

Analyzing the Impact of Middleboxes in the Upgrade Mechanism in HTTP2

O. González de Dios, M. Varvello, S. Eising, J. Gusano, **P. Aranda**, D. Lopez

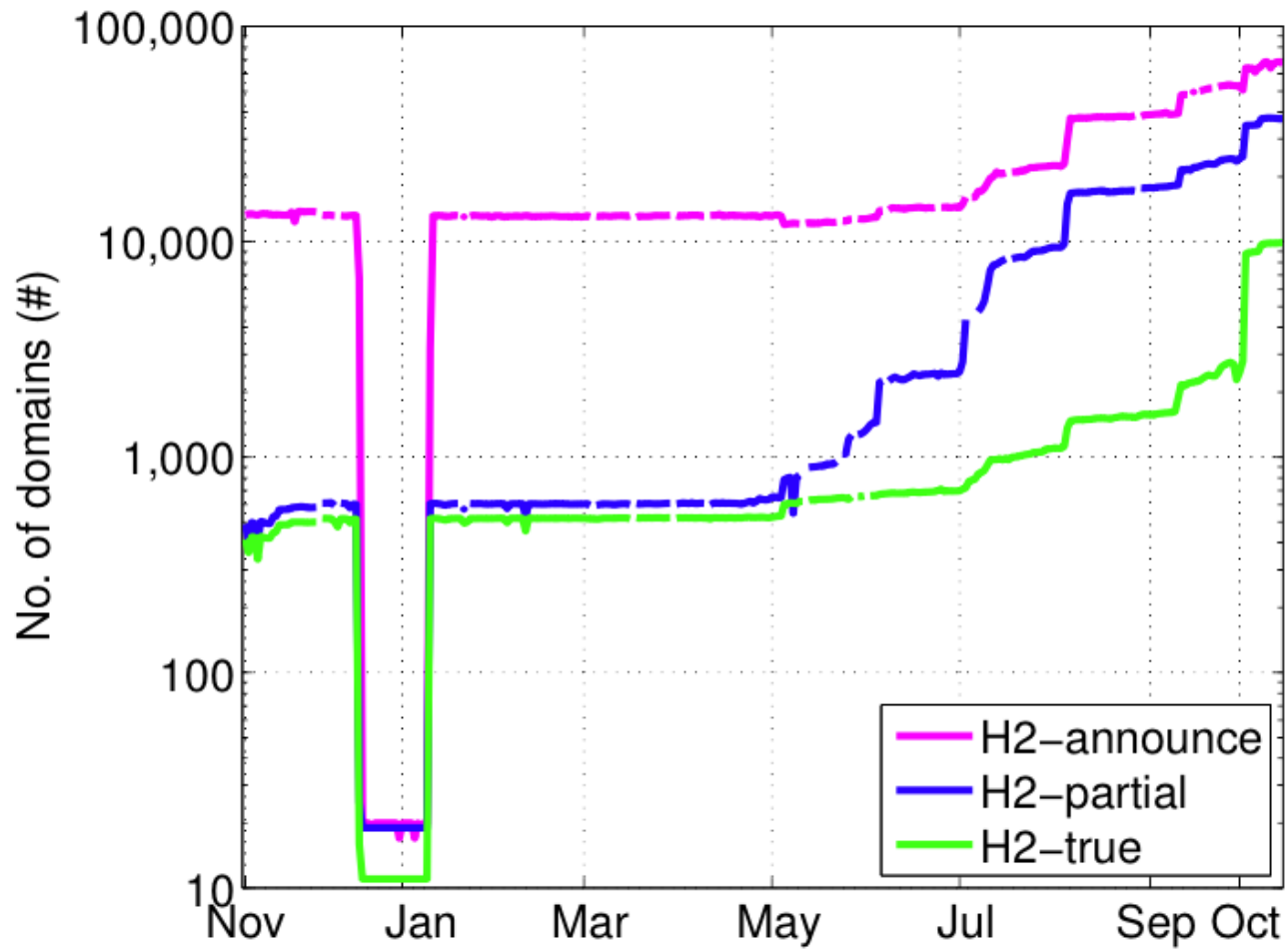
Outline

- Motivation
 - HTTP/2 (h2 and h2c) adoption
 - Upgrade mechanism in HTTP/2
 - Interaction of upgrade mechanism with middleboxes
 - Measurement platform
 - Apache HTTP/2 module (h2 and h2c)
 - TOR for world-wide vantage points
 - Preliminary Results
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Motivation

