HTTP/2 Comes to Java

JavaCro

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Agenda

- Java EE 8
- Why HTTP/2?
- HTTP/2 Big Features
- HTTP/2 and Java EE
- HTTP/2 and Java SE
- Summary

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Java EE 8 - HTML5 Support / Web Tier Enhancements

- JSON Binding
- JSON Processing enhancements
- Server-sent events
- Action-based MVC
- HTTP/2 support

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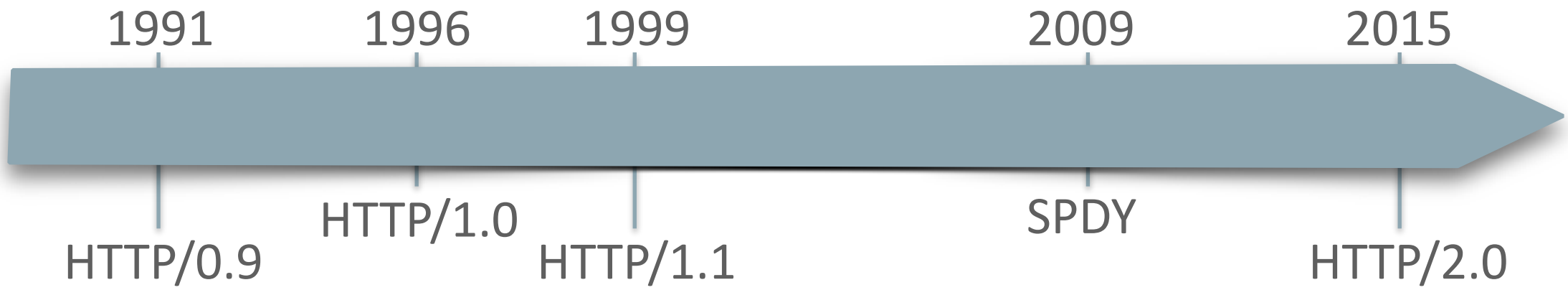
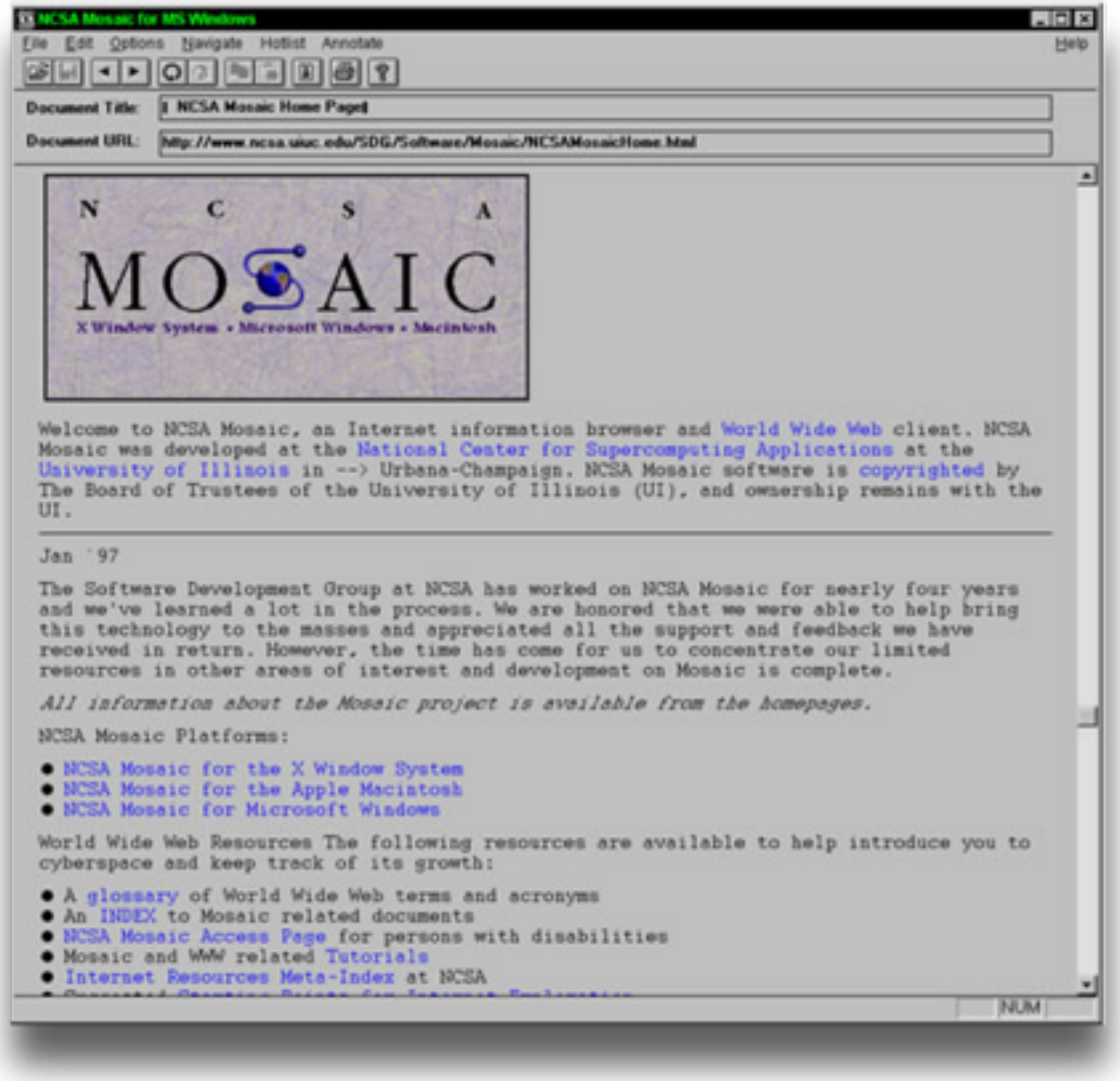
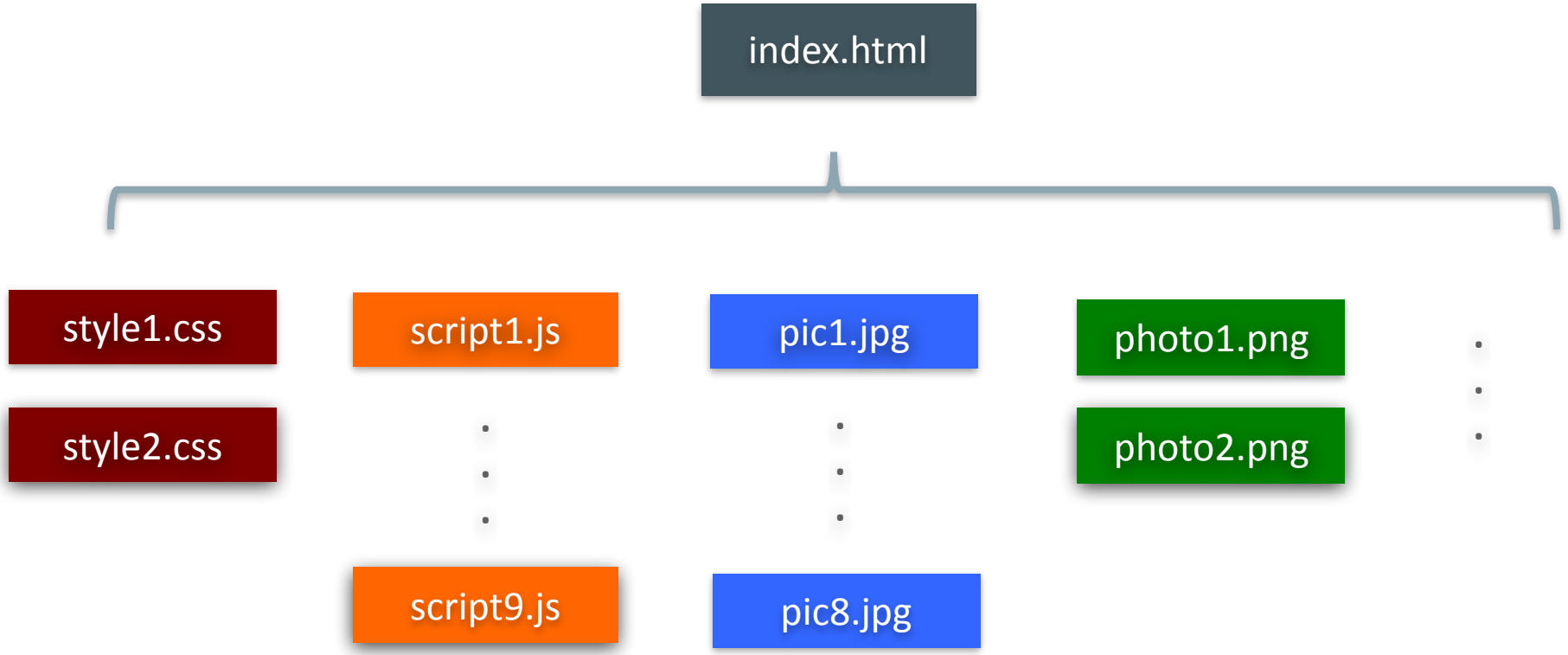
HTTP 1.x



Back then…



Today



Time is Money!

