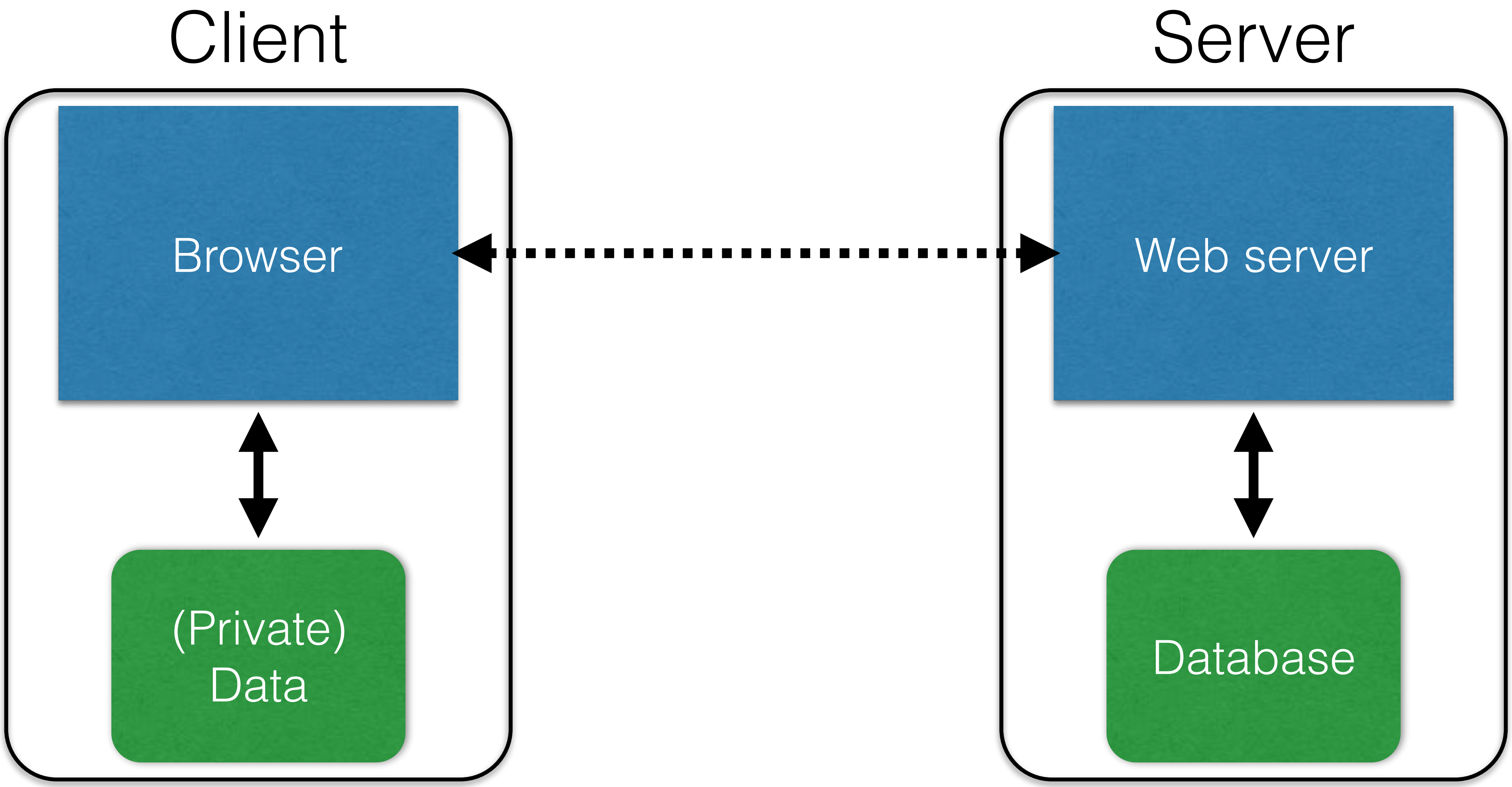
WEB SECURITY:
WEB BACKGROUND

CMSC 414

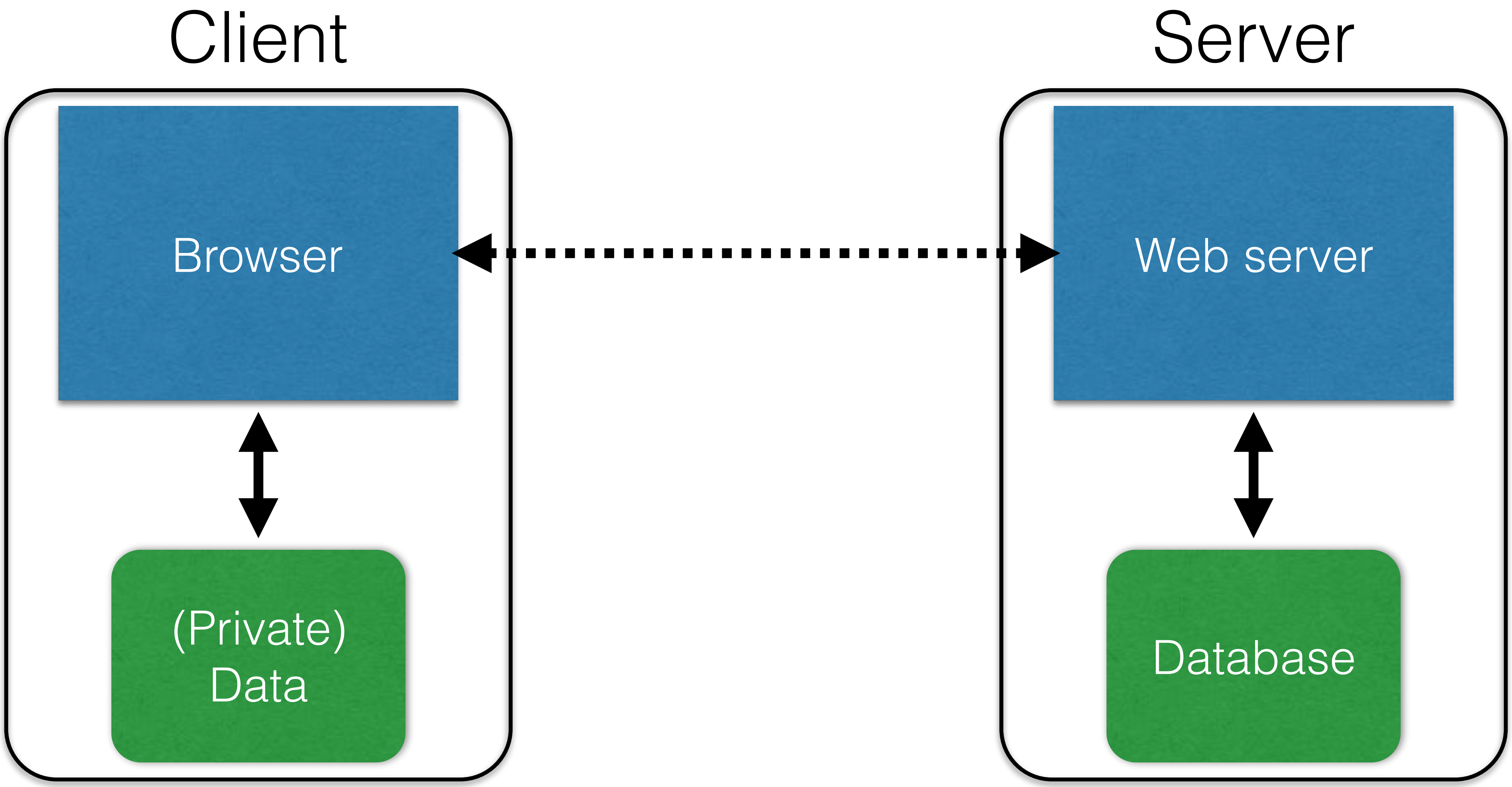
FEB 20 2018

A very basic web architecture



DB is a separate entity, logically (and often physically)

A very basic web architecture



(Much) user data is part of the browser

DB is a separate entity, logically (and often physically)

Interacting with web servers

Get and put *resources* which are identified by a URL

`http://www.cs.umd.edu/~dml/home.html`

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```
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```

Protocol

```
ftp
https
tor
```

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Hostname/server

Translated to an IP address by DNS
(more on this later)

Interacting with web servers

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Here, the file home.html is static content
i.e., a fixed file returned by the server

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http://facebook.com/delete.php?f=joe123&w=16
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Interacting with web servers

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`http://facebook.com/delete.php?f=joe123&w=16`

Arguments

Here, the file home.html is dynamic content
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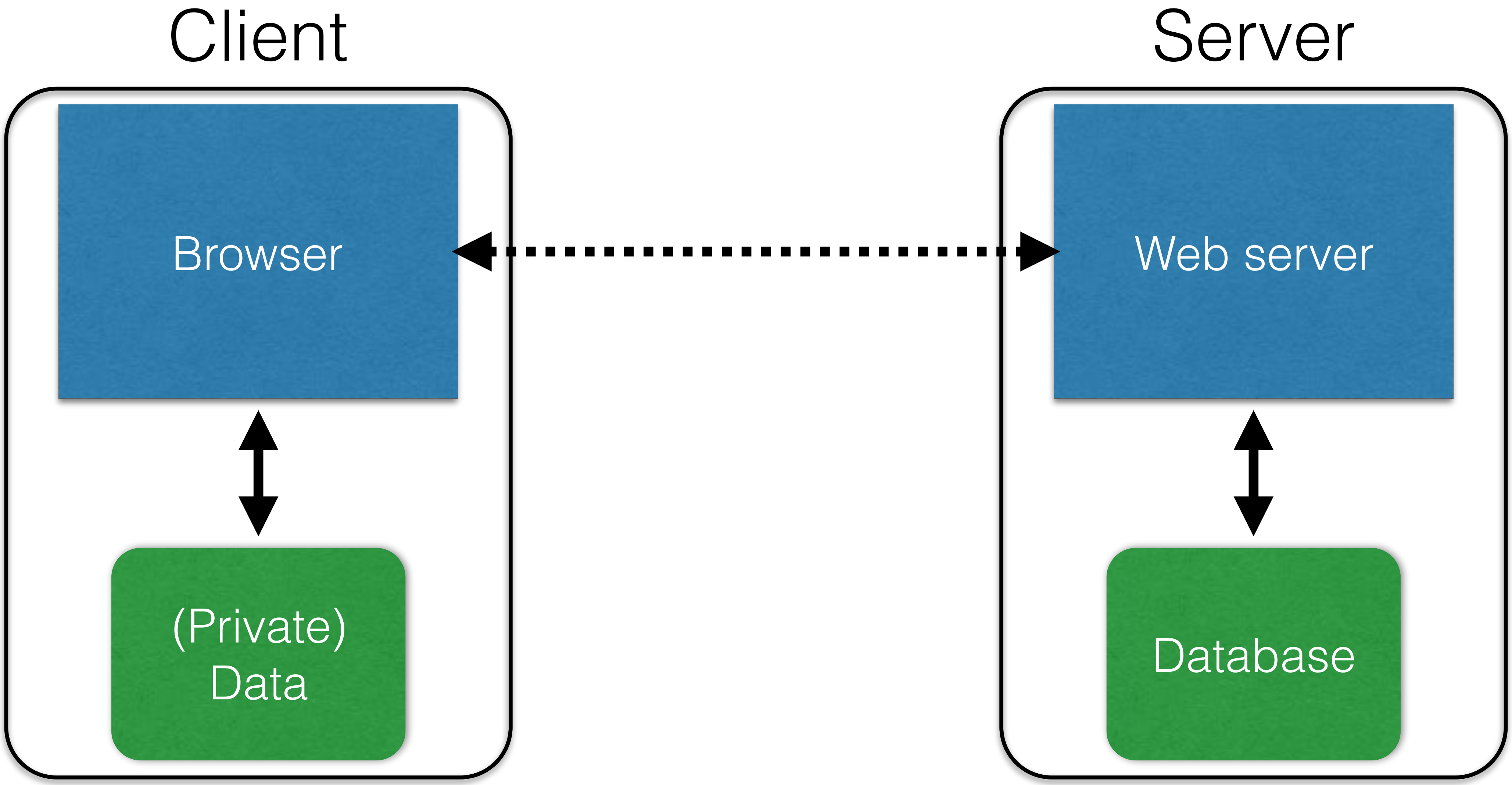
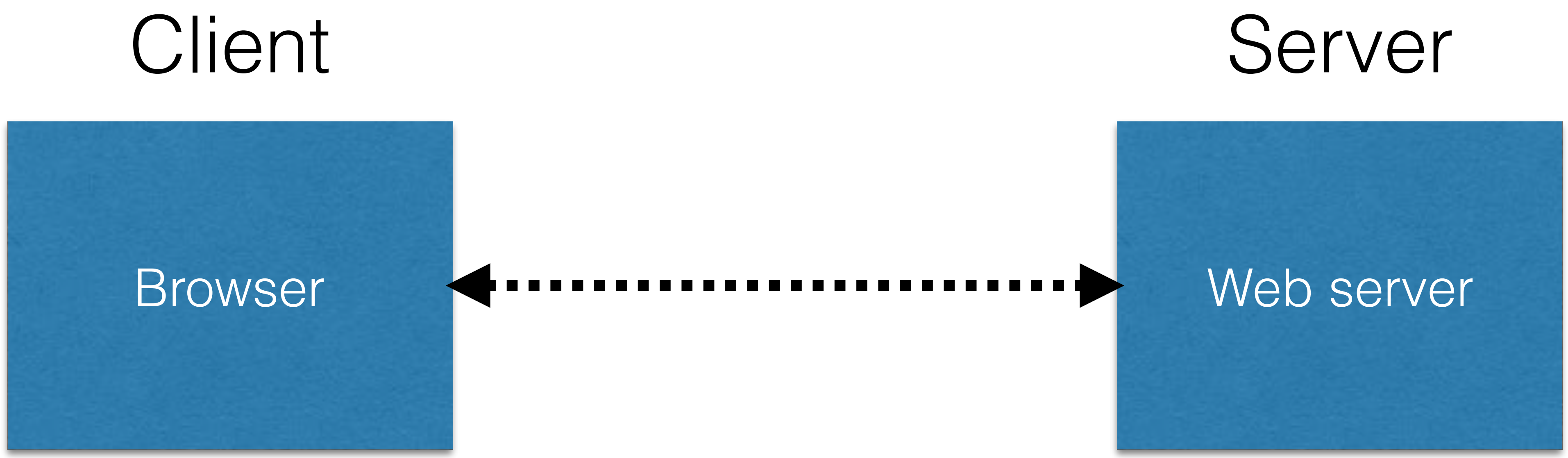
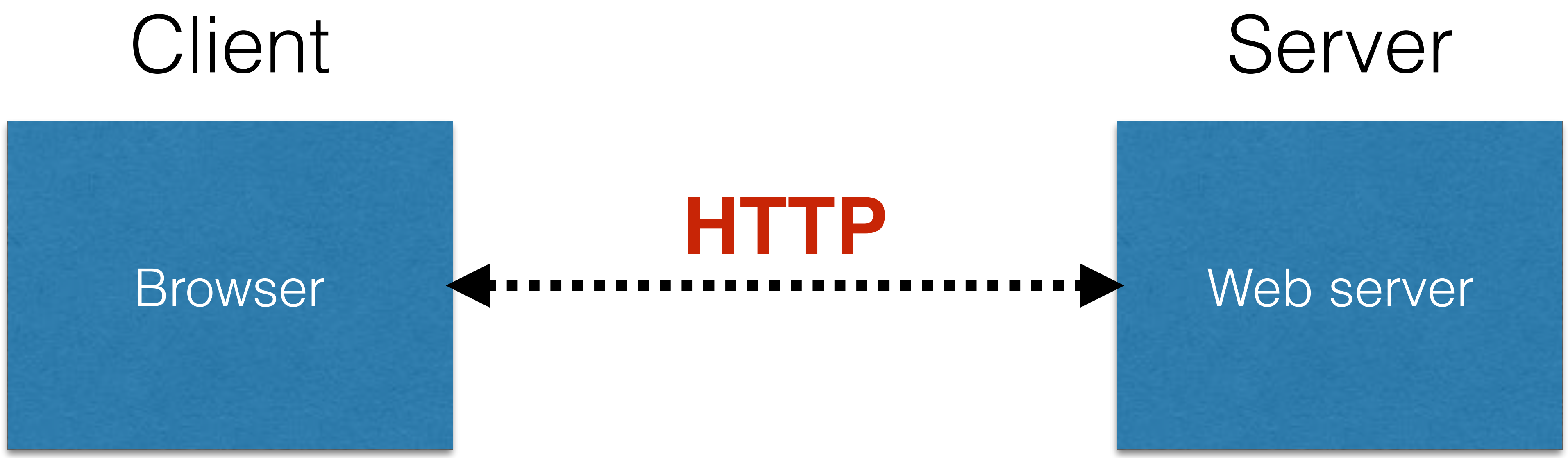
Basic structure of web traffic