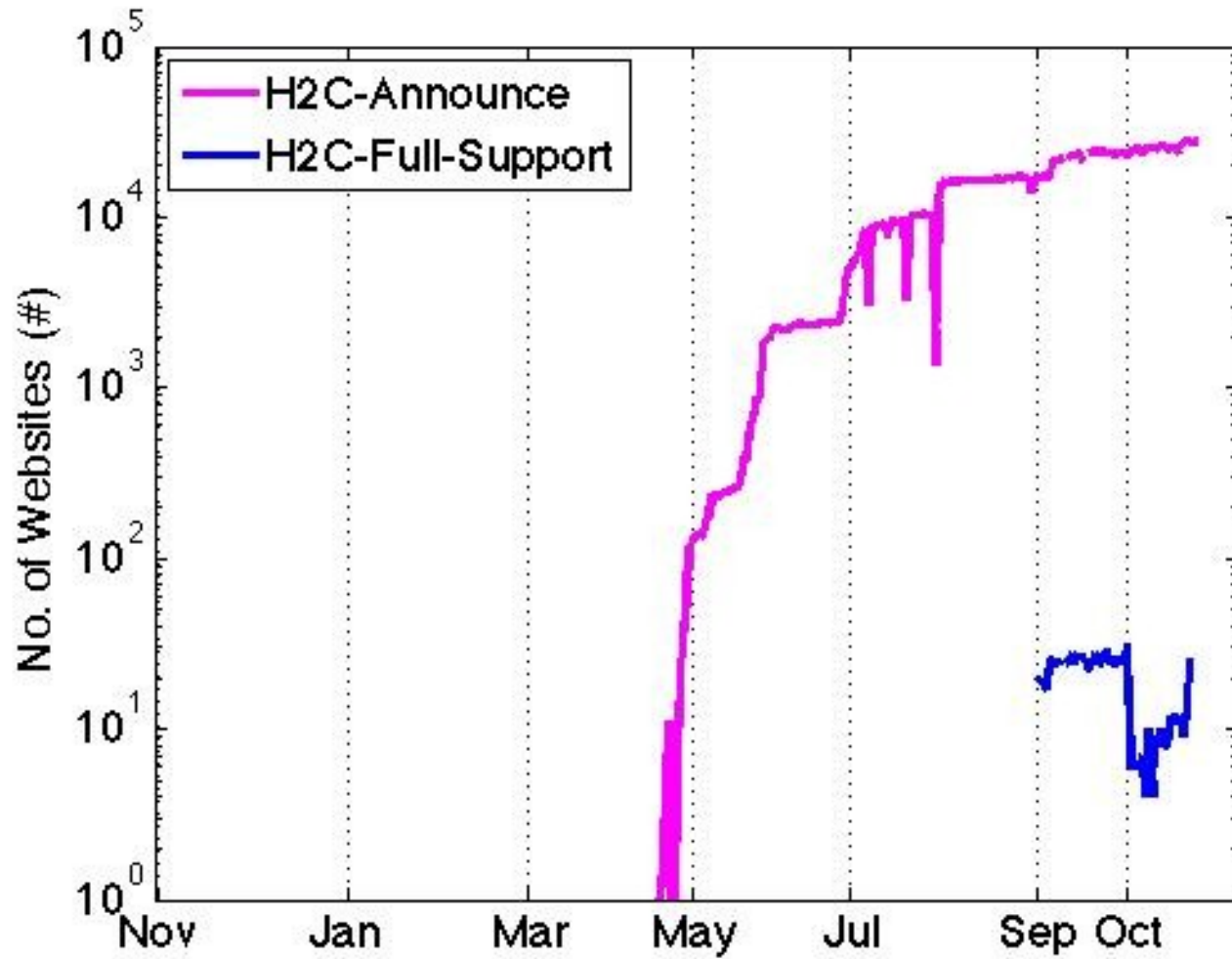
- HTTP/2: the new version of HTTP
 - expected to replace version 1.1 (around from 1999)
 - H2 promises to make the Web faster and more efficient:
 - compresses headers
 - server push
 - fixing head of line blocking
 - loads page elements in parallel over a single TCP connection.
 - RFC 7540 does not require encrypting H2 connections with Transport Layer Security (TLS) (as originally proposed)
 - h2c: some use cases do not need end-to-end encryption
 - h2:TLS is used
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HTTP/2 Adoption



