SSL/TLS and HTTP/2 State of the Art in Our Servers

Jean-Frederic Clere

What I will cover

- HTTP/2
  - HTTP/2 and ALPN
- Servers
  - Apache HTTPD
  - Tomcat
  - Traffic server
- Demos
- Questions?

Who I am

Jean-Frederic Clere

Red Hat

Years writing JAVA code and server software

Tomcat committer since 2001

Doing OpenSource since 1999

Cyclist/Runner etc

Lived 15 years in Spain (Barcelona)

Now in Neuchâtel (CH)

Why HTTP/2

- HTTP/1.1: June 1999 (RFC 2616)
  - 1999:
    - 1 page ~ 1kB HTML
  - 2015:
    - 1 page ~ 3MB HTML + IMAGES + JS + CSS etc
- Protocol:
  - Not adapted / inefficient / etc

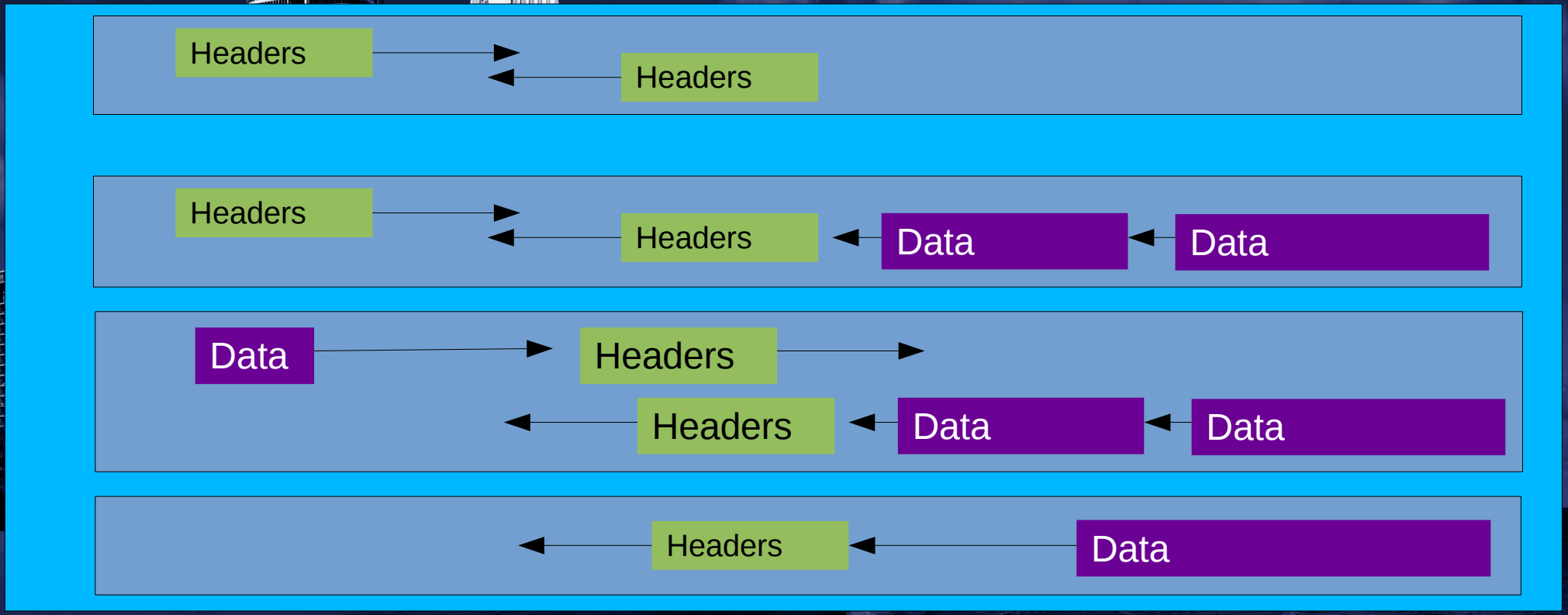
HTTP/2 general

- HTTP/2:
  - Binary
  - Frame
  - Multiplex
  - Based on SPDY
  - TLS everywhere:
    - Browers use https and strong ciphers
  - No forward proxy
  - h2c: Clear text only with reverse proxy (proxy to back-end server) requires upgrade.