Basic structure of web traffic



Basic structure of web traffic



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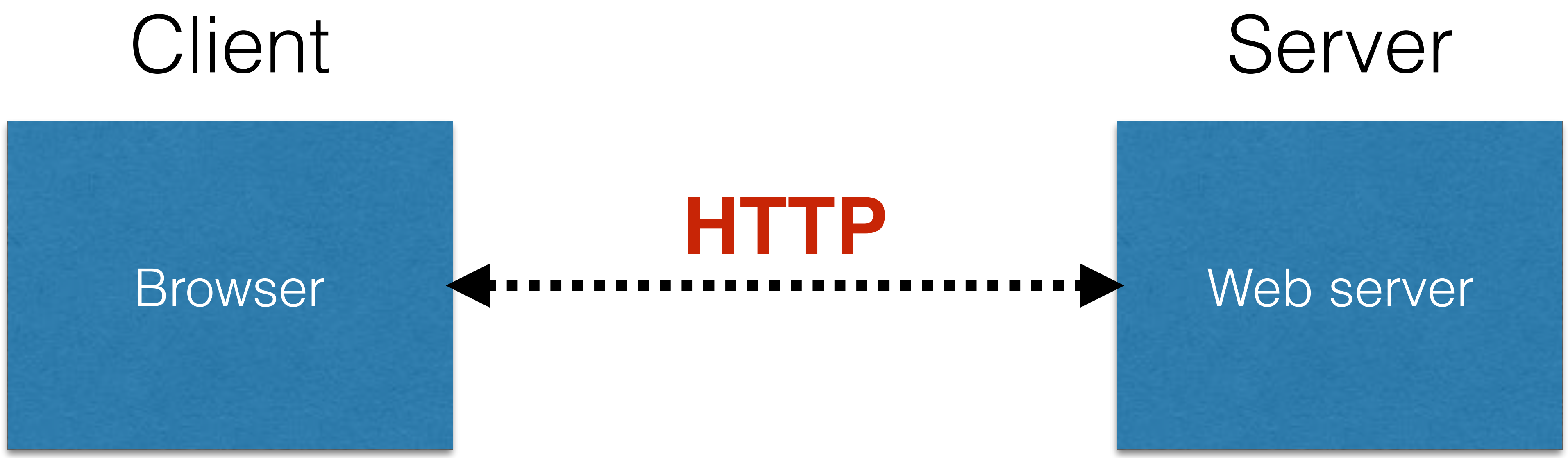


- HyperText Transfer Protocol (HTTP)
    - An “application-layer” protocol for exchanging collections of data

Basic structure of web traffic

Client

Browser

Server

Web server

Basic structure of web traffic

Client

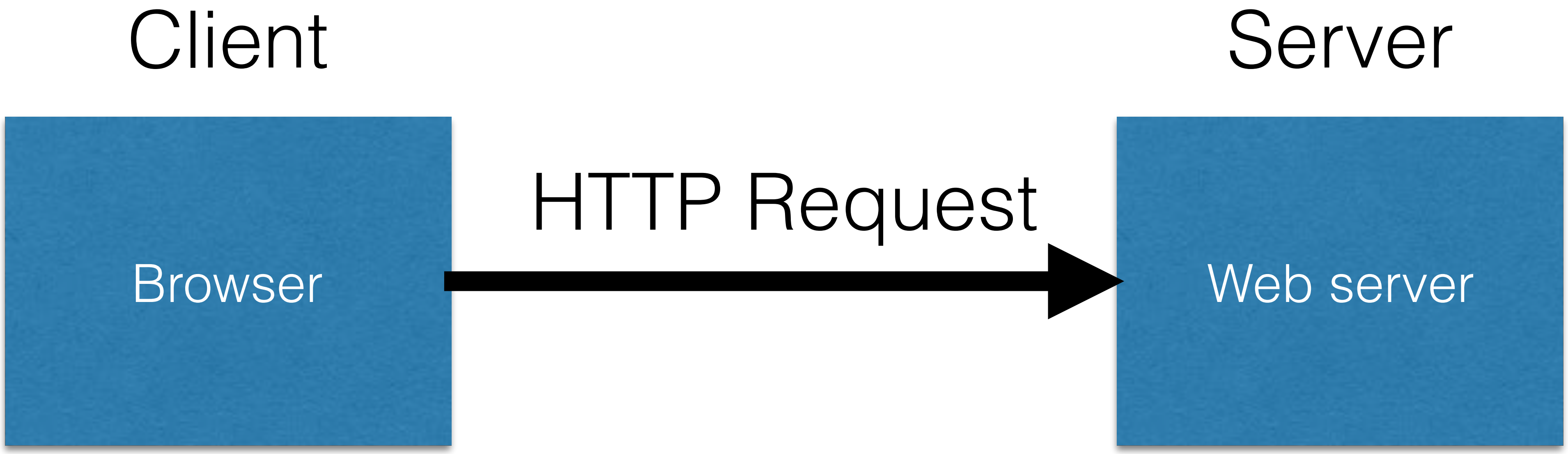
Server

Browser

Web server

User clicks

Basic structure of web traffic



Client

Server

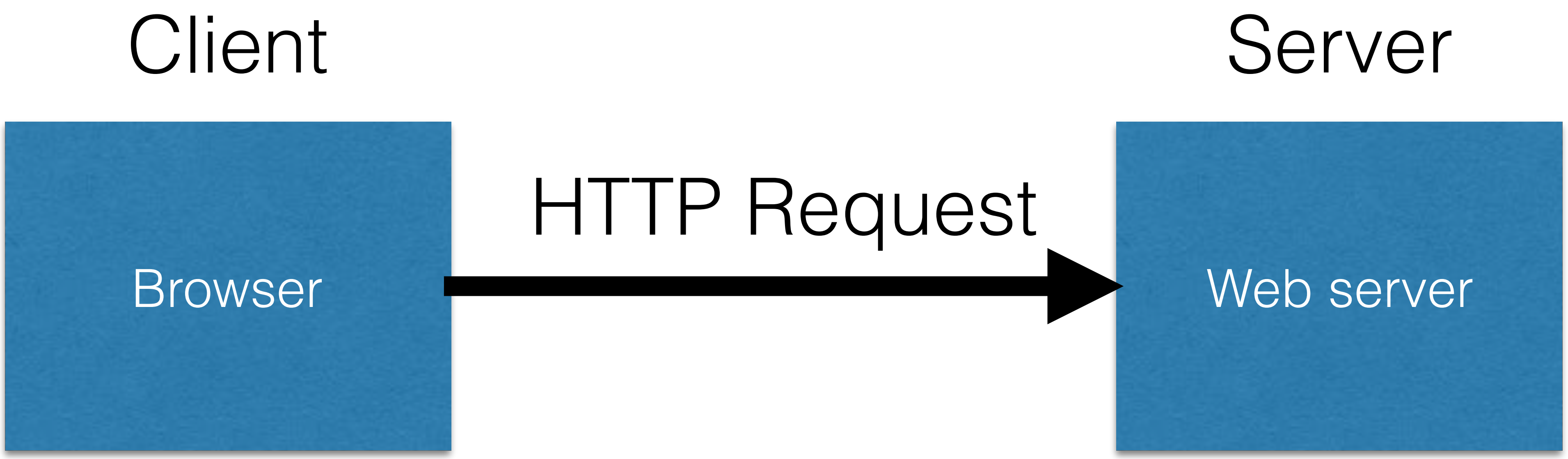
Browser

HTTP Request

Web server

User clicks

Basic structure of web traffic



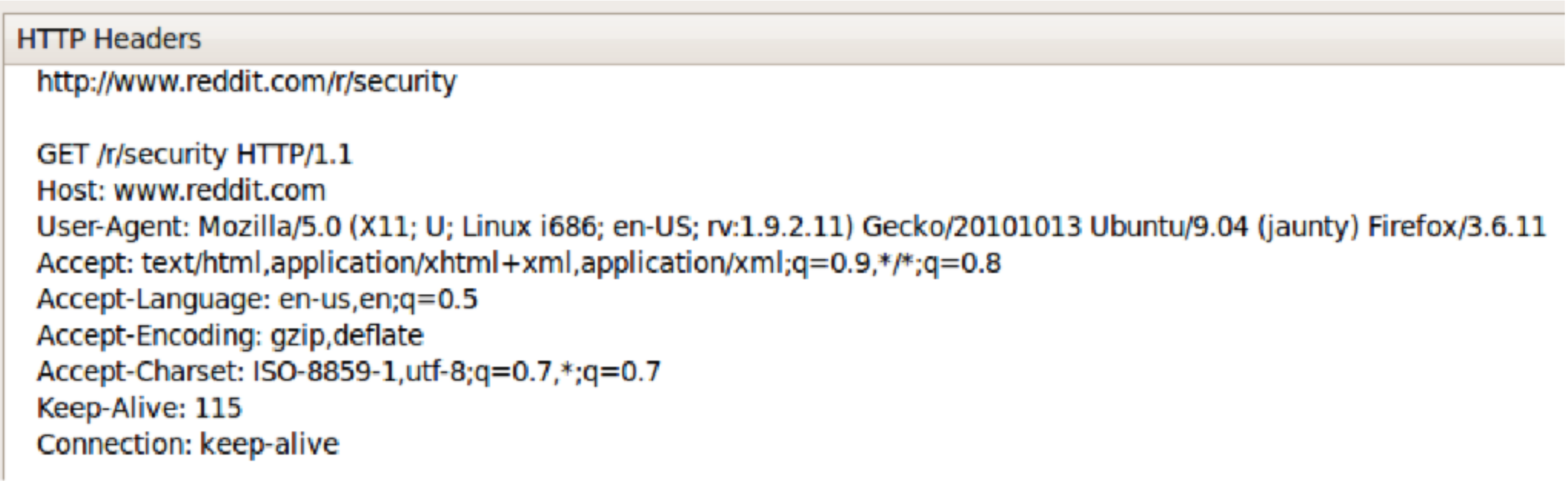
User clicks

- Requests contain:
  - The URL of the resource the client wishes to obtain
  - Headers describing what the browser can do

- Requests be GET or POST
  - GET: all data is in the URL itself (supposed to have no side-effects)
  - POST: includes the data as separate fields (can have side-effects)