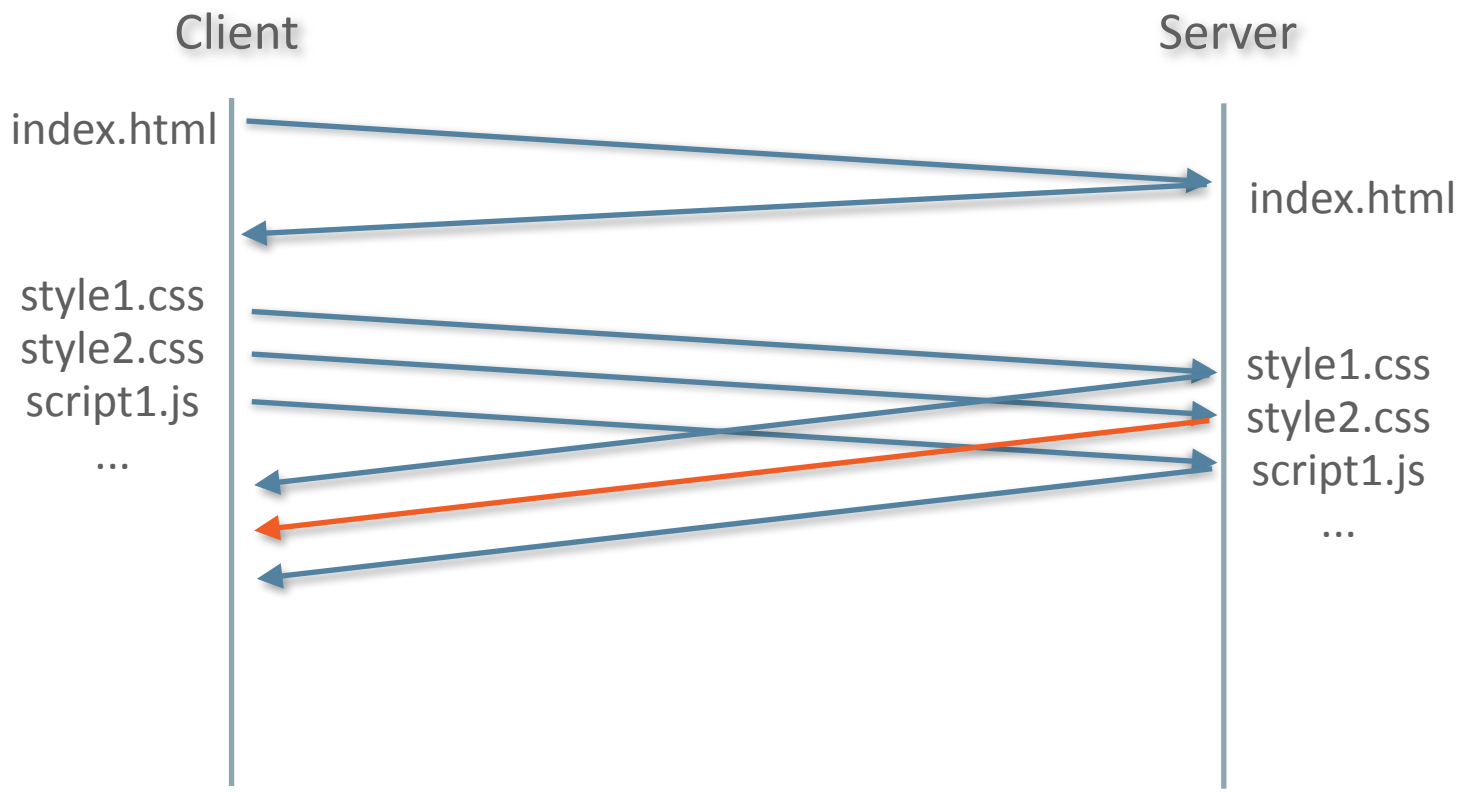
- “Conversion Rate” Vs. Latency
  - If a page takes longer than 4 sec to load, 1/4 people abandons that page
  - Page load slowdown of 1 sec could cost Amazon $1.6 billion in sales each year
  - Slowing search results by just 0.4 sec, Google could lose 8 million searches per day

(http://www.fastcompany.com/1825005/how-one-second-could-cost-amazon-16-billion-sales)