HTTP/2 general

- Two specifications:
  - Hypertext Transfer Protocol version 2 - RFC7540
  - HPACK - Header Compression for HTTP/2 - RFC7541
- By the Internet Engineering Task Force
- ALPN Application-Layer Protocol Negotiation - RFC 7301

HTTP/2 Multiplexed



HTTP/2 : more

- HTTP headers compression
  - ~ 80 % save
- Request priority
  - Both sides
- Server Push
  - Prevent round trip to get element of a page
  - Faster / better rendering on browsers.

HTTP/2 When Browsers

- Browser with HTTP/2 and TLS
  - FireFox 34
  - Chrome 40 (with ALPN before was NPN)
  - IE 11
  - Opera and Safari 9
- Stats from docs.trafficserver and ci.trafficserver:
  - 80% is over HTTP/2 (data from 23th of September)
- → go for it now!

ALPN Client Hello (Firefox)

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	::1	::1	TCP	94	46254→8443 [SYN]
2	0.000032000	::1	::1	TCP	94	8443→46254 [SYN,
3	0.000049000	::1	::1	TCP	86	46254→8443 [ACK]
4	0.000311000	::1	::1	TLSv1.2	603	Client Hello
5	0.000321000	::1	::1	TCP	86	8443→46254 [ACK]
6	0.001006000	::1	::1	TLSv1.2	232	Server Hello, Cha
7	0.001019000	::1	::1	TCP	86	46254→8443 [ACK]
8	0.001257000	::1	::1	TLSv1.2	137	Change Cipher Spe
9	0.001471000	::1	::1	TLSv1.2	243	Application Data
10	0.001494000	::1	::1	TLSv1.2	318	Application Data
11	0.001859000	::1	::1	TLSv1.2	130	Application Data
12	0.001906000	::1	::1	TLSv1.2	124	Application Data
13	0.003090000	::1	::1	TLSv1.2	124	Application Data
14	0.003138000	::1	::1	TLSv1.2	132	Application Data

```
    ALPN Extension Length: 39
  ▼ ALPN Protocol
      ALPN string length: 5
      ALPN Next Protocol: h2-16
      ALPN string length: 5
      ALPN Next Protocol: h2-15
      ALPN string length: 5
      ALPN Next Protocol: h2-14
      ALPN string length: 2
      ALPN Next Protocol: h2
      ALPN string length: 8
      ALPN Next Protocol: spdy/3.1
      ALPN string length: 8
      ALPN Next Protocol: http/1.1
  ▼ Extension: status_request
```

ALPN Server Hello (tomcat)

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	::1	::1	TCP	94	46254→8443 [SYN] Seq=0 Win=
2	0.000032000	::1	::1	TCP	94	8443→46254 [SYN, ACK] Seq=0
3	0.000049000	::1	::1	TCP	86	46254→8443 [ACK] Seq=1 Ack=
4	0.000311000	::1	::1	TLSv1.2	603	Client Hello
5	0.000321000	::1	::1	TCP	86	8443→46254 [ACK] Seq=1 Ack=
6	0.001006000	::1	::1	TLSv1.2	232	Server Hello, Change Cipher
7	0.001019000	::1	::1	TCP	86	46254→8443 [ACK] Seq=518 Ack
8	0.001257000	::1	::1	TLSv1.2	137	Change Cipher Spec, Hello R
9	0.001471000	::1	::1	TLSv1.2	243	Application Data
10	0.001494000	::1	::1	TLSv1.2	318	Application Data
11	0.001859000	::1	::1	TLSv1.2	130	Application Data
12	0.001906000	::1	::1	TLSv1.2	124	Application Data
13	0.003090000	::1	::1	TLSv1.2	124	Application Data
14	0.003138000	::1	::1	TLSv1.2	132	Application Data

```
    Cipher Suite: TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256 (0xc02f)
    Compression Method: null (0)
    Extensions Length: 14
  ▼ Extension: renegotiation_info
      Type: renegotiation_info (0xff01)
      Length: 1
    ▶ Renegotiation Info extension
  ▼ Extension: Application Layer Protocol Negotiation
      Type: Application Layer Protocol Negotiation (0x0010)
      Length: 5
      ALPN Extension Length: 3
    ▼ ALPN Protocol
        ALPN string length: 2
        ALPN Next Protocol: h2
```

Requirements

- OpenSSL for our 3 servers
  - At least 1.0.2c
- Tomcat (8.5 / trunk)
  - Tomcat-native (1.2.6 / trunk)
- Httpd (2.4.17 / trunk)
  - HTTP/2 C Library (libnghttp2)
- TrafficServer (since ATS v5.3.2).
  - Nothing except openssl.