HTTP GET requests

http://www.reddit.com/r/security



```
http://www.reddit.com/r/security

GET /r/security HTTP/1.1
Host: www.reddit.com
User-Agent: Mozilla/5.0 (X11; U; Linux i686; en-US; rv:1.9.2.11) Gecko/20101013 Ubuntu/9.04 (jaunty) Firefox/3.6.11
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 115
Connection: keep-alive
```

HTTP GET requests

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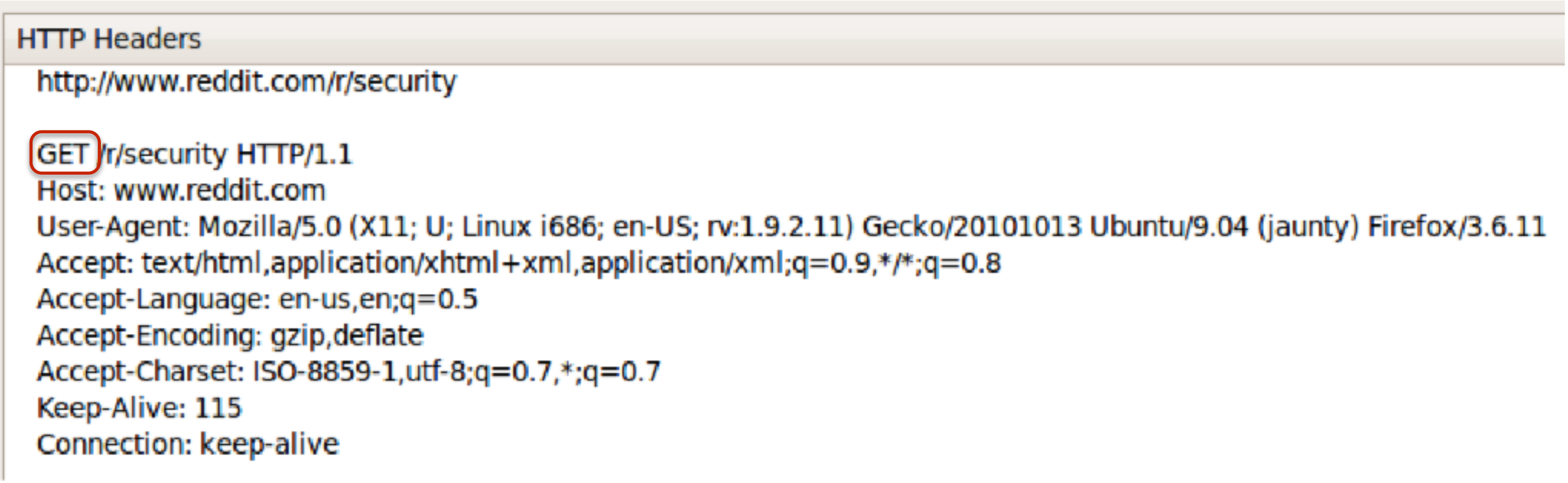

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HTTP GET requests

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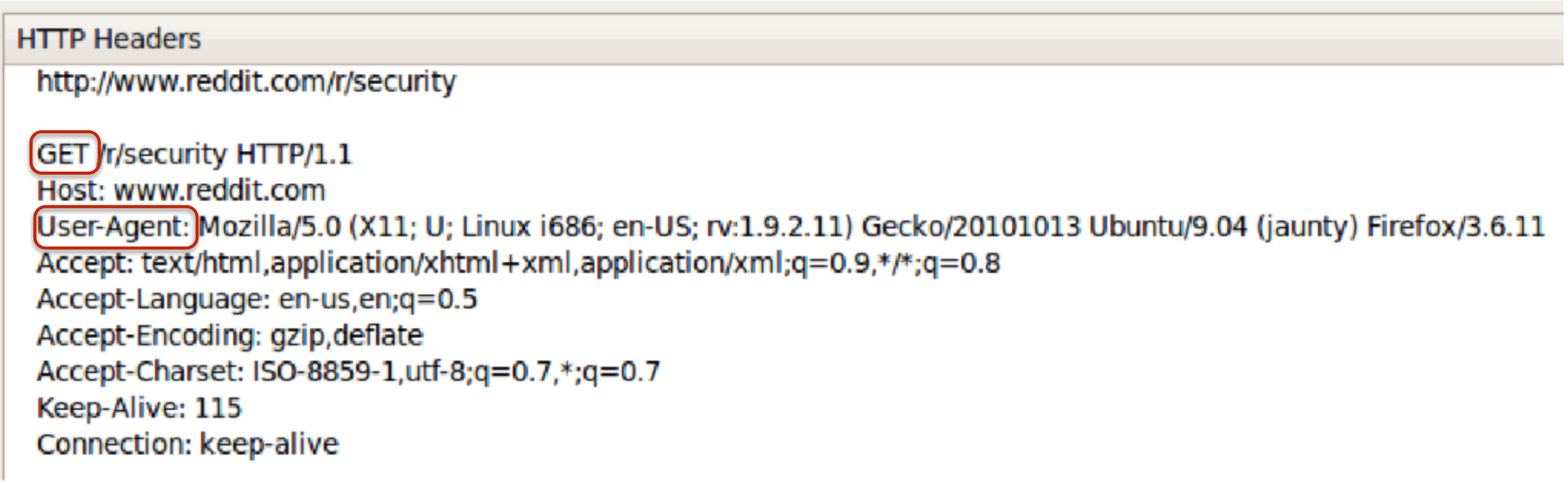

HTTP Headers

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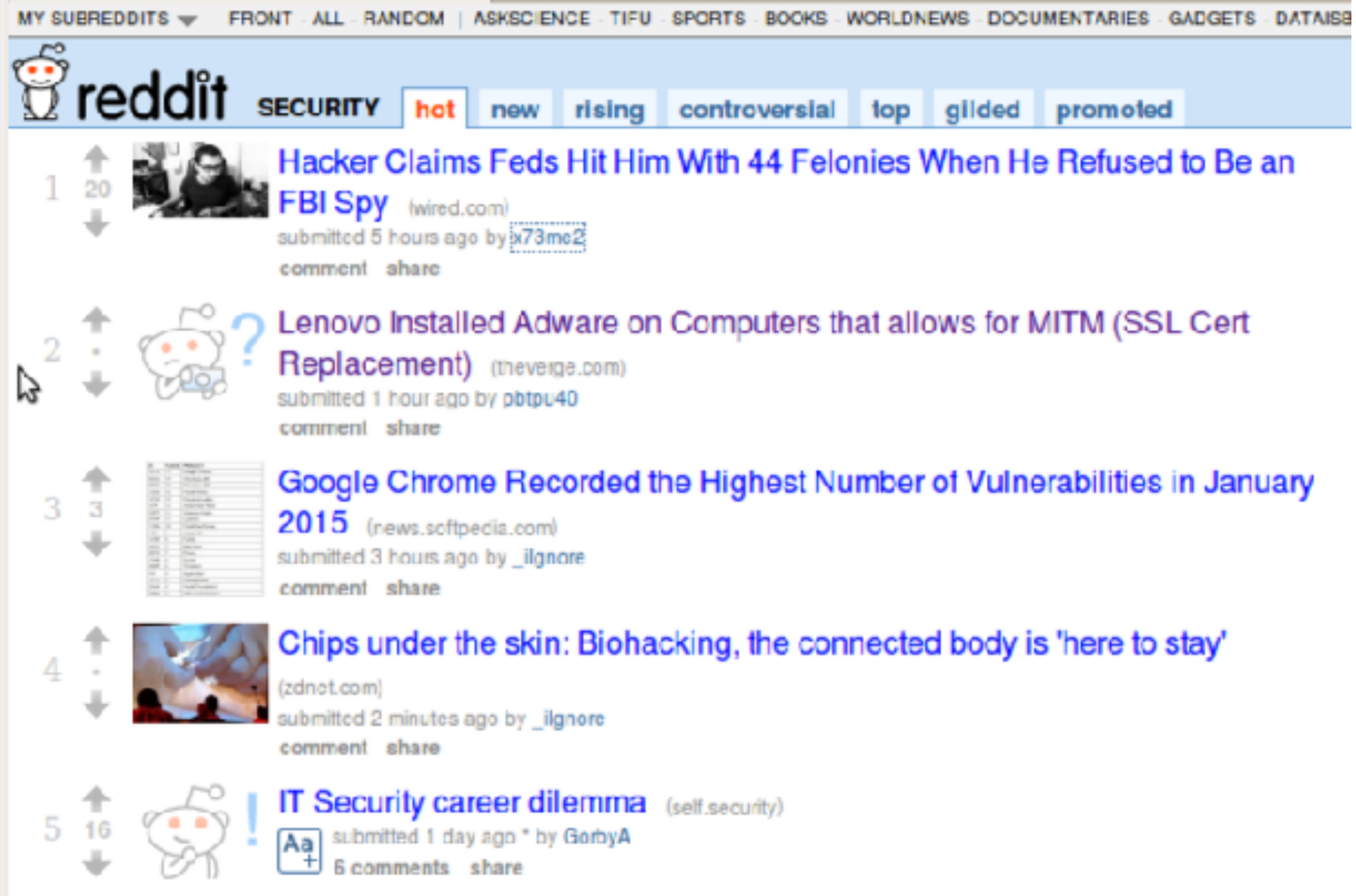
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 115
Connection: keep-alive
```

User-Agent is typically a browser
but it can be wget, JDK, etc.



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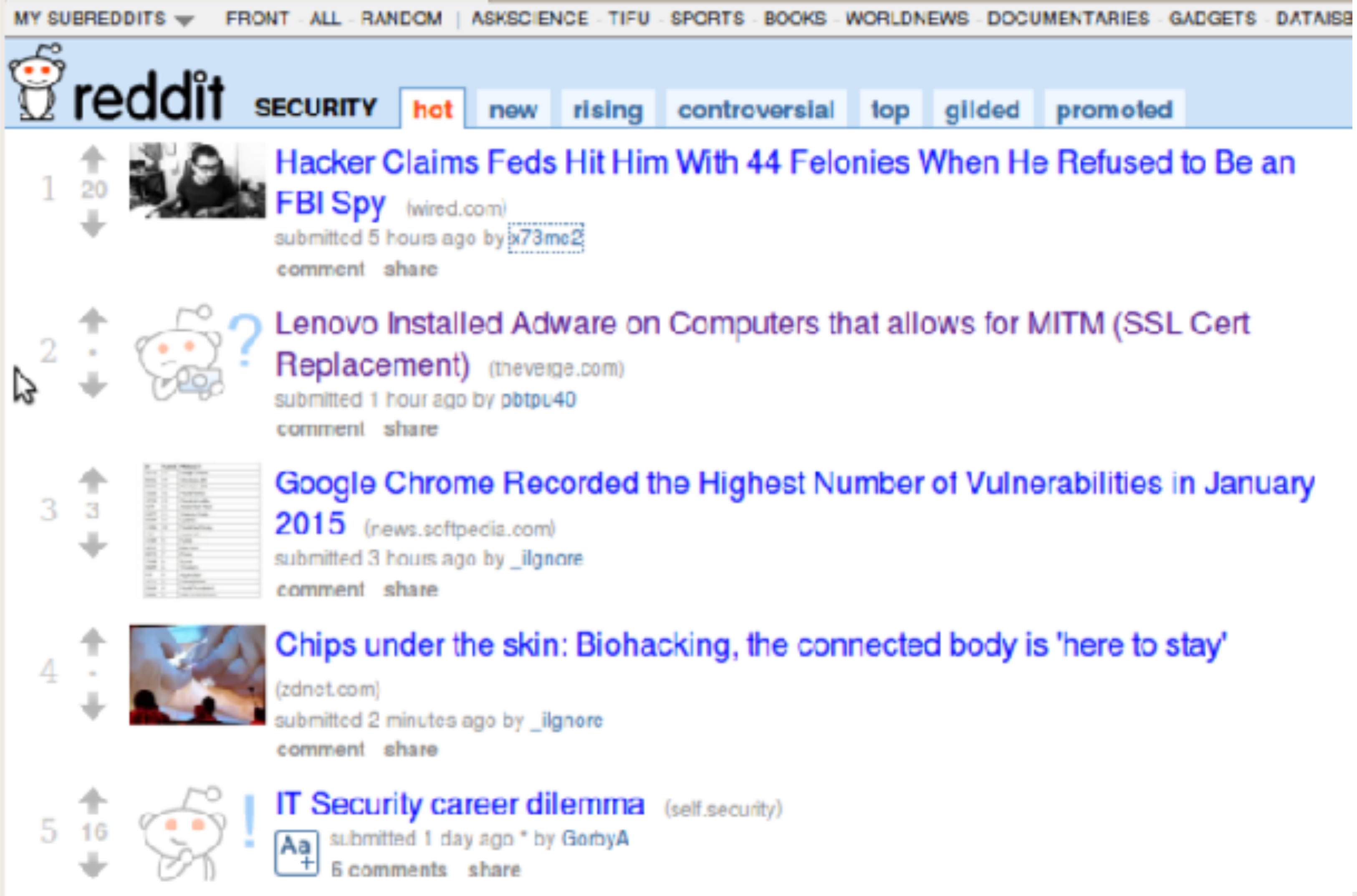
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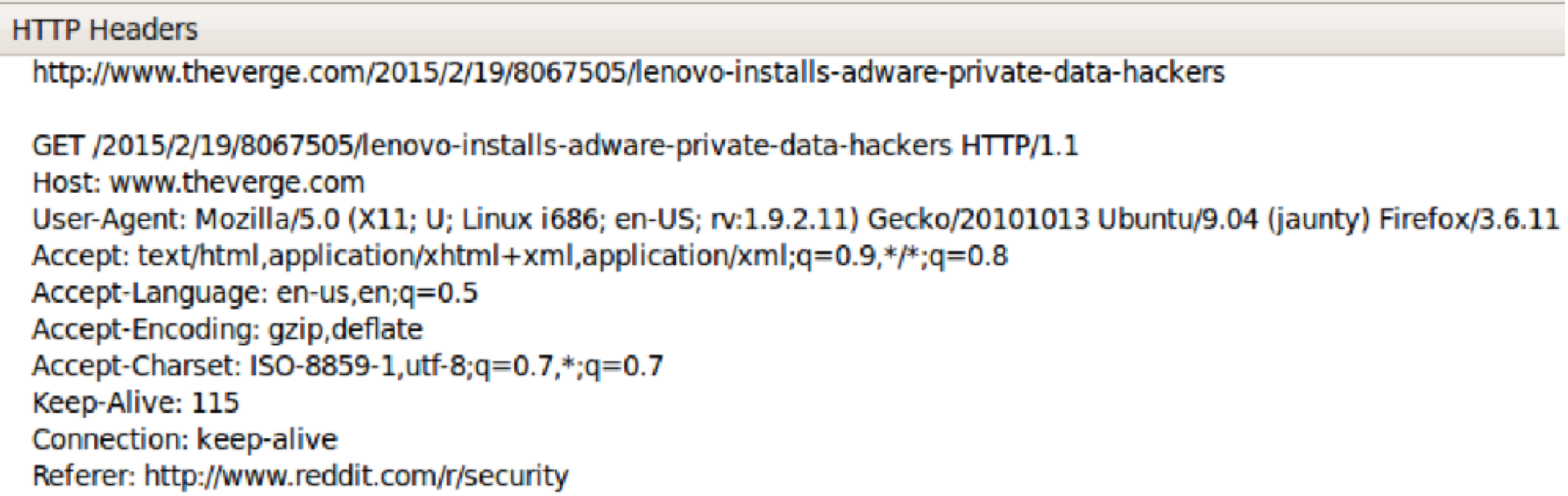
HTTP Headers

