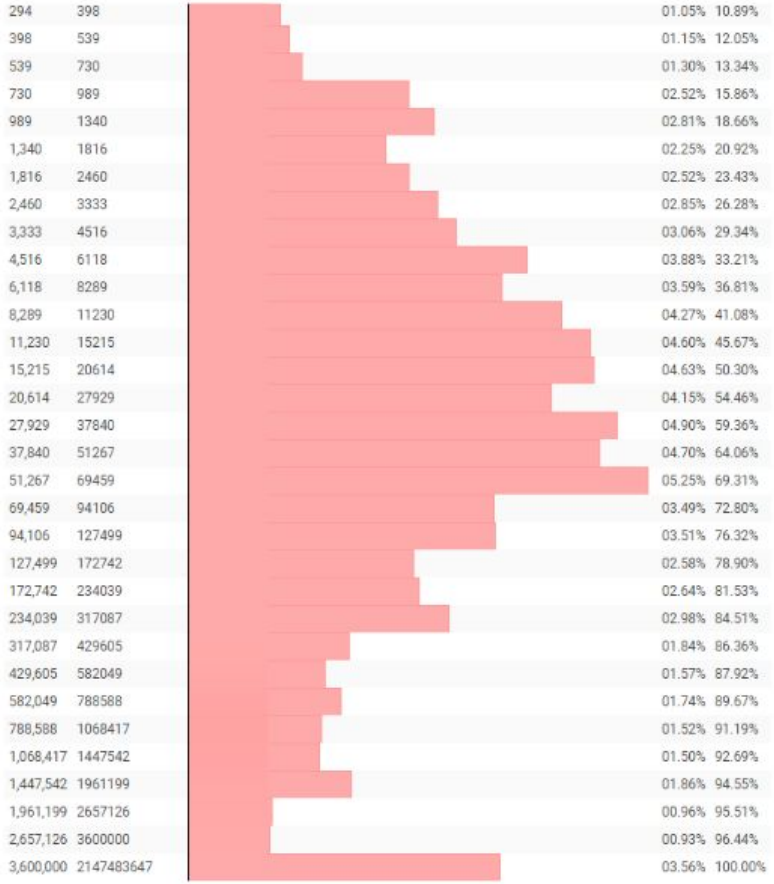


Chrome stats (adoption)

- ~10-100M connections
  - At any given time, # of open WS
- Out of all HTML pages
  - Async XHR: 44.5%
  - Fetch: 7.6%
  - WS: 3.7%
- ~7% dynamic pages use WS

Chrome stats (duration)

- 50 %ile: 20s
- 97 %ile: 3600s



294	398	01.05%	10.89%
398	539	01.15%	12.05%
539	730	01.30%	13.34%
730	989	02.52%	15.86%
989	1340	02.81%	18.66%
1,340	1816	02.25%	20.92%
1,816	2460	02.52%	23.43%
2,460	3333	02.85%	26.28%
3,333	4516	03.06%	29.34%
4,516	6118	03.88%	33.21%
6,118	8289	03.59%	36.81%
8,289	11230	04.27%	41.08%
11,230	15215	04.60%	45.67%
15,215	20614	04.63%	50.30%
20,614	27929	04.15%	54.46%
27,929	37840	04.90%	59.36%
37,840	51267	04.70%	64.06%
51,267	69459	05.25%	69.31%
69,459	94106	03.49%	72.80%
94,106	127499	03.51%	76.32%
127,499	172742	02.58%	78.90%
172,742	234039	02.64%	81.53%
234,039	317087	02.98%	84.51%
317,087	429605	01.84%	86.36%
429,605	582049	01.57%	87.92%
582,049	788588	01.74%	89.67%
788,588	1068417	01.52%	91.19%
1,068,417	1447542	01.50%	92.69%
1,447,542	1961199	01.86%	94.55%
1,961,199	2657126	00.96%	95.51%
2,657,126	3600000	00.93%	96.44%
3,600,000	2147483647	03.56%	100.00%