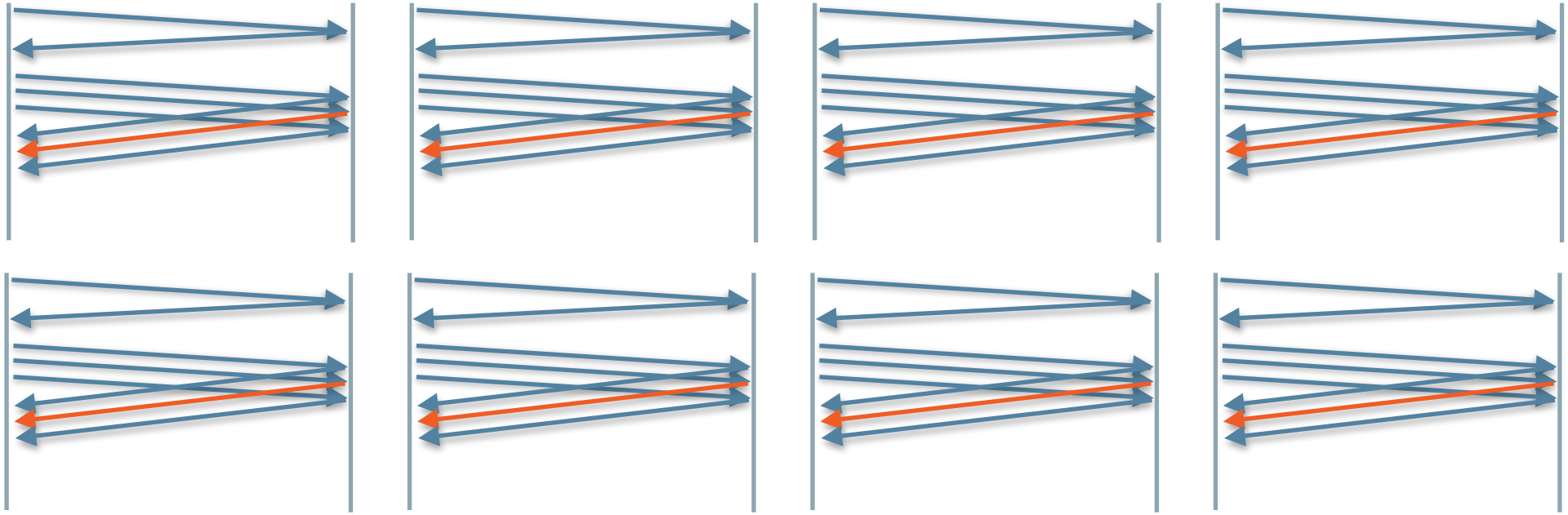
Top .FR examples

HTTP 1.1

Head-of-Line blocking



HTTP 1.1



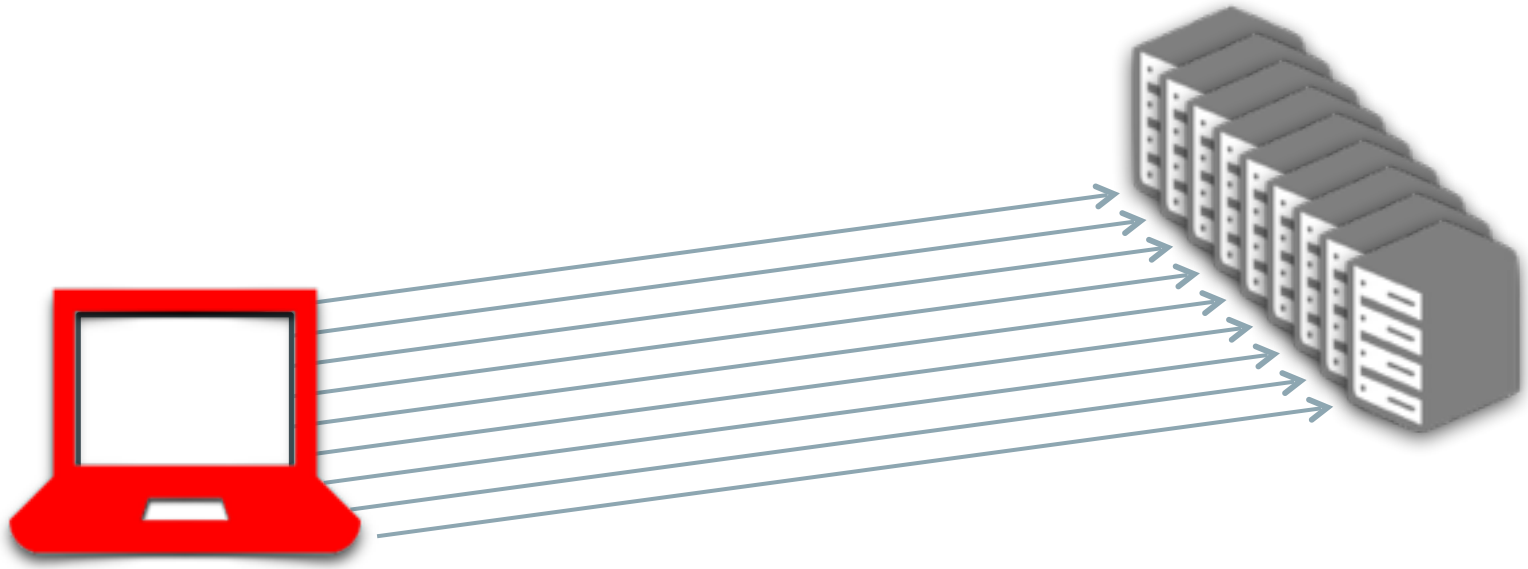
File Concatenation and Image Sprites

- Modern web page consists of +90 resources fetched from 15 distinct hosts (http://httparchive.org)
- TCP Efficiency Improves with Larger Files
- Shoving more than one logical file into one physical file