```
http://www.theverge.com/2015/2/19/8067505/lenovo-installs-adware-private-data-hackers

GET /2015/2/19/8067505/lenovo-installs-adware-private-data-hackers HTTP/1.1
Host: www.theverge.com
User-Agent: Mozilla/5.0 (X11; U; Linux i686; en-US; rv:1.9.2.11) Gecko/20101013 Ubuntu/9.04 (jaunty) Firefox/3.6.11
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
Accept-Language: en-us,en;q=0.5
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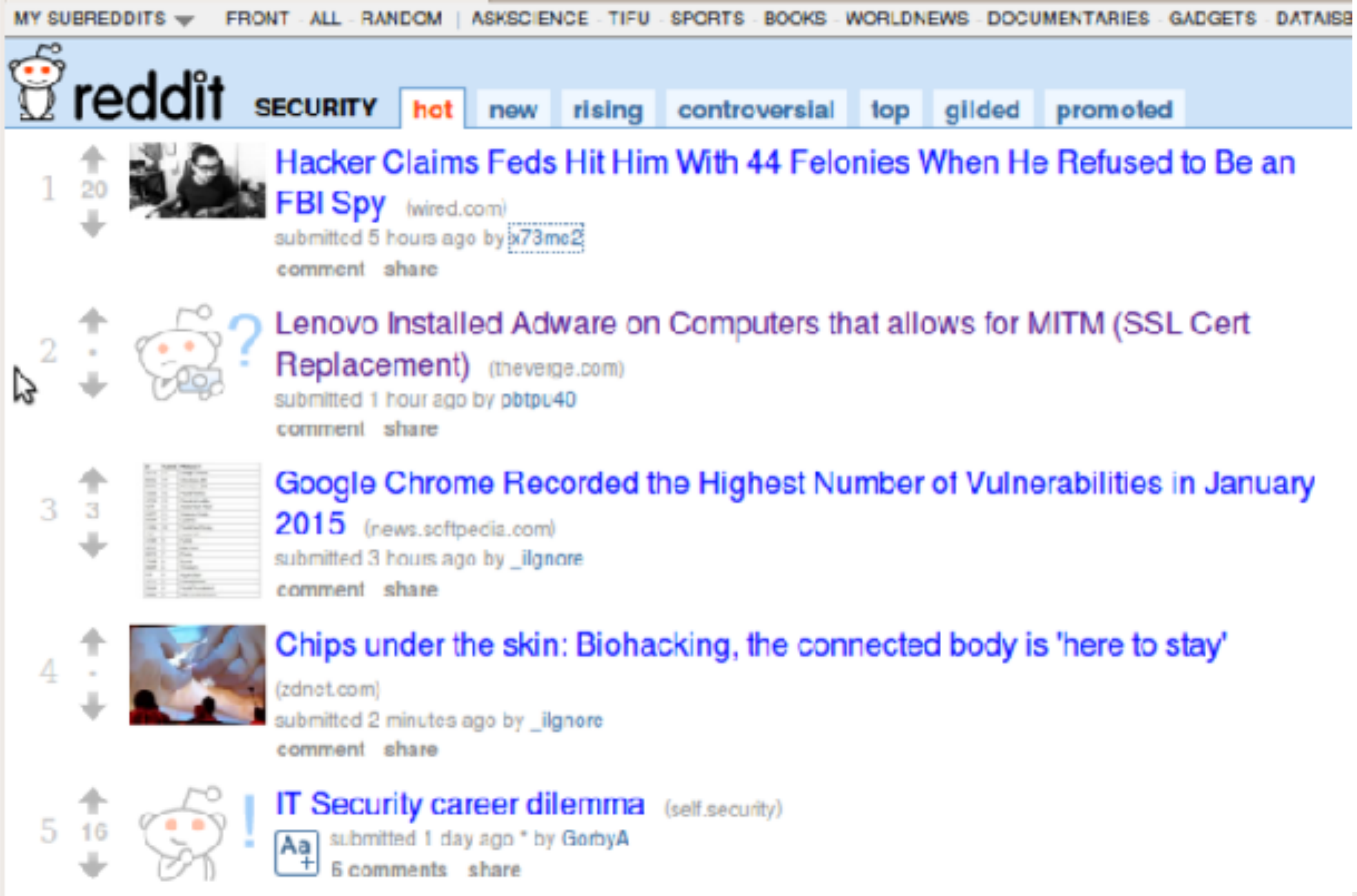

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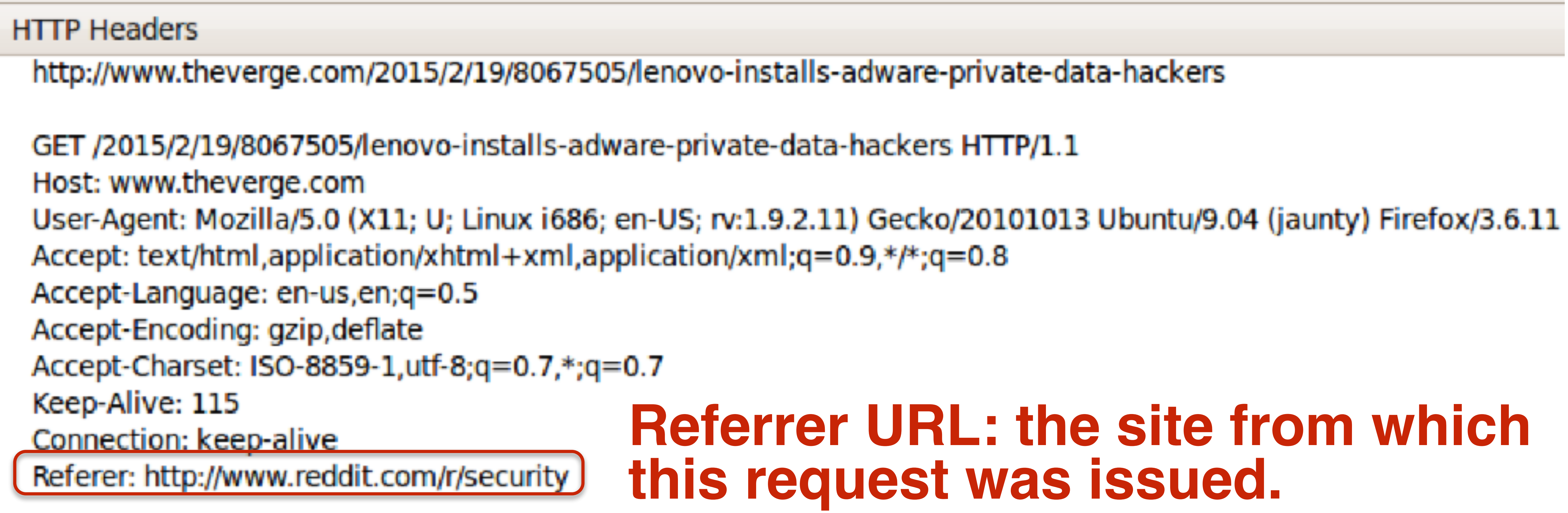

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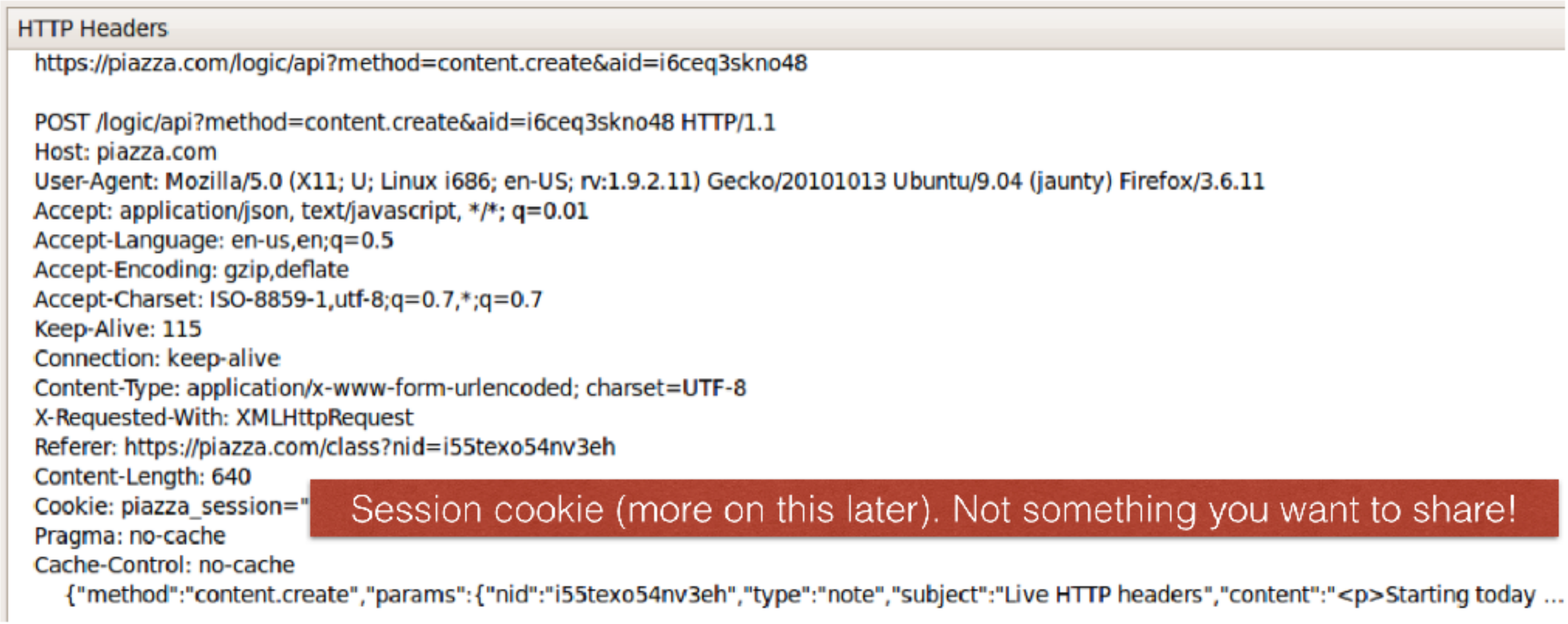
Keep-Alive: 115
Connection: keep-alive
Referer: http://www.reddit.com/r/security
```

Referrer URL: the site from which this request was issued.

HTTP POST requests

Posting on Piazza



HTTP Headers