Status

- Tomcat (trunk/8.5)
  - Full support / released as stable.
  - Needs servlet 4.0 (JSR 369) for server PUSH API
  - Can't be full JAVA until JDK9 (ALPN support)
- Httpd (available since 2.4.17)
  - Full support (since 2.4.20)
- TrafficServer (since 5.3.0) (flow control 6.1)
  - Missing Priorities (6.2?) and Server PUSH (later)

TC connector server.xml

```
<Connector
    port="8002"
    scheme="https"
    SSLEnabled="true"
    ciphers="TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256"
    SSLCertificateFile="/home/jfclere/CERTS/newcert.pem"
    SSLCertificateKeyFile="/home/jfclere/CERTS/newkey.txt.pem"
    protocol="org.apache.coyote.http11.Http11AprProtocol">
     <UpgradeProtocol className="org.apache.coyote.http2.Http2Protocol" />
 <Connector/>



 <Connector port="8003" protocol="HTTP/1.1"
          SSLEnabled="true" scheme="https" secure="true"
          keystoreFile="conf/.keystore" keystorePass="changeit"
          socket.directBuffer="true" socket.directSslBuffer="true">
          <UpgradeProtocol className="org.apache.coyote.http2.Http2Protocol" />
 </Connector>
```

Tomcat / configuration

In bin/setenv.sh:

LD_LIBRARY_PATH=/home/jfclere/tomcat-native/native/.libs

export LD_LIBRARY_PATH

And the libtcnative-1.so linked with openssl-1.0.2c, checking with ldd:

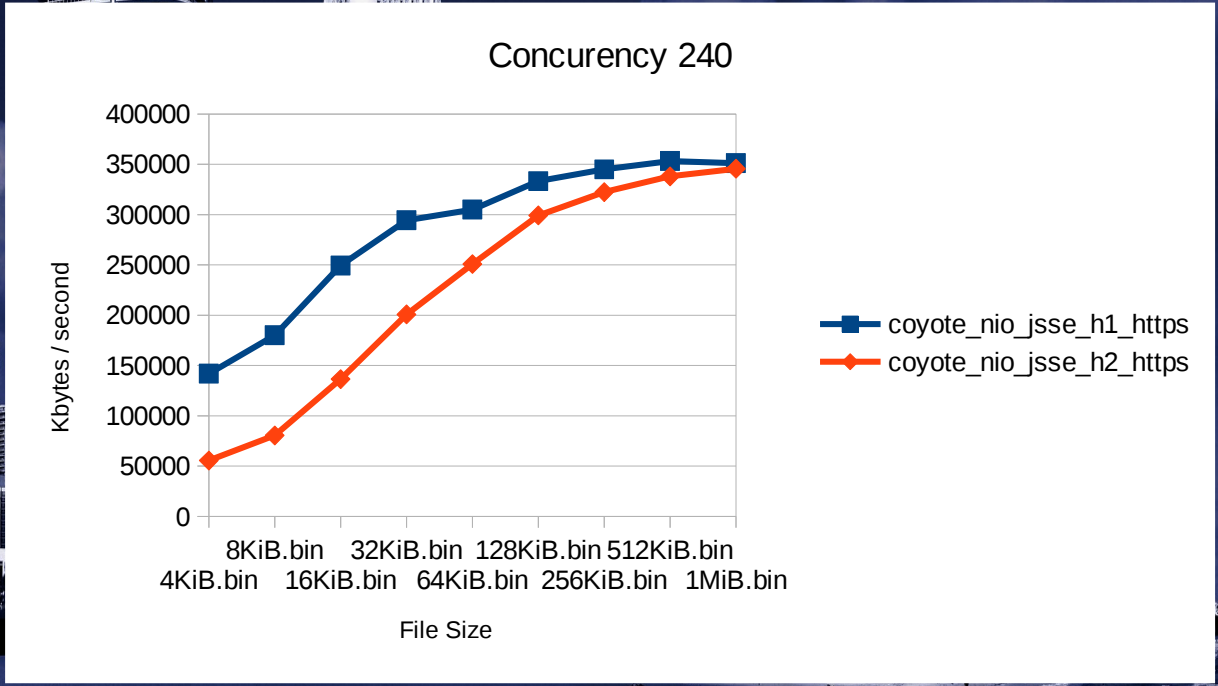
libssl.so.1.0.0 => /home/jfclere/OPENSSL-1.0.2c/lib/libssl.so.1.0.0 (0x00007f6ab147b000)