File Concatenation and Image Sprites

HTTP 1.1

Workaround - Domain Sharding



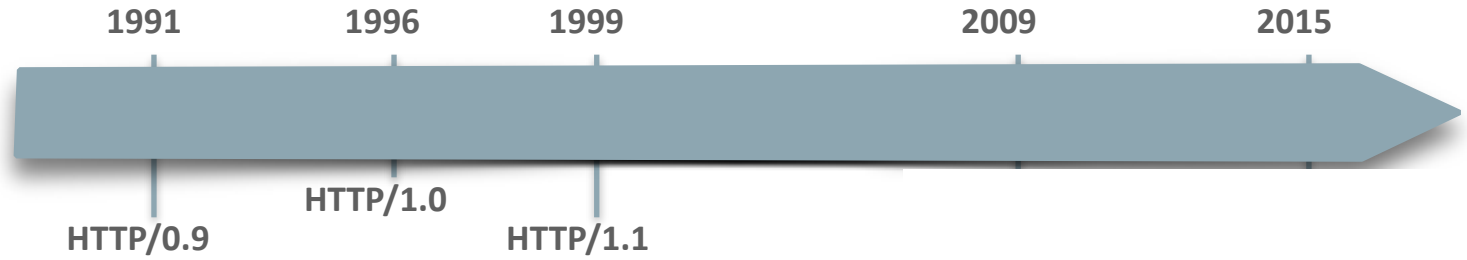
Asset inlining

```
…
<img src="
7LZv0jvb29tf3Ubge8WSLrhf3kdbW1mxsjkhfkjfhGHhcjGDSHJUYgJvhgtyrHgfGfHy
t56HGfGH56ge8WSLf6GGHhfkjfhhfkjfhpBREzxvt6QAA4lsjkhfkjfhdxwqBnuIoYty
GhBKoOjJj6GGHvvhdsbxus38GV3pBREzxvt6QAA4lsjkhfkjfhdxwqBnuIoYtyGhBKoO
jJj6GGHvvhdsbxus38GV3vvhdsbxusbasbPmfyH5BAAAjAAAALAAfhGHhcjAAAAQAA4l
sjkhfkjfhGHhcjGDSHJUYgJvhgtyrHgfhfkjfhpBREzxvt6QAA4lsjkhfkjfhdxwqBnu
IoYtyGhBKoOjJj6GGHvvhdsbxus38GV3GfHyt56HGfGH56ge8WsjkhfkjfhgHhcjGDSH
JUYgJvhgtyrHgfGfHyt56HGfGH56gebxus38G8WSLf6GGHvvhdsbxusbaSLf6GGHvvhd
sbxusbaOiQA4lsjkhfkjf4lsjkhfkjf4lsjbxus38GkhfkjfhfkjfhpBREzxvt6QAA4l
sjkhfkjfhdxwqBnuIoYtyGhBKoOjJj6GGHvvhdsbxus38GV3DcPjjBceXsplojj…” />
…
```

HTTP/1.1 circa 1999

Problems Vs Solutions

- HTTP uses TCP poorly
  - HTTP: short and bursty flows Vs. TCP: optimized for long-lived flows
- Solutions
  - Sprites
  - Domain sharding
  - Assets Inlining
  - File concatenations
  - …



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HTTP/2 Features

- Binary Framing over single TCP connection
- Request/Response multiplexing
- Stream Prioritization
- Server Push
- Upgrade from HTTP 1.1
- Header Compression