```
https://piazza.com/logic/api?method=content.create&aid=i6ceq3skno48

POST /logic/api?method=content.create&aid=i6ceq3skno48 HTTP/1.1
Host: piazza.com
User-Agent: Mozilla/5.0 (X11; U; Linux i686; en-US; rv:1.9.2.11) Gecko/20101013 Ubuntu/9.04 (jaunty) Firefox/3.6.11
Accept: application/json, text/javascript, */*; q=0.01
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 115
Connection: keep-alive
Content-Type: application/x-www-form-urlencoded; charset=UTF-8
X-Requested-With: XMLHttpRequest
Referer: https://piazza.com/class?nid=i55texo54nv3eh
Content-Length: 640
Cookie: piazza_session="
Pragma: no-cache
Cache-Control: no-cache
    {"method":"content.create","params":{"nid":"i55texo54nv3eh","type":"note","subject":"Live HTTP headers","content":"<p>Starting today ...
```

Session cookie (more on this later). Not something you want to share!

HTTP POST requests

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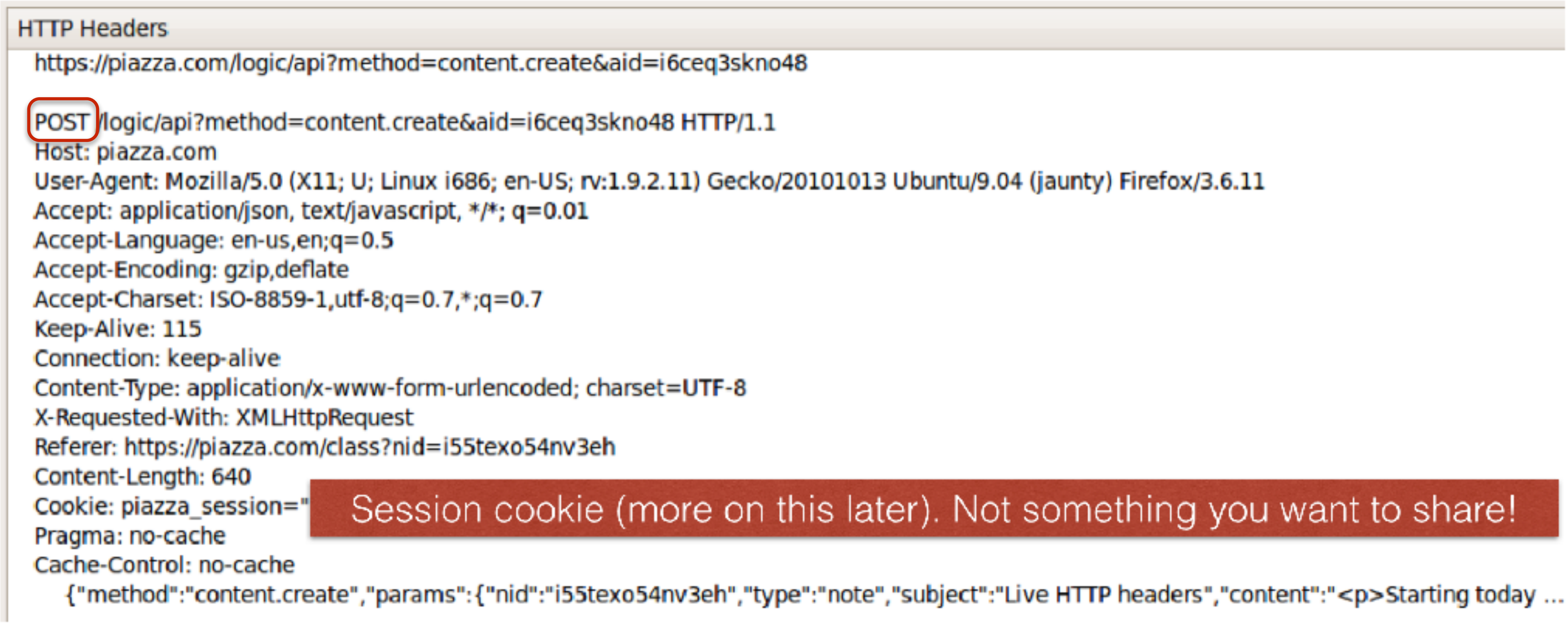

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Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 115
Connection: keep-alive
Content-Type: application/x-www-form-urlencoded; charset=UTF-8
X-Requested-With: XMLHttpRequest
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Content-Length: 640
Cookie: piazza_session="
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HTTP POST requests

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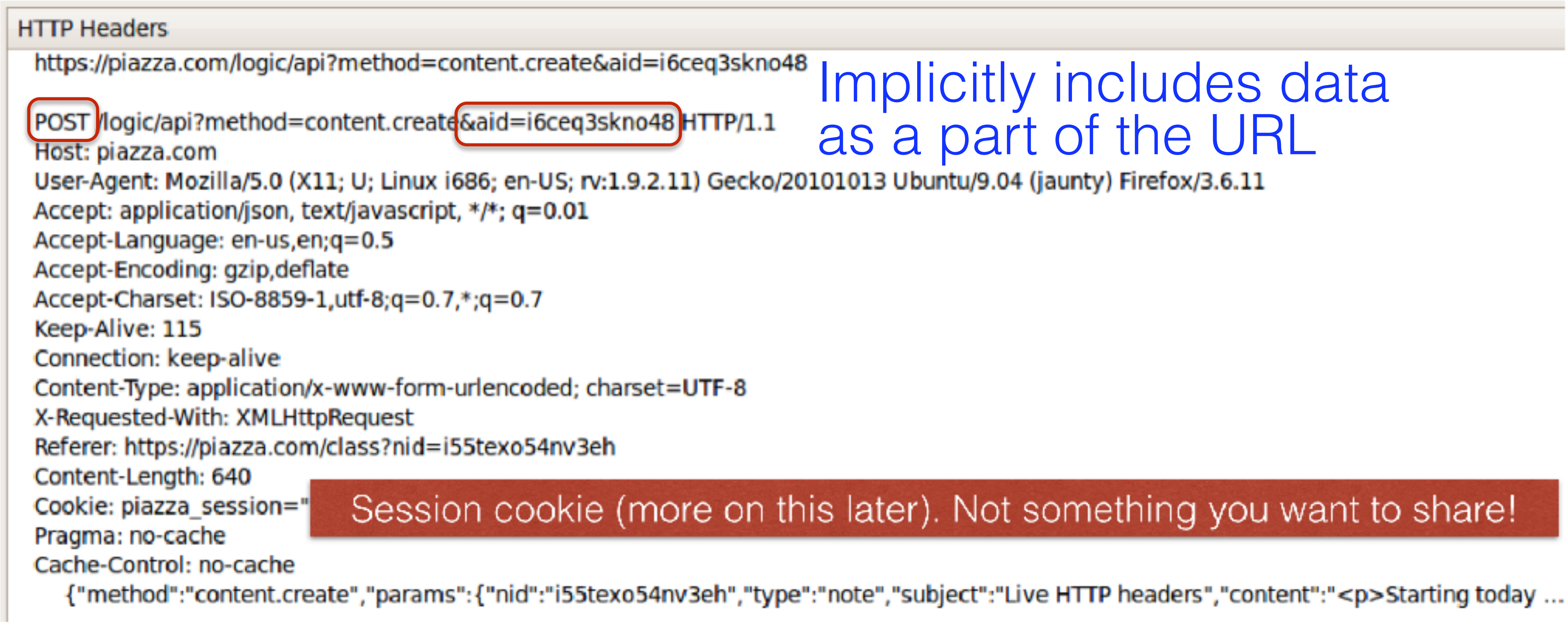

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HTTP Headers
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  POST /logic/api?method=content.create&aid=i6ceq3skno48 HTTP/1.1
  Host: piazza.com
  User-Agent: Mozilla/5.0 (X11; U; Linux i686; en-US; rv:1.9.2.11) Gecko/20101013 Ubuntu/9.04 (jaunty) Firefox/3.6.11
  Accept: application/json, text/javascript, */*; q=0.01
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  Accept-Encoding: gzip,deflate
  Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
  Keep-Alive: 115
  Connection: keep-alive
  Content-Type: application/x-www-form-urlencoded; charset=UTF-8
  X-Requested-With: XMLHttpRequest
  Referer: https://piazza.com/class?nid=i55texo54nv3eh
  Content-Length: 640
  Cookie: piazza_session="[redacted]
  Pragma: no-cache
  Cache-Control: no-cache
     {"method":"content.create","params":{"nid":"i55texo54nv3eh","type":"note","subject":"Live HTTP headers","content":"<p>Starting today ...
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Implicitly includes data as a part of the URL

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HTTP POST requests

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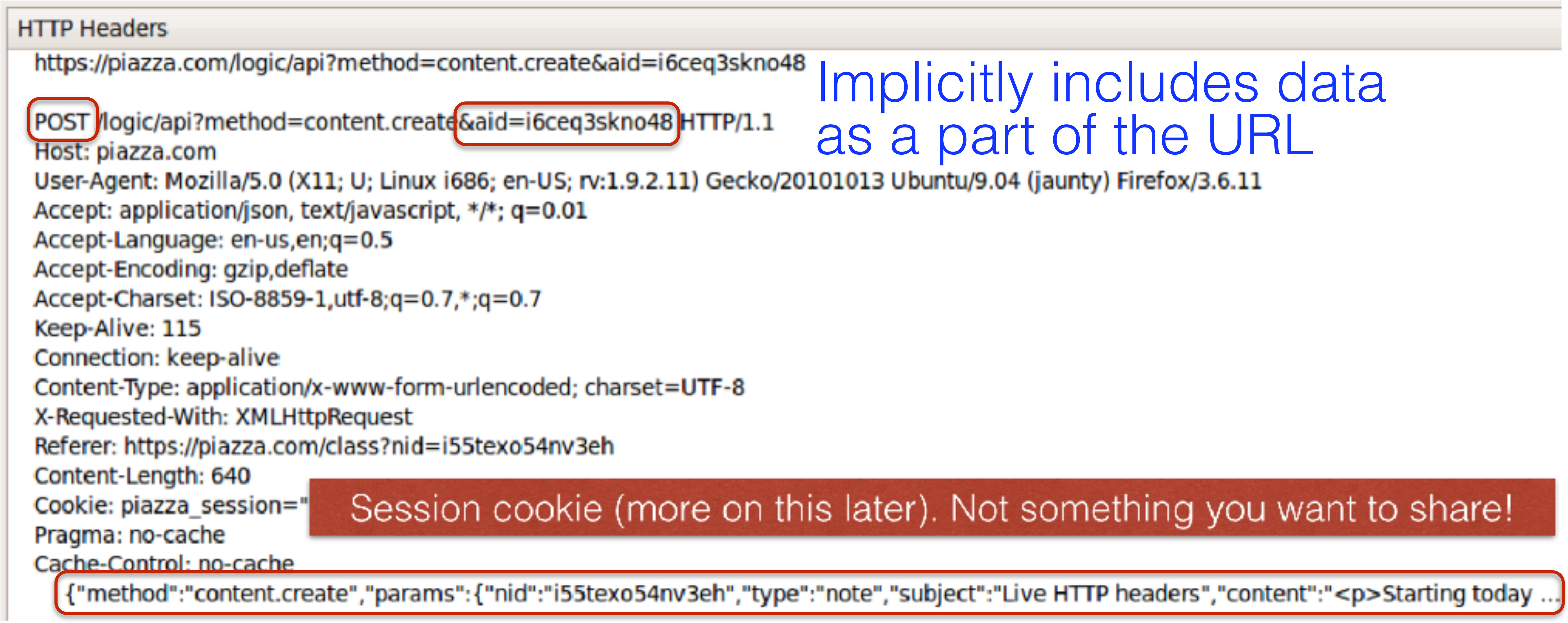

HTTP Headers

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https://piazza.com/logic/api?method=content.create&aid=i6ceq3skno48

POST /logic/api?method=content.create&aid=i6ceq3skno48 HTTP/1.1
Host: piazza.com
User-Agent: Mozilla/5.0 (X11; U; Linux i686; en-US; rv:1.9.2.11) Gecko/20101013 Ubuntu/9.04 (jaunty) Firefox/3.6.11
Accept: application/json, text/javascript, */*; q=0.01
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 115
Connection: keep-alive
Content-Type: application/x-www-form-urlencoded; charset=UTF-8
X-Requested-With: XMLHttpRequest
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Content-Length: 640
Cookie: piazza_session="
Pragma: no-cache
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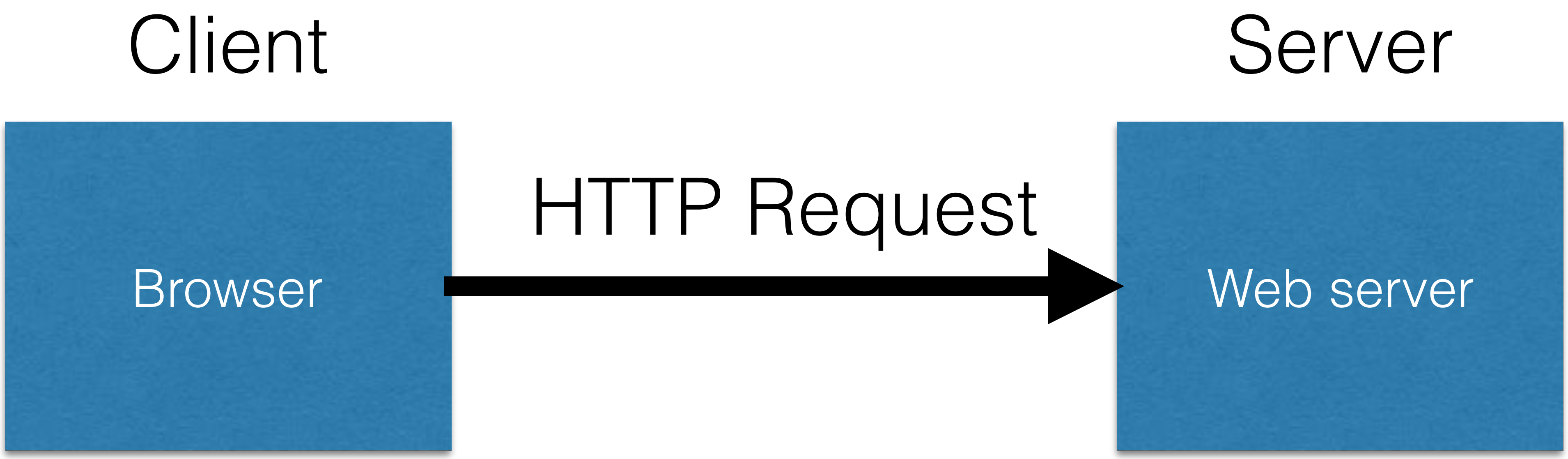
  {"method":"content.create","params":{"nid":"i55texo54nv3eh","type":"note","subject":"Live HTTP headers","content":"<p>Starting today ...
```

Implicitly includes data as a part of the URL

Session cookie (more on this later). Not something you want to share!