Chrome stats (connection success rate)

Chrome 58+, Stable releases

Windows

- ~60% over WS
- ~98% over HTTP/HTTPS

Other platforms

- Chromecast: 98%
- Android: 84%
- Chrome OS: 32%
- Linux: 20%
- Mac: 8%

Client-to-server message size (ArrayBuffer)

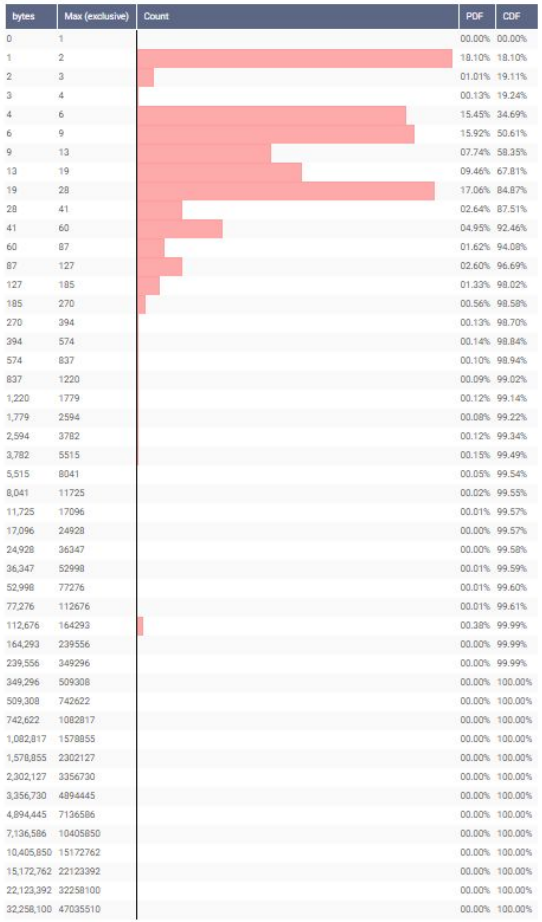
Dominated by small messages

- < 10 bytes

=>

- Variable length framing justified?
- Per-message compression

Chrome 58+, Stable releases, Windows



bytes	Max (exclusive)	Count	PDF	CDF
0	1		00.00%	00.00%
1	2		18.10%	18.10%
2	3		01.01%	19.11%
3	4		00.13%	19.24%
4	6		15.45%	34.69%
6	9		15.92%	50.61%
9	13		07.74%	58.35%
13	19		09.46%	67.81%
19	28		17.06%	84.87%
28	41		02.64%	87.51%
41	60		04.95%	92.46%
60	87		01.62%	94.08%
87	127		02.60%	96.69%
127	185		01.33%	98.02%
185	270		00.56%	98.58%
270	394		00.13%	98.70%
394	574		00.14%	98.84%
574	837		00.10%	98.94%
837	1220		00.09%	99.02%
1,220	1779		00.12%	99.14%
1,779	2594		00.08%	99.22%
2,594	3782		00.12%	99.34%
3,782	5515		00.15%	99.49%
5,515	8041		00.05%	99.54%
8,041	11725		00.02%	99.55%
11,725	17096		00.01%	99.57%
17,096	24928		00.00%	99.57%
24,928	36347		00.00%	99.58%
36,347	52998		00.01%	99.59%
52,998	77276		00.01%	99.60%
77,276	112676		00.01%	99.61%
112,676	164293		00.38%	99.99%
164,293	239556		00.00%	99.99%
239,556	349296		00.00%	99.99%
349,296	509308		00.00%	100.00%
509,308	742622		00.00%	100.00%
742,622	1082817		00.00%	100.00%
1,082,817	1578855		00.00%	100.00%
1,578,855	2302127		00.00%	100.00%
2,302,127	3356730		00.00%	100.00%
3,356,730	4894445		00.00%	100.00%
4,894,445	7136586		00.00%	100.00%
7,136,586	10405850		00.00%	100.00%
10,405,850	15172762		00.00%	100.00%
15,172,762	22123392		00.00%	100.00%
22,123,392	32258100		00.00%	100.00%
32,258,100	47035510		00.00%	100.00%