libcrypto.so.1.0.0 => /home/jfclere/OPENSSL-1.0.2c/lib/libcrypto.so.1.0.0 (0x00007f6ab1028000)

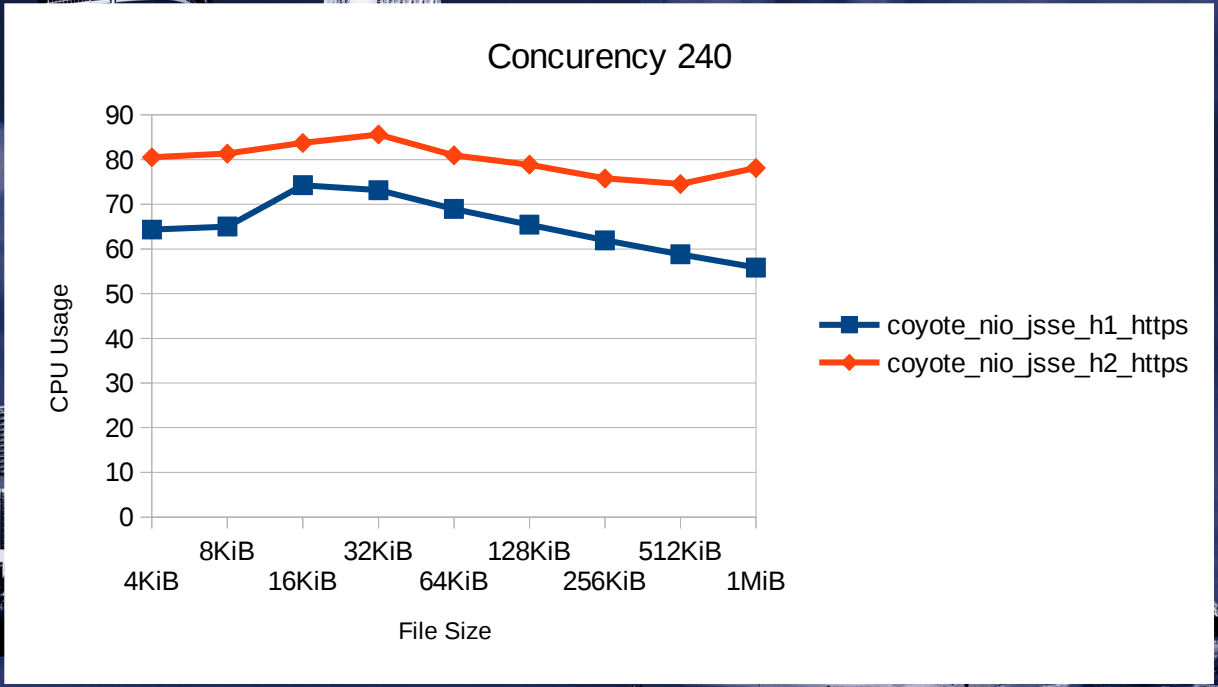
libapr-1.so.0 => /home/jfclere/APR-1.4.x/lib/libapr-1.so.0 (0x00007f6ab0dfa000)

Usually the openssl of recent distribution (fedora 23) will work.