<http://isthewebhttp2yet.com/measurements/adoption.html>

H2C Adoption



The Upgrade Mechanism in HTTP/2

- HTTP Upgrade mechanism allows to switch from HTTP/1.1 to HTTP/2
- GET message with special header:
 - Connection: Upgrade, HTTP2-Settings
 - Upgrade: h2c

```
Hypertext Transfer Protocol
▶ GET / HTTP/1.1\r\n
Host: testhttp2.bluevia.com\r\n
Connection: Upgrade, HTTP2-Settings\r\n
Upgrade: h2c\r\n
HTTP2-Settings: AAMAAABkAAQAAP__\r\n
\r\n
[Full request URI: http://testhttp2.bluevia.com/]
[HTTP request 1/1]
[Response in frame: 8]
```

```
6 0... 135.red-83-55-... test-tp-http-02.aislada... HTTP 184 GET / HTTP/1.1
8 0... test-tp-http-0... 135.red-83-55-158.dynami... HTTP 139 HTTP/1.1 101 Switching Protocols
9 0... test-tp-http-0... 135.red-83-55-158.dynami... HTTP2 2804 SETTINGS, HEADERS, DATA[Packet size limited during capture]
10 0... test-tp-http-0... 135.red-83-55-158.dynami... HTTP2 2671 Unknown type (47)
```

Impact of Middleboxes on the Upgrade Mechanism

- Middleboxes can modify HTTP headers
 - Remove/modify Connection header
 - Remove Upgrade header
 - Remove HTTP2-Settings

GET at CLIENT side

```
▼ Hypertext Transfer Protocol
▶ GET / HTTP/1.1\r\n
Host: testhttp2.bluevia.com\r\n
Connection: Upgrade, HTTP2-Settings\r\n
Upgrade: h2c\r\n
HTTP2-Settings: AAMAAABkAAQAAP__\r\n
Accept: */*\r\n
User-Agent: nghttp2/1.0.1\r\n
\r\n
[Full request URI: http://testhttp2.bluevia.com/]
[HTTP request 1/1]
```

GET at Server Side after proxy

```
▼ Hypertext Transfer Protocol
▶ GET / HTTP/1.1\r\n
Accept: */*\r\n
User-Agent: nghttp2/1.0.1\r\n
Host: testhttp2.bluevia.com\r\n
Cache-Control: max-age=43200\r\n
Connection: keep-alive\r\n
\r\n
[Full request URI: http://testhttp2.bluevia.com/]
[HTTP request 1/1]
```

Measurement Platform

- Set up h2c-ready Apache web server listening on two ports
 - Port 80 likely to go through middlebox
 - Port 12345 likely to be bypassed
- Attempt h2c upgrade on both ports
 - Client: (1) send GET requests with UPGRADE field (2) check if response is 101 (switching protocols)
 - Server: traffic analysis for conflictive cases

Server: HTTP/2 module for Apache

- Objective
 - Provide a reference platform for our experiments
 - Full HTTP/2 module developed by Greenbytes with the support of GSMA and Telefonica.
 - Donated to Apache
 - Available in Apache version 2.4.17.
- <http://httpd.apache.org/download.cgi>

Client: TOR for World-Wide Vantage Points

- Tor is an anonymity network
 - Protect user identity via onion routing
 - User can select exit points (IPs) for their traffic or get randomly assigned exit points
- We build a tool to constantly demand a new TOR exit point
 - We use this tool to gather several vantage points world-wide possibly behind middleboxes

TOR

The anonymous Internet

Daily Tor users per 100,000 Internet users

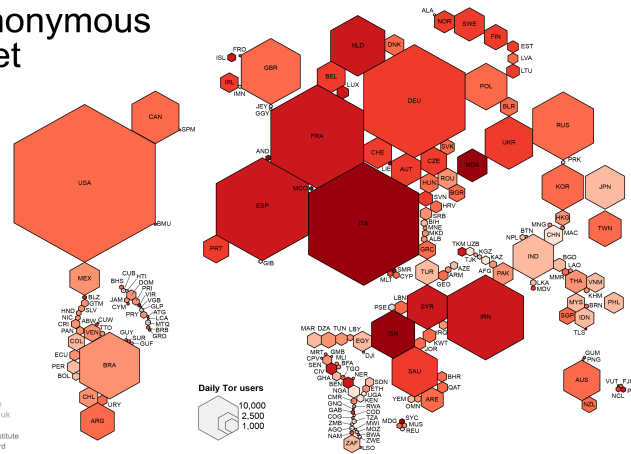
> 200
100 - 200
50 - 100
25 - 50
10 - 25
5 - 10
< 5
no information