Client-to-server message size

1. ArrayBufferView
2. Blob

bytes	Max (exclusive)	Count	PDF	CDF
0	1		00.00%	00.00%
1	2		14.01%	14.01%
2	3		00.05%	14.07%
3	4		00.34%	14.40%
4	6		02.15%	16.55%
6	9		01.76%	18.32%
9	13		26.42%	44.73%
13	19		53.25%	97.98%
19	28		00.24%	98.22%
28	41		00.55%	98.77%
41	60		00.28%	99.05%
60	87		00.21%	99.26%
87	127		00.14%	99.40%
127	185		00.12%	99.52%
185	270		00.25%	99.77%
270	394		00.02%	99.79%
394	574		00.10%	99.89%
574	837		00.02%	99.91%
837	1220		00.01%	99.92%
1,220	1779		00.04%	99.96%
1,779	2594		00.01%	99.97%
2,594	3782		00.00%	99.98%
3,782	5515		00.00%	99.98%
5,515	8041		00.00%	99.98%
8,041	11725		00.00%	99.98%
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164,293	239556		00.00%	99.99%
239,556	349296		00.01%	100.00%
349,296	509308		00.00%	100.00%
509,308	742622		00.00%	100.00%
742,622	1082817		00.00%	100.00%
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2,302,127	3356730		00.00%	100.00%
3,356,730	4894445		00.00%	100.00%
4,894,445	7136586		00.00%	100.00%
7,136,586	10405850		00.00%	100.00%

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0	1		00.00%	00.00%
1	2		00.00%	00.00%
2	3		00.00%	00.00%
4	6		00.00%	00.00%
6	9		00.02%	00.02%
9	13		00.00%	00.02%
13	19		00.61%	00.63%
19	28		03.85%	04.48%
28	41		04.52%	09.00%
41	60		33.14%	42.14%
60	87		09.48%	51.62%
87	127		08.45%	60.07%
127	185		06.81%	66.88%
185	270		01.51%	68.40%
270	394		00.17%	68.57%
394	574		00.25%	68.82%
574	837		00.13%	68.95%
837	1220		18.03%	86.97%
1,220	1779		01.14%	88.12%
1,779	2594		10.58%	98.70%
2,594	3782		00.41%	99.10%
3,782	5515		00.15%	99.26%
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17,096	24928		00.02%	99.79%
24,928	36347		00.04%	99.83%
36,347	52998		00.05%	99.88%
52,998	77276		00.07%	99.95%
77,276	112676		00.02%	99.97%
112,676	164293		00.02%	99.99%
164,293	239556		00.00%	99.99%
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3,356,730	4894445		00.00%	100.00%
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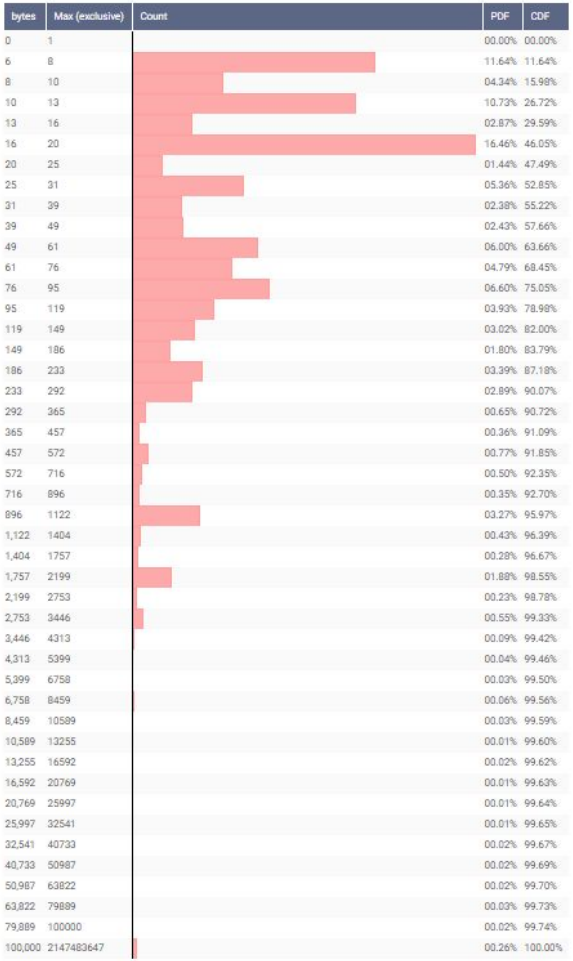
10,405,850	15172762		00.00%	100.00%
15,172,762	22123392		00.00%	100.00%
22,123,392	32258100		00.00%	100.00%
32,258,100	47035510		00.00%	100.00%
47,035,510	68582439		00.00%	100.00%
68,582,439	100000000		00.00%	100.00%
100,000,000	2147483647		00.00%	100.00%