Tomcat / Performances



Tomcat/ Performances



Tomcat / Demo

- No server push (may be change it: SimpleImagePush)
- Multiplexing
- headers compression
- Page html page:
  - That requires a lot (~1000) of (~4Kbytes) images to render.

TrafficServer / Configuration

- records.config
  - CONFIG proxy.config.ssl.number.threads INT 0
  - **CONFIG proxy.config.http.server_ports STRING 8888:ssl**
  - CONFIG proxy.config.url_remap.pristine_host_hdr INT 1
  - CONFIG proxy.config.http2.enabled INT 1
  - CONFIG proxy.config.ssl.TLSv1_1 INT 1
  - CONFIG proxy.config.ssl.TLSv1_2 INT 1
- ssl_multicert.config:
  - **dest_ip=* ssl_cert_name=newcert.pem ssl_key_name=newkey.txt.pem**
- remap.config:
  - **map / http://127.0.0.1:8080**
- ip_allow.config:
  - src_ip=**192.168.1.38** action=ip_allow method=ALL
  - src_ip=::-ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff action=ip_allow method=ALL

TrafficServer / Demo

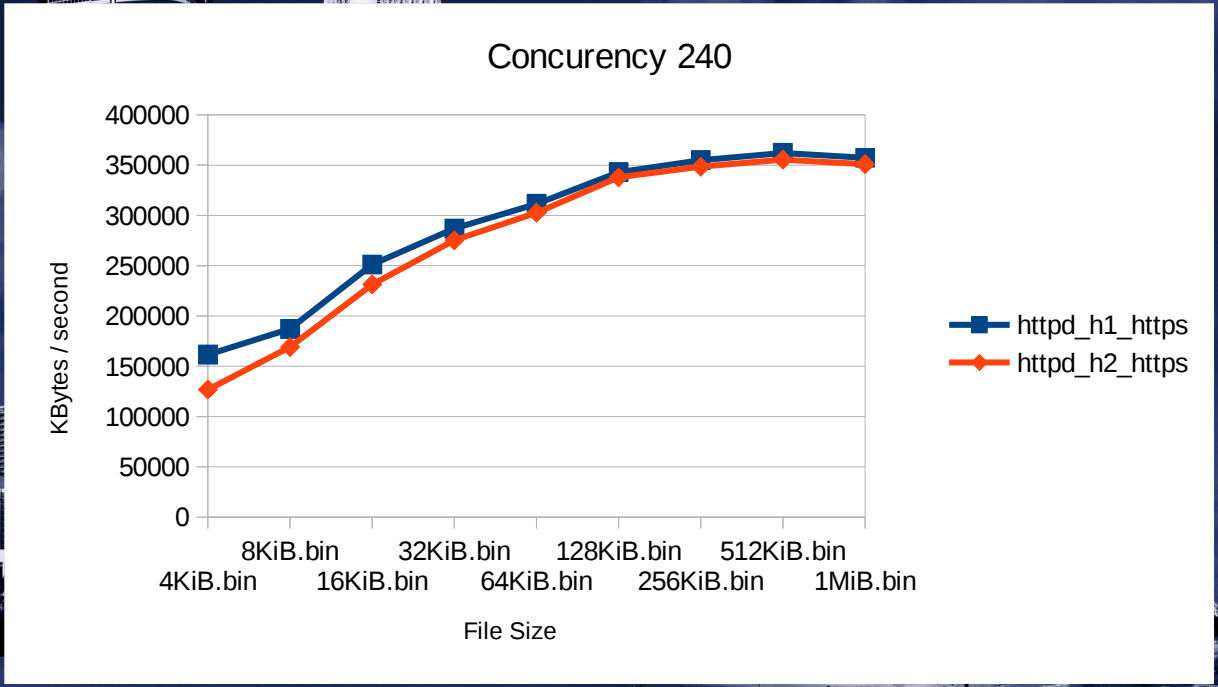
- Like tomcat one
- Uses http/1.1 tomcat nio connector on 8080 as back-end.