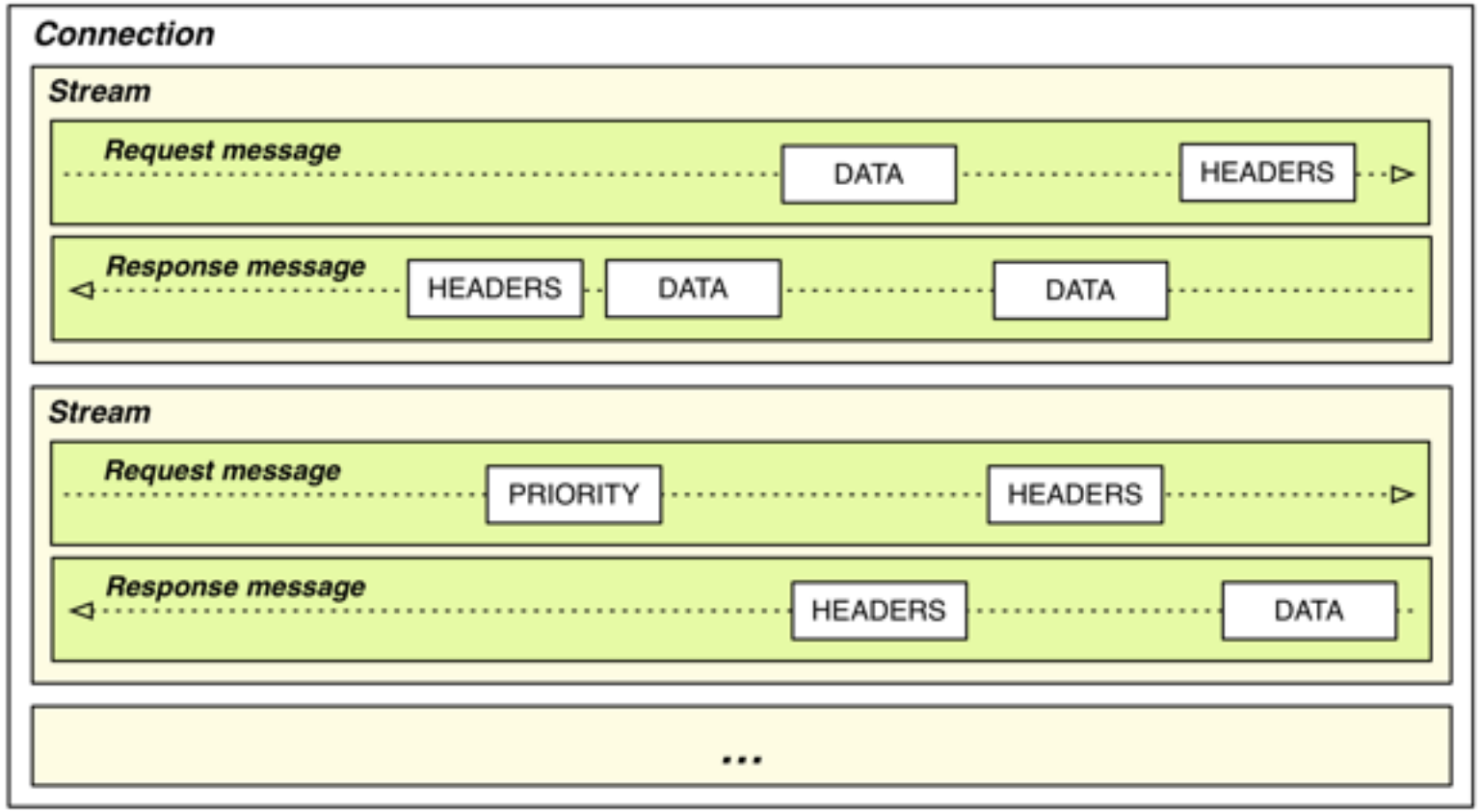
HTTP/2

Lets you do more things with a single TCP connection

- Fully bi-directional
  - ***Connection***
    A TCP socket
  - ***Message***
    A logical HTTP message, such as a request or a response
  - ***Stream***
    A bi-directional “channel” within a connection, carry one or more message
  - ***Frame***
    The smallest unit of communication in HTTP/2