Average number of Tor users per day calculated between August 2012 and July 2013

data sources:
Tor Metrics Portal
metrics.torproject.org
World Bank
data.worldbank.org

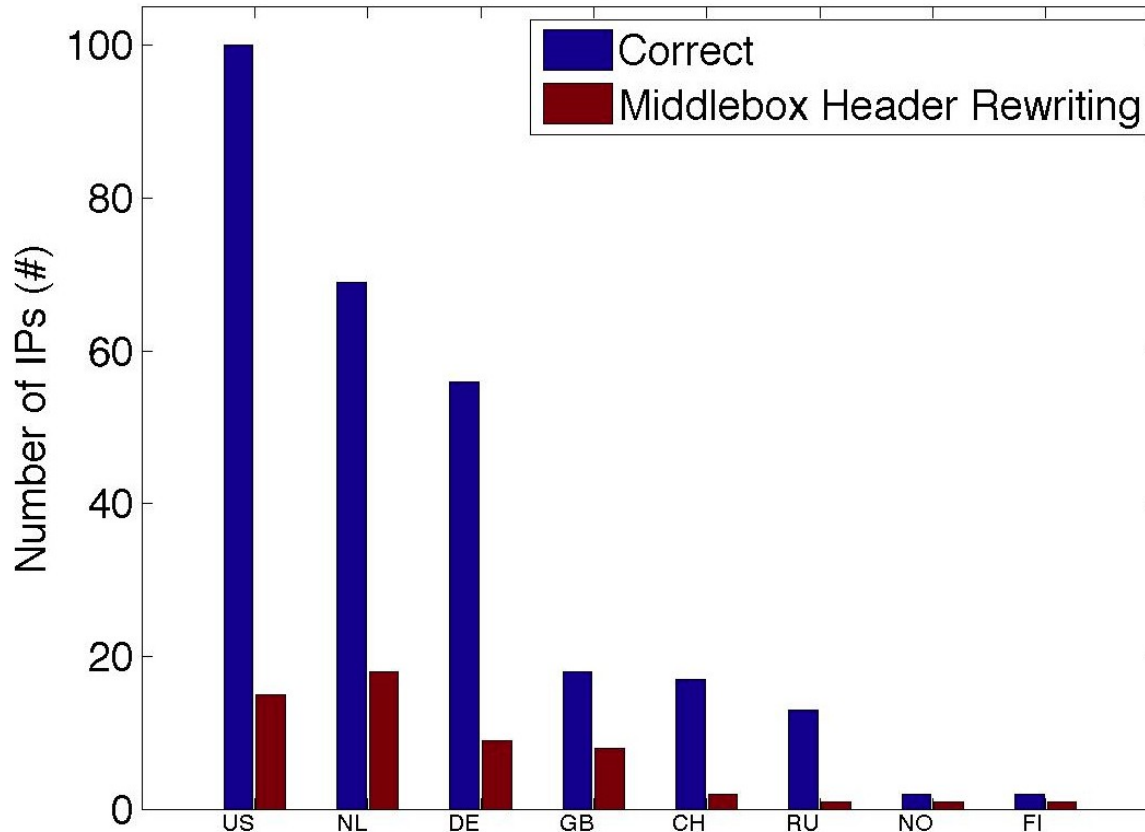
by Mark Graham
(@geoplace) and
Stefano De Sabbata
(@masp4thought)
Internet Geographies at
the Oxford Internet Institute
2014 - geography.oii.ox.ac.uk

Oxford Internet Institute
University of Oxford



Preliminary Results

- On average, 10% of the 600 TOR exit nodes we leverage were behind a middlebox tampering with the UPGRADE header field and thus failing h2c upgrade



Conclusion

- HTTP/2 adoption is ramping up
 - 78k sites announce H2 support
 - 20k sites announce H2C support
 - <http://isthewebhttp2yet.com/>
- We build a measurement platform:
 - Full HTTP/2-ready Apache web
 - Test clients distributed worldwide using TOR
 - Able to measure mbox impacts
- Some Middleboxes tamper with UPGRADE mechanism
- We find that 10% of TOR exit points are unable to use full HTTP2