HTTPd / Configuration

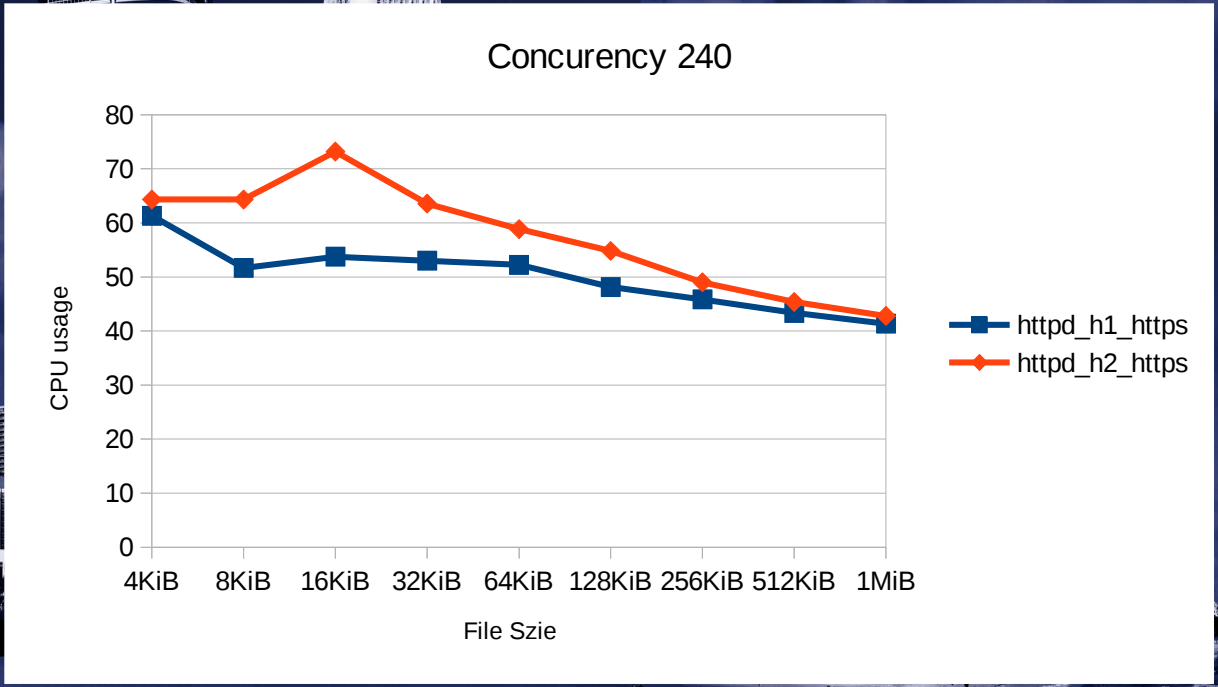
- httpd.conf:

```
LoadModule h2_module modules/mod_h2.so
Listen 8006
<VirtualHost *:8006>
  Protocols h2 http/1.1
  ProtocolsHonorOrder on
  SSLEngine on
  SSLCertificateFile "/home/jfclere/CERTS/newcert.pem"
  SSLCertificateKeyFile "/home/jfclere/CERTS/newkey.pem"
  SSLCACertificateFile "/etc/pki/CA/cacert.pem"
</VirtualHost>
```

HTTPd / Performances



HTTPd / Performances



HTTPd / Configuration proxy

- httpd.conf:

```
LoadModule h2_module modules/mod_h2.so
LoadModule proxy_http2_module modules/mod_proxy_http2.so
Listen 8006
<VirtualHost *:8006>
  Protocols h2 http/1.1
  ProtocolsHonorOrder on
  SSLEngine on
  ...
  ProxyPass "/" "h2c://localhost:8003/"
</VirtualHost>
```

HTTPd / Demo

- Like the tomcat one:
  - htdocs/http2.html
  - htdocs/images/ the images.

HTTP/2 ready?

- Conclusion:
  - Using HTTP/2 without PUSH is already good.
  - “safer” crypto is good but expensive.
  - No need to rewrite application to get the gains.

GO FOR IT

Questions?
Thank you!

- jfclere@gmail.com
- users@tomcat.apache.org
- users@httpd.apache.org
- users@trafficserver.apache.org
- https://http2.github.io/
- Demo generator:
  - https://github.com/jfclere/h2_demos

Jean-Frederic Clere

@jfclere

jfclere@gmail.com