Explicitly includes data as a part of the request's content

Basic structure of web traffic



User clicks

Basic structure of web traffic

Client

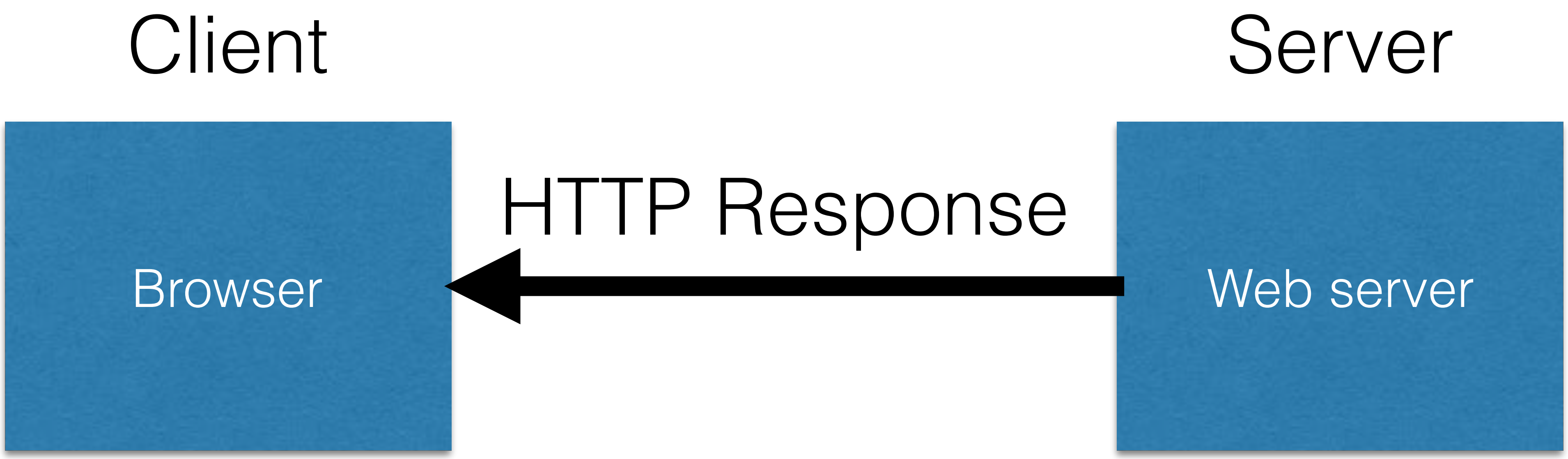
Server

Browser

Web server

User clicks

Basic structure of web traffic



User clicks

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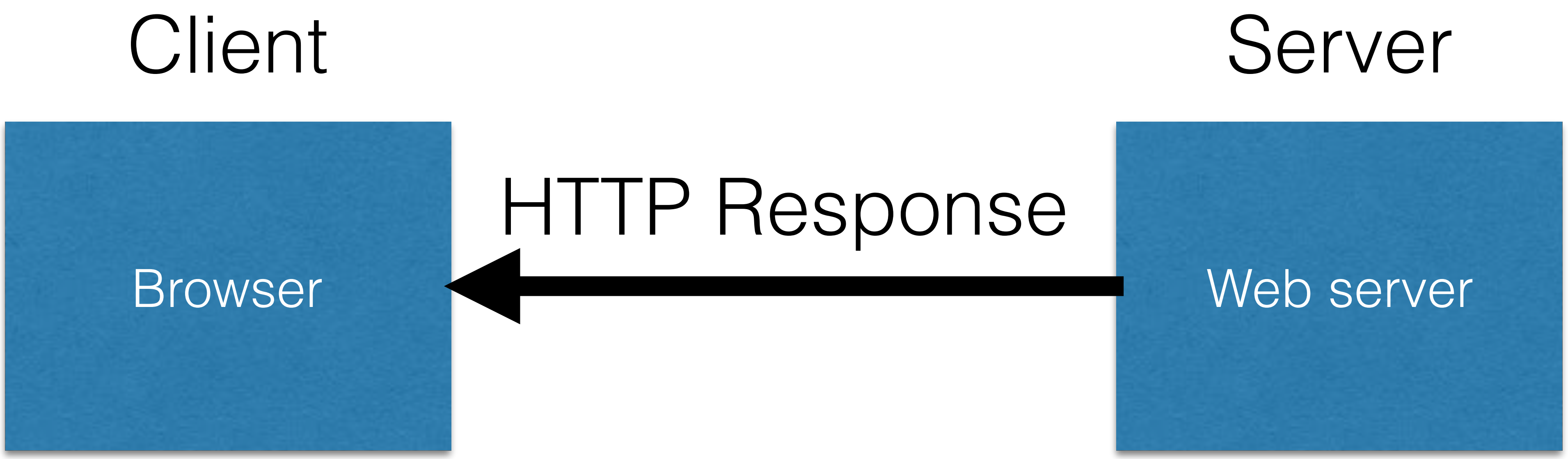
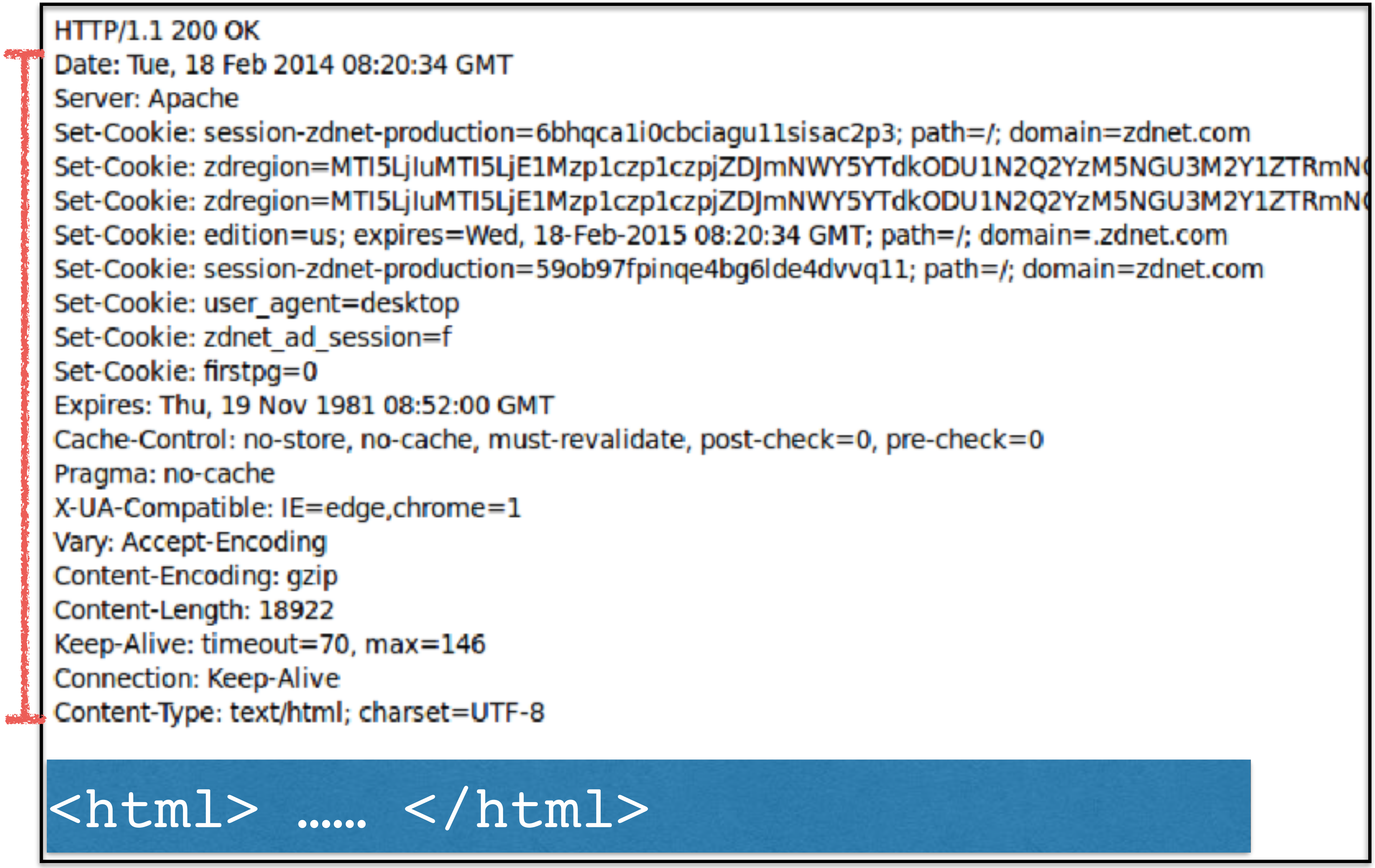


User clicks

- Responses contain:
  - Status code
  - Headers describing what the server provides
  - Data
  - Cookies
    - State it would like the browser to store on the site's behalf

HTTP responses



```
HTTP/1.1 200 OK
Date: Tue, 18 Feb 2014 08:20:34 GMT
Server: Apache
Set-Cookie: session-zdnet-production=6bhqca1i0cbciagu11sisac2p3; path=/; domain=zdnet.com
Set-Cookie: zdregion=MTI5LjIuMTI5LjE1Mzp1czp1czpjZDJmNWY5YTdkODU1N2Q2YzM5NGU3M2Y1ZTRmN
Set-Cookie: zdregion=MTI5LjIuMTI5LjE1Mzp1czp1czpjZDJmNWY5YTdkODU1N2Q2YzM5NGU3M2Y1ZTRmN
Set-Cookie: edition=us; expires=Wed, 18-Feb-2015 08:20:34 GMT; path=/; domain=.zdnet.com
Set-Cookie: session-zdnet-production=59ob97fpinqe4bg6lde4dvvq11; path=/; domain=zdnet.com
Set-Cookie: user_agent=desktop
Set-Cookie: zdnet_ad_session=f
Set-Cookie: firstpg=0
Expires: Thu, 19 Nov 1981 08:52:00 GMT
Cache-Control: no-store, no-cache, must-revalidate, post-check=0, pre-check=0
Pragma: no-cache
X-UA-Compatible: IE=edge,chrome=1
Vary: Accept-Encoding
Content-Encoding: gzip
Content-Length: 18922
Keep-Alive: timeout=70, max=146
Connection: Keep-Alive
Content-Type: text/html; charset=UTF-8

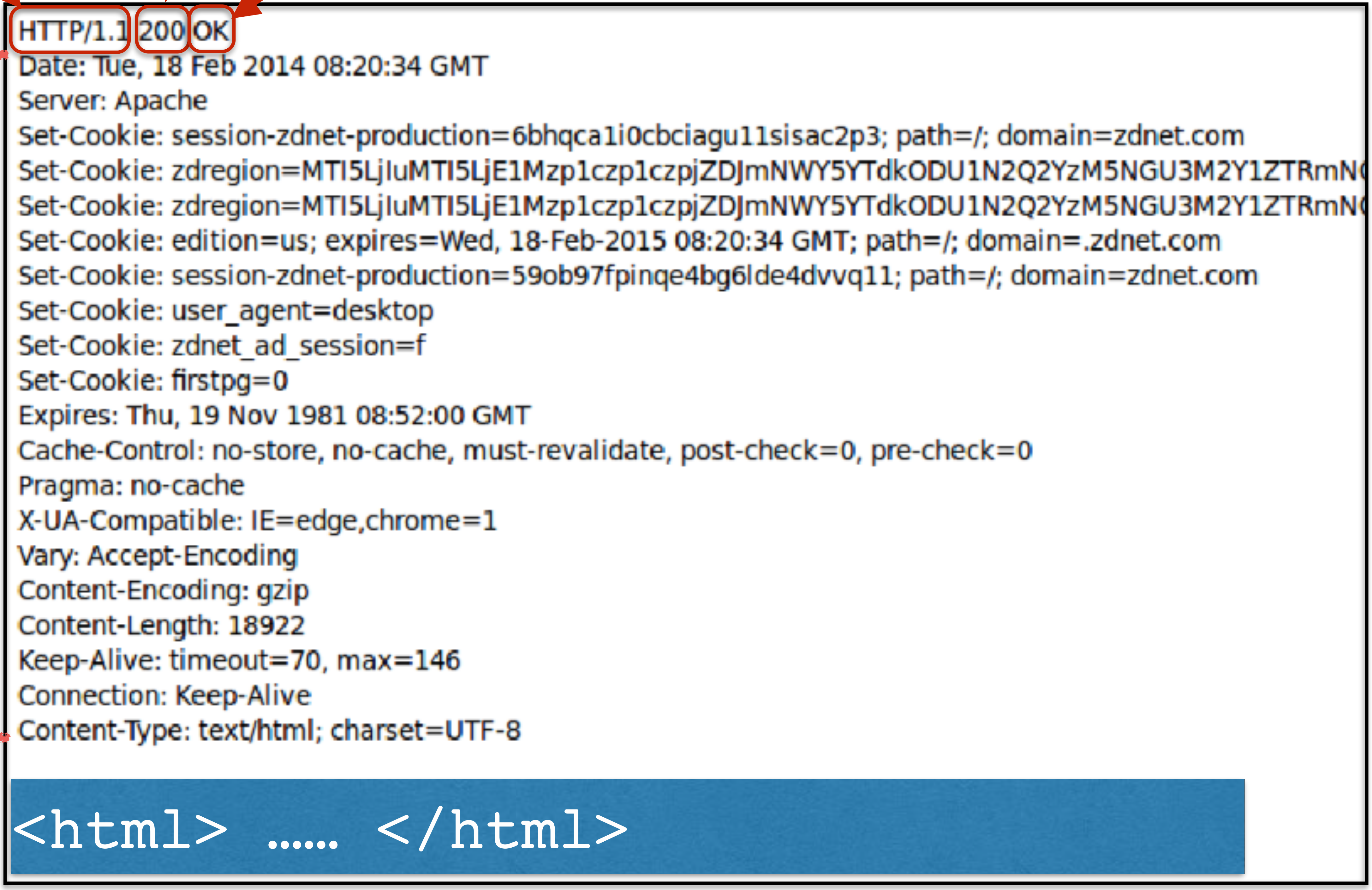
<html> ...... </html>
```