Client-to-server I/O write size

Median: < 30 bytes



bytes	Max (exclusive)	Count	PDF	CDF
0	1		00.00%	00.00%
6	8		11.64%	11.64%
8	10		04.34%	15.98%
10	13		10.73%	26.72%
13	16		02.87%	29.59%
16	20		16.46%	46.05%
20	25		01.44%	47.49%
25	31		05.36%	52.85%
31	39		02.38%	55.22%
39	49		02.43%	57.66%
49	61		06.00%	63.66%
61	76		04.79%	68.45%
76	95		06.60%	75.05%
95	119		03.93%	78.98%
119	149		03.02%	82.00%
149	186		01.80%	83.79%
186	233		03.39%	87.18%
233	292		02.89%	90.07%
292	365		00.65%	90.72%
365	457		00.36%	91.09%
457	572		00.77%	91.85%
572	716		00.50%	92.35%
716	896		00.35%	92.70%
896	1122		03.27%	95.97%
1,122	1404		00.43%	96.39%
1,404	1757		00.28%	96.67%
1,757	2199		01.88%	98.55%
2,199	2753		00.23%	98.78%
2,753	3446		00.55%	99.33%
3,446	4313		00.09%	99.42%
4,313	5399		00.04%	99.46%
5,399	6758		00.03%	99.50%
6,758	8459		00.06%	99.56%
8,459	10589		00.03%	99.59%
10,589	13255		00.01%	99.60%
13,255	16592		00.02%	99.62%
16,592	20769		00.01%	99.63%
20,769	25997		00.01%	99.64%
25,997	32541		00.01%	99.65%
32,541	40733		00.02%	99.67%
40,733	50987		00.02%	99.69%
50,987	63822		00.02%	99.70%
63,822	79889		00.03%	99.73%
79,889	100000		00.02%	99.74%
100,000	2147483647		00.26%	100.00%

Server-to-Client message size (ArrayBuffer, Blob)

bytes	Max (exclusive)	Count	PDF	CDF
0	1		00.00%	00.00%
1	2		01.50%	01.50%
2	3		00.07%	01.56%
3	4		00.37%	01.94%
4	6		09.24%	11.18%
6	9		08.53%	19.72%
9	13		06.85%	26.57%
13	19		04.43%	31.00%
19	28		01.53%	32.53%
28	41		10.27%	42.80%
41	60		05.85%	48.66%
60	87		13.06%	61.72%
87	127		04.75%	66.47%
127	185		04.34%	70.81%
185	270		04.18%	74.99%
270	394		07.27%	82.26%
394	574		03.76%	86.02%
574	837		02.32%	88.34%
837	1220		02.77%	91.11%
1,220	1779		02.75%	93.87%
1,779	2594		01.54%	95.41%
2,594	3782		01.25%	96.66%
3,782	5515		01.05%	97.71%
5,515	8041		00.76%	98.48%
8,041	11725		00.49%	98.97%
11,725	17096		00.30%	99.27%
17,096	24928		00.16%	99.42%
24,928	36347		00.15%	99.58%
36,347	52998		00.15%	99.72%
52,998	77276		00.14%	99.87%
77,276	112676		00.07%	99.94%
112,676	164293		00.04%	99.97%
164,293	239556		00.01%	99.99%
239,556	349296		00.01%	100.00%
349,296	509308		00.00%	100.00%
509,308	742622		00.00%	100.00%
742,622	1082817		00.00%	100.00%
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32,258,100	47035510		00.00%	100.00%
47,035,510	68582439		00.00%	100.00%
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100,000,000	2147483647		00.00%	100.00%