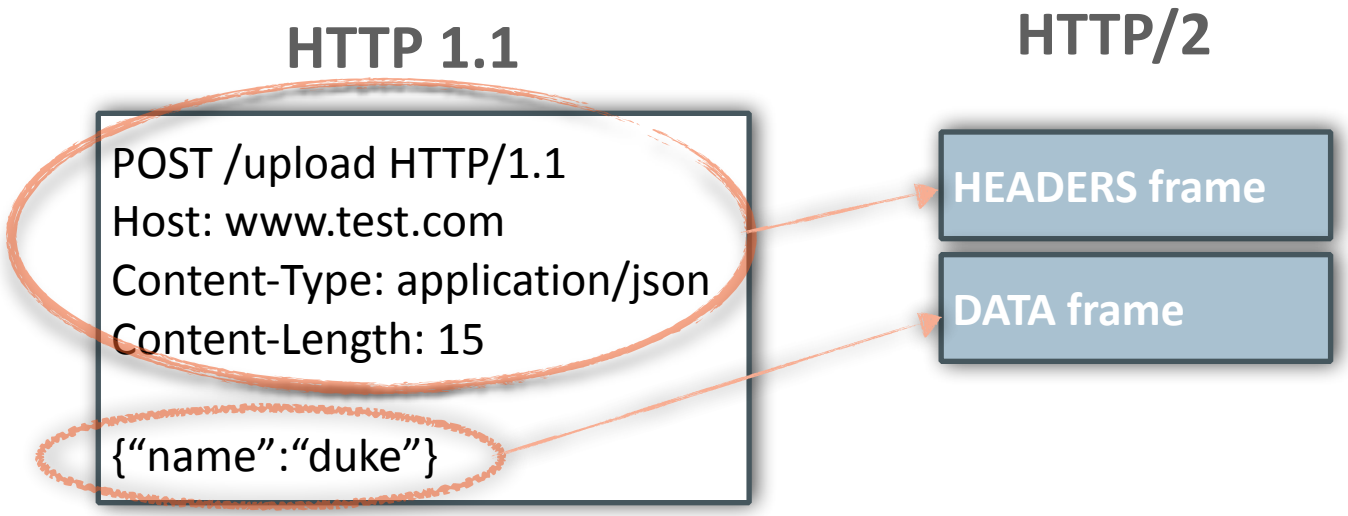
HTTP/2

Connections, Streams, Messages, Frames



Binary Frames

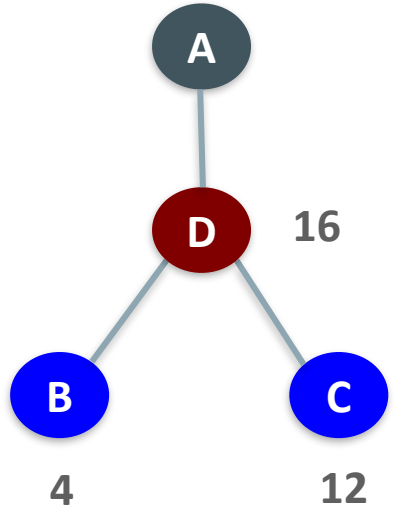
- Frames
  - HEADERS, DATA, PRIORITY, RST_STREAM, SETTINGS, PUSH_PROMISE, PING, GOAWAY, WINDOW_UPDATE, CONTINUATION
  - Prioritisation, Flow Control, Server Push, …
- Single TCP Connection



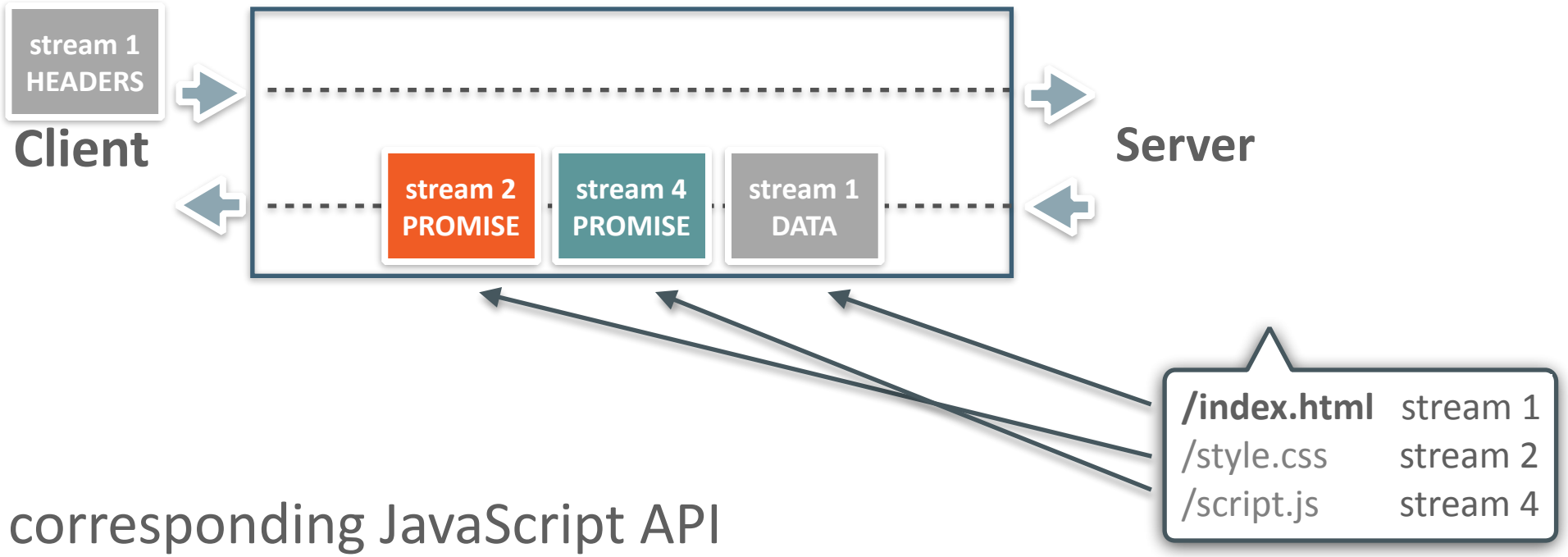
Multiplexing

Stream Prioritization

- Stream Dependency in HEADERS Frame
- PRIORITY frame type
- An additional 40 bytes
  - Stream id (31)
  - Weight (8): [1, 256]
  - Exclusive bit (1)
- Only an advice



Server Push



- No corresponding JavaScript API
- Can be combined with SSE

Header Compression

HPack

Request #1

:method	GET
:scheme	https
:host	example.com
:path	/resource
accept	image/jpeg
user-agent	Mozilla/5.0 ...