HTTP responses

HTTP version

Status code

Reason phrase

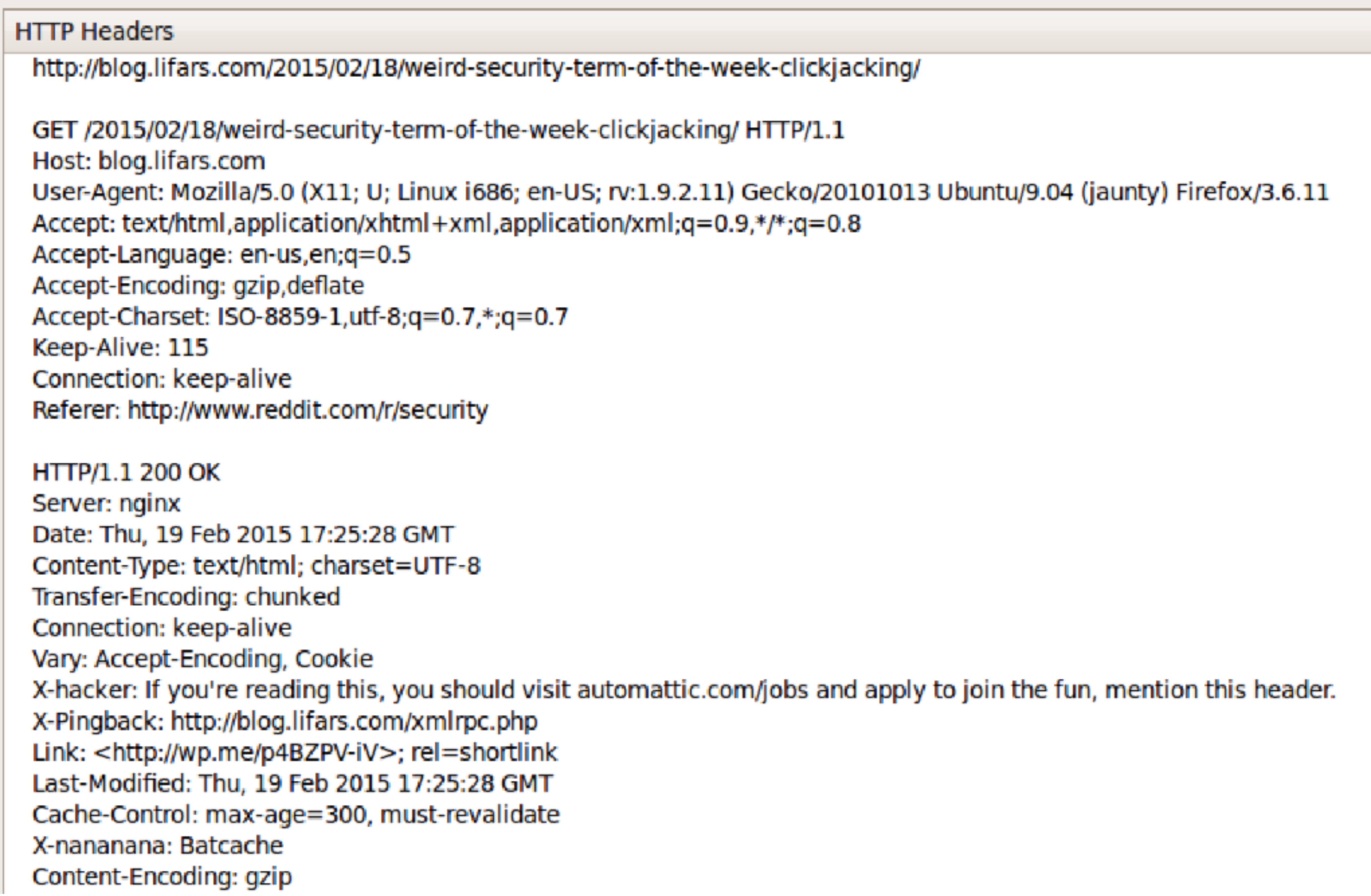


Headers

Data

```
HTTP/1.1 200 OK
Date: Tue, 18 Feb 2014 08:20:34 GMT
Server: Apache
Set-Cookie: session-zdnet-production=6bhqca1i0cbciagu11sisac2p3; path=/; domain=zdnet.com
Set-Cookie: zdregion=MTI5LjIuMTI5LjE1Mzp1czp1czpjZDJmNWY5YTdkODU1N2Q2YzM5NGU3M2Y1ZTRmN
Set-Cookie: zdregion=MTI5LjIuMTI5LjE1Mzp1czp1czpjZDJmNWY5YTdkODU1N2Q2YzM5NGU3M2Y1ZTRmN
Set-Cookie: edition=us; expires=Wed, 18-Feb-2015 08:20:34 GMT; path=/; domain=.zdnet.com
Set-Cookie: session-zdnet-production=59ob97fpinqe4bg6lde4dvvq11; path=/; domain=zdnet.com
Set-Cookie: user_agent=desktop
Set-Cookie: zdnet_ad_session=f
Set-Cookie: firstpg=0
Expires: Thu, 19 Nov 1981 08:52:00 GMT
Cache-Control: no-store, no-cache, must-revalidate, post-check=0, pre-check=0
Pragma: no-cache
X-UA-Compatible: IE=edge,chrome=1
Vary: Accept-Encoding
Content-Encoding: gzip
Content-Length: 18922
Keep-Alive: timeout=70, max=146
Connection: Keep-Alive
Content-Type: text/html; charset=UTF-8

<html> ...... </html>
```

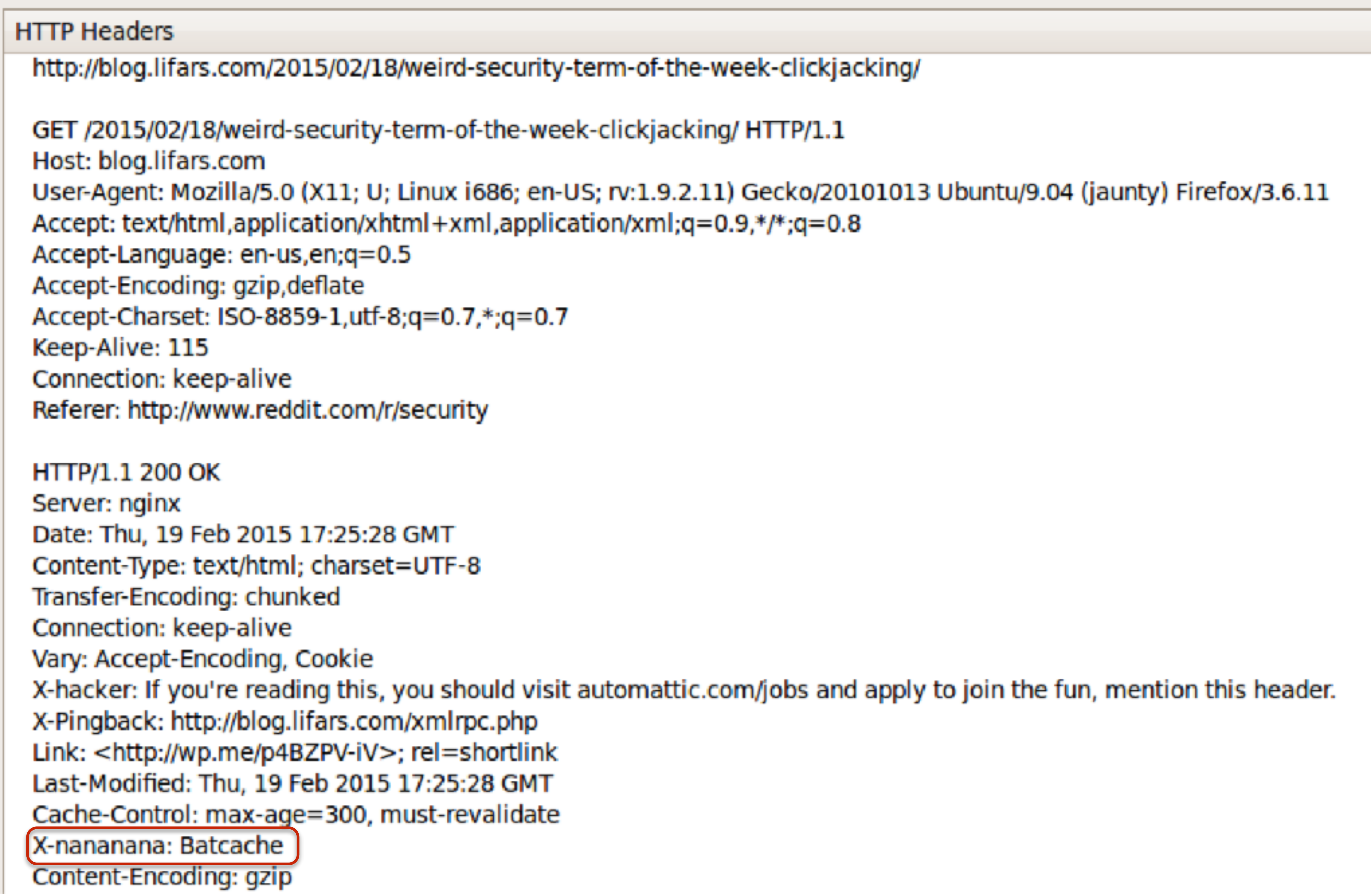


HTTP Headers

```
http://blog.lifars.com/2015/02/18/weird-security-term-of-the-week-clickjacking/

GET /2015/02/18/weird-security-term-of-the-week-clickjacking/ HTTP/1.1
Host: blog.lifars.com
User-Agent: Mozilla/5.0 (X11; U; Linux i686; en-US; rv:1.9.2.11) Gecko/20101013 Ubuntu/9.04 (jaunty) Firefox/3.6.11
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 115
Connection: keep-alive
Referer: http://www.reddit.com/r/security

HTTP/1.1 200 OK
Server: nginx
Date: Thu, 19 Feb 2015 17:25:28 GMT
Content-Type: text/html; charset=UTF-8
Transfer-Encoding: chunked
Connection: keep-alive
Vary: Accept-Encoding, Cookie
X-hacker: If you're reading this, you should visit automattic.com/jobs and apply to join the fun, mention this header.
X-Pingback: http://blog.lifars.com/xmlrpc.php
Link: <http://wp.me/p4BZPV-iV>; rel=shortlink
Last-Modified: Thu, 19 Feb 2015 17:25:28 GMT
Cache-Control: max-age=300, must-revalidate
X-nananana: Batcache
Content-Encoding: gzip
```



HTTP Headers

```
http://blog.lifars.com/2015/02/18/weird-security-term-of-the-week-clickjacking/

GET /2015/02/18/weird-security-term-of-the-week-clickjacking/ HTTP/1.1
Host: blog.lifars.com
User-Agent: Mozilla/5.0 (X11; U; Linux i686; en-US; rv:1.9.2.11) Gecko/20101013 Ubuntu/9.04 (jaunty) Firefox/3.6.11
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 115
Connection: keep-alive
Referer: http://www.reddit.com/r/security

HTTP/1.1 200 OK
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Content-Type: text/html; charset=UTF-8
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X-Pingback: http://blog.lifars.com/xmlrpc.php
Link: <http://wp.me/p4BZPV-iV>; rel=shortlink
Last-Modified: Thu, 19 Feb 2015 17:25:28 GMT
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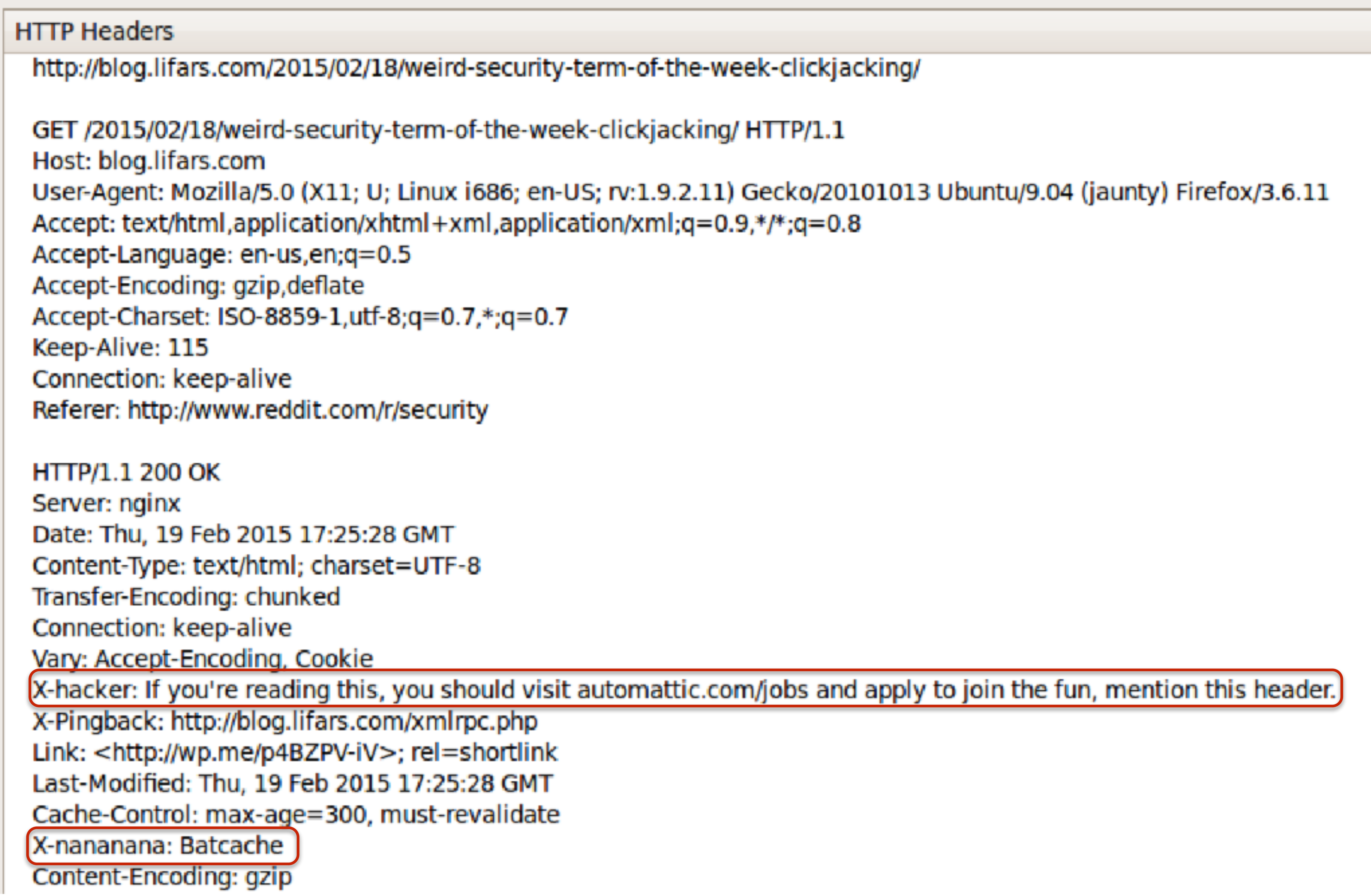
X-nananana: Batcache
Content-Encoding: gzip
```



```
http://blog.lifars.com/2015/02/18/weird-security-term-of-the-week-clickjacking/

GET /2015/02/18/weird-security-term-of-the-week-clickjacking/ HTTP/1.1
Host: blog.lifars.com
User-Agent: Mozilla/5.0 (X11; U; Linux i686; en-US; rv:1.9.2.11) Gecko/20101013 Ubuntu/9.04 (jaunty) Firefox/3.6.11
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 115
Connection: keep-alive
Referer: http://www.reddit.com/r/security

HTTP/1.1 200 OK
Server: nginx
Date: Thu, 19 Feb 2015 17:25:28 GMT
Content-Type: text/html; charset=UTF-8
Transfer-Encoding: chunked
Connection: keep-alive
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Link: <http://wp.me/p4BZPV-iV>; rel=shortlink
Last-Modified: Thu, 19 Feb 2015 17:25:28 GMT
Cache-Control: max-age=300, must-revalidate
X-nananana: Batcache
Content-Encoding: gzip
```

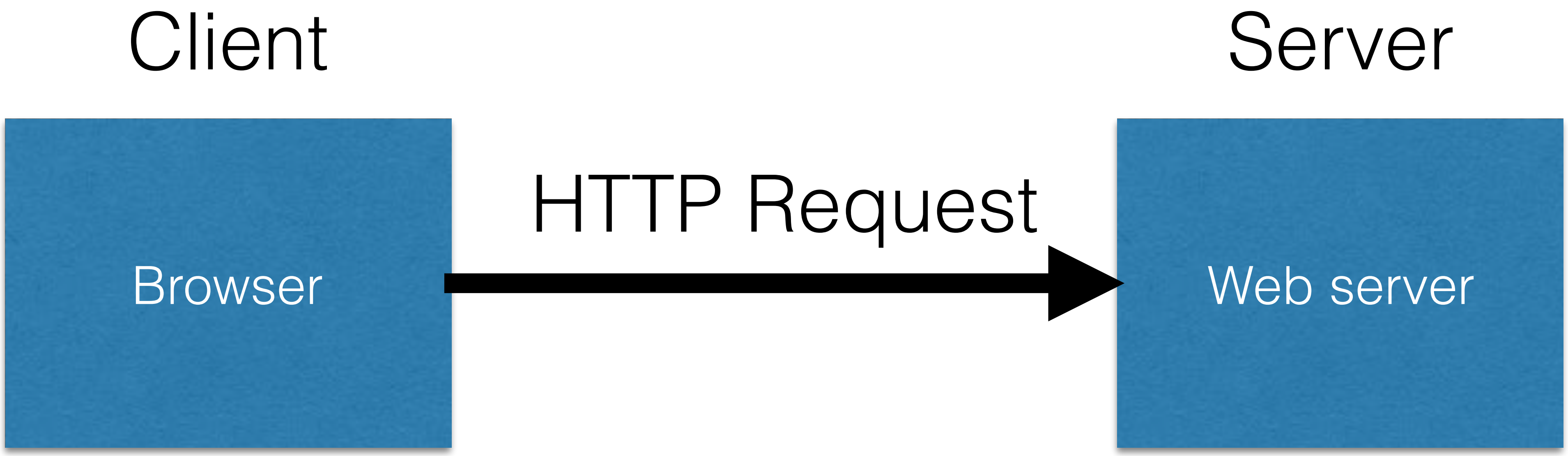
HTTP is *stateless*

- The lifetime of an HTTP session is typically:
  - Client connects to the server
  - Client issues a request
  - Server responds
  - Client issues a request for something in the response
  - …. repeat ….
  - Client disconnects

- HTTP has no means of noting “oh this is the same client from that previous session”

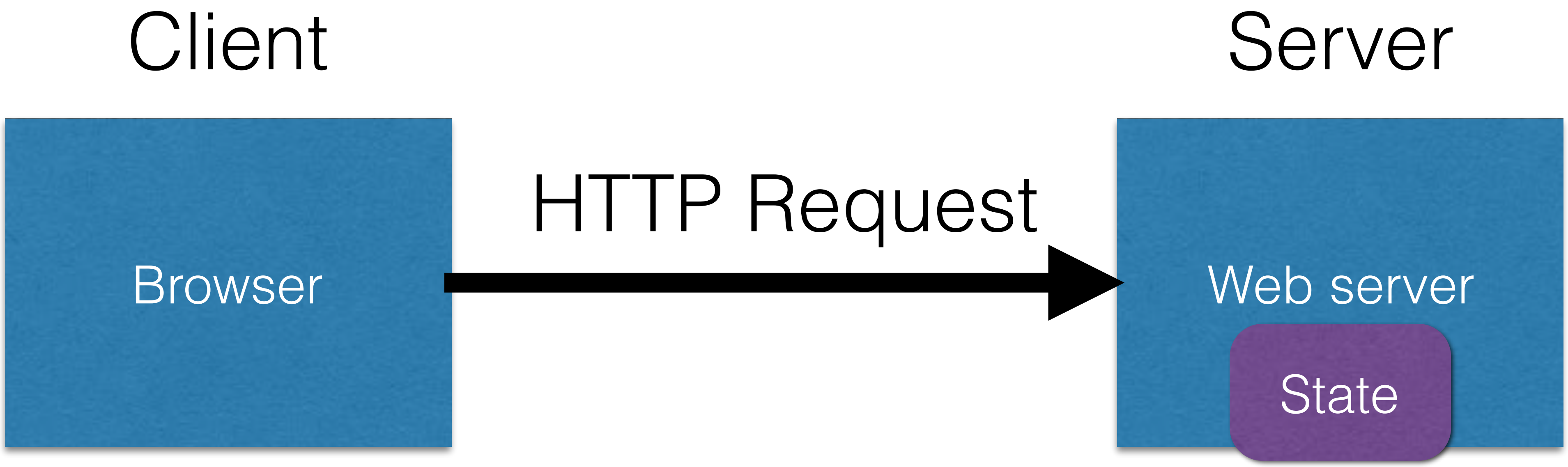
- *With this alone, you’d have to log in at every page load*

Maintaining state across HTTP sessions



- Server processing results in intermediate state
- Send the state to the client in *hidden fields*
- Client returns the state in subsequent responses

Maintaining state across HTTP sessions



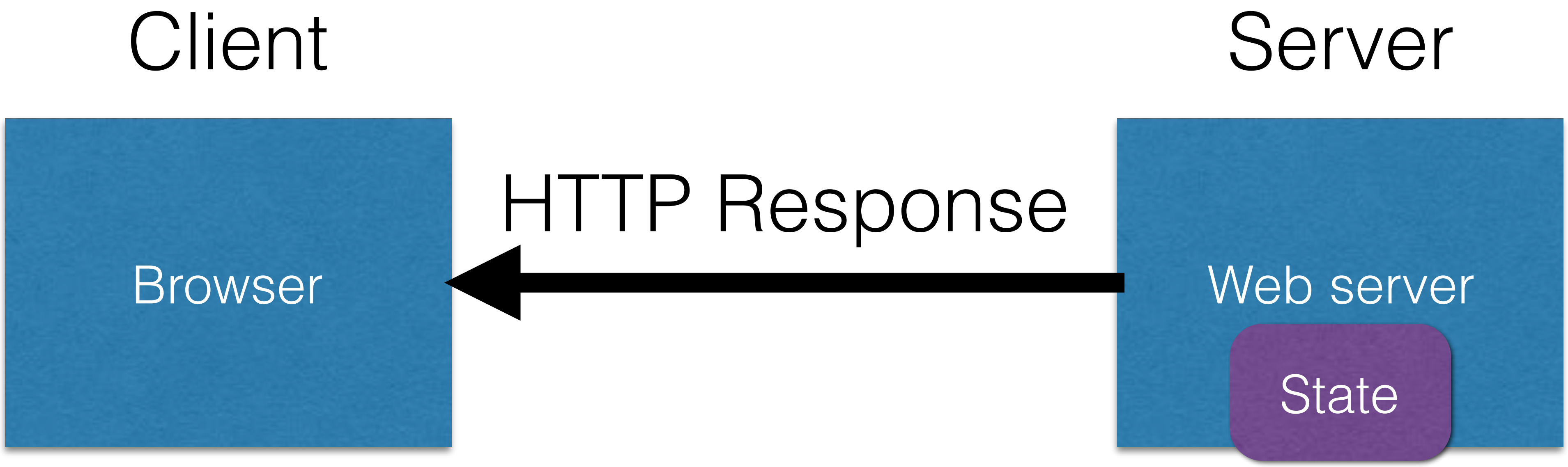
- Server processing results in intermediate state
- Send the state to the client in *hidden fields*
- Client returns the state in subsequent responses

Maintaining state across HTTP sessions

Client
Server
Browser
Web server
State

- Server processing results in intermediate state
- Send the state to the client in *hidden fields*
- Client returns the state in subsequent responses

Maintaining state across HTTP sessions



- Server processing results in intermediate state
- Send the state to the client in *hidden fields*
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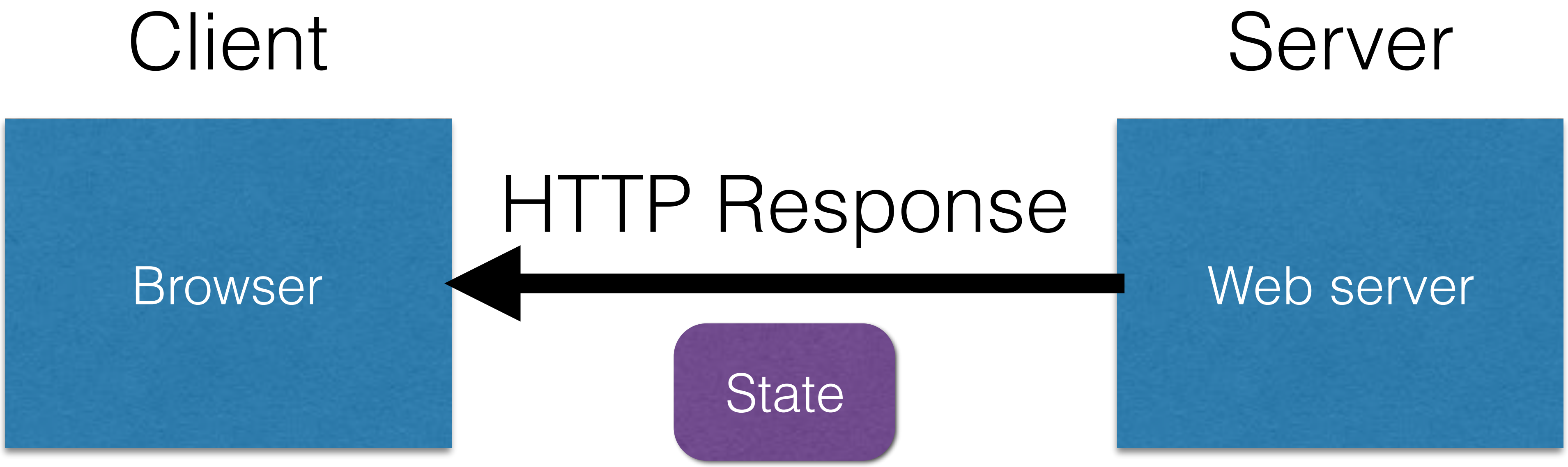
Maintaining state across HTTP sessions



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