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0	1		00.05%	00.05%
1	2		00.14%	00.18%
2	3		00.00%	00.18%
3	4		00.01%	00.19%
4	6		00.32%	00.51%
6	9		00.08%	00.59%
9	13		00.10%	00.69%
13	19		00.22%	00.91%
19	28		02.71%	03.62%
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8,041	11725		02.00%	96.65%
11,725	17096		00.62%	97.27%
17,096	24928		00.56%	97.83%
24,928	36347		00.35%	98.18%
36,347	52998		00.46%	98.64%
52,998	77276		00.44%	99.08%
77,276	112676		00.27%	99.35%
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15,172,762	22123392		00.00%	100.00%
22,123,392	32258100		00.00%	100.00%
32,258,100	47035510		00.00%	100.00%
47,035,510	68582439		00.00%	100.00%
68,582,439	100000000		00.00%	100.00%
100,000,000	2147483647		00.00%	100.00%

Comparison: streaming HTTP

Web, mobile ...

- No WebSocket traffic served in production
- Long-lived requests: < 10 min.

Buffering connections (HTTPS)

- 1-3% of production traffic
- ad-hoc method with false positive

Solution space

- Bidi end-points
  - RPC handshake, followed by an e2e session
  - In-order, full-duplex message delivery
  - Atomic or “fragmented” messages transfer

  Transport choices
  - TCP: WS, ...
  - HTTP/2: grpc.io, rsocket.io ...

  Canonical example: speech recognition
  - Causality, low-latency
  - Short-lived (e.g. 60s)

Solution space (cont'd)

- REST
  - POST, GET, streaming as optimization
  - Stateful, as an e2e concern, requires infrastructure support
- REST + Push
  - Push: hop by hop?
- P2P, PubSub's ...
- Web clients: > 90% "WS" use cases just want a better hanging GET

Discussion

Existing work

- WiSH: WS compatible byte-stream framing
- HTTP/2 frames => WS messages

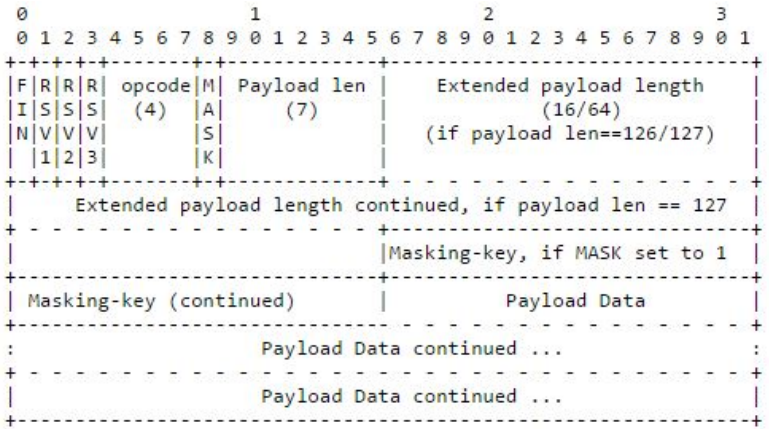
Questions

- WS over QUIC: any concern to mux different L7 protocols?
- ....

Appendix

WebSockets

RPC handshake + message-framed TCP byte stream



application/web-stream

https://tools.ietf.org/html/draft-yoshino-wish