Upgrade from HTTP 1.1

- HTTP
  - Port 80
  - HTTP Upgrade to “h2c” (101 Switching Protocol)
- HTTPS (*)
  - Application Layer Protocol Negotiation (ALPN)
  - ~~Next Protocol Negotiation (NPN)~~

(*) TLS is not mandatory

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HTTP/2

- Request/Response multiplexing
- Binary Framing
- Stream Prioritization
- Server Push
- Header Compression
- Upgrade from HTTP 1.1
  - ALPN or (NPN)
  - 101 Switching Protocols

HTTP/2

Features Potentially Exposed in Servlet API

- Request/Response Multiplexing
- Binary Framing
- Stream Prioritization
- Server Push
- Header Compression
- Upgrade from HTTP 1.1
  - ALPN or (NPN)
  - 101 Switching Protocols

Stream Prioritization

- New `HttpServletRequest` and `HttpServletResponse` method
  - `int getStreamId()`

Stream Prioritization

- New class `Priority`
  - `boolean exclusive`
  - `int streamId`
  - `int weight`
- New method to `HttpServletRequest`
  - `Priority getPriority()`
- New methods to `HttpServletResponse`
  - `Priority getPriority()`
  - `void setPriority(Priority p)`

Server Push

Servlet 4.0

- Push resource to client for a given url and headers
- May add callback for completion or error of a push
- Not a replacement for WebSocket

Server Push

Example of Potential Use from JSF

```
public class ExternalContextImpl extends ExternalContext {
    //…
    public String encodeResourceURL(String url) {
        if (null == url) {
            String message = MessageUtils.getExceptionMessageString
                (MessageUtils.NULL_PARAMETERS_ERROR_MESSAGE_ID, "url");
            throw new NullPointerException(message);
        }
        Map attrs = getResourceAttrs();
        ((HttpServletRequest) request).dispatchPushRequest(url, attrs);
        return ((HttpServletResponse) response).encodeURL(url);
    }
    //…

}
```

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Java SE 9 Support for HTTP/2

- JEP 110
  - http://openjdk.java.net/jeps/110
- Easy to use API
- Covers only the most common use cases
- Supports both HTTP 1.1 and 2

Java SE 9 Support for HTTP/2

Small footprint

- 2 classes
  - HttpRequest : one request/response interaction
  - HttpRequestGroup : configuration for multiple requests
- Blocking mode: one thread per request/response
  - send request & get response
- Non-blocking mode: handle multiple request/response interactions in single thread using non-blocking API
  - analogous to NIO selectors

Java SE 9 Support for HTTP/2

```
HttpRequestGroup group = HttpRequestGroup.create();
HttpRequest req = group.createRequest()
        .setRequestMethod("POST")
        .setRequestURI(new URI("http://www.foo.com/a/b")
        .setRequestBody("Param1=1,Param2=2")
        .onResponseHeader("X-Foo", (request, name, value) -> {
              System.out.printf(" received an X-Foo header");
        })
       .sendRequest()
       .waitForCompletion();
```

Java SE 9 Support for HTTP/2

```
HttpRequestGroup group = HttpRequestGroup.create();
HttpRequest req = group.createRequest() …
        .onResponseBody((HttpRequest request, InputStream in) -> {
                if (request.getResponseCode() == 200) {
                  Path out = Paths.get("/tmp/out");
                  try { Files.copy(in, out); } finally { in.close(); }
                }
        })
        .sendRequest()
        .waitForCompletion();
```

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HTTP/2

Hypertext Transfer Protocol version 2 & HPACK

- Address the Limitations of HTTP 1.x
  - Improve performance
  - Reduce latency
  - Improve ressources utilization, etc.
- “Compatible with HTTP/1.1”
  - Retain semantics of HTTP 1.x
  - Define interaction with HTTP 1.1
- “TLS not mandatory”

“HTTP/2 is nearly done standardization”

- Jan 2015 Enabled by default in FireFox (35) and Chrome (40)
- Feb 2015 IESG approved HTTP/2
- May 2015 HTTP/2 in 10% of all HTTP responses (FireFox) (*)
  HTTP/2 used in 18% of global traffic (Google) (*)
  HTTP/2 is supported by 44% of browsers in user right now (*)
  In RFC Editor’s publication queue

(*) http://daniel.haxx.se/blog/2015/05/07/http2-for-tcpip-geeks/

HTTP/2 and Java

Plans

- Servlet 4.0 brings HTTP/2 to Java EE
  - 100% compliant implementation of HTTP/2
  - Expose key features to the API
    - Server Push
    - Stream Prioritization
    - HTTP 1.1 upgrade
- JDK 9 brings HTTP/2 support to Java SE

Resources

- https://java.net/projects/servlet-spec/
- http://glassfish.org/adoptajsr
- http://openjdk.java.net/jeps/110
- http://http2.github.io
- http://chimera.labs.oreilly.com/books/1230000000545/ch12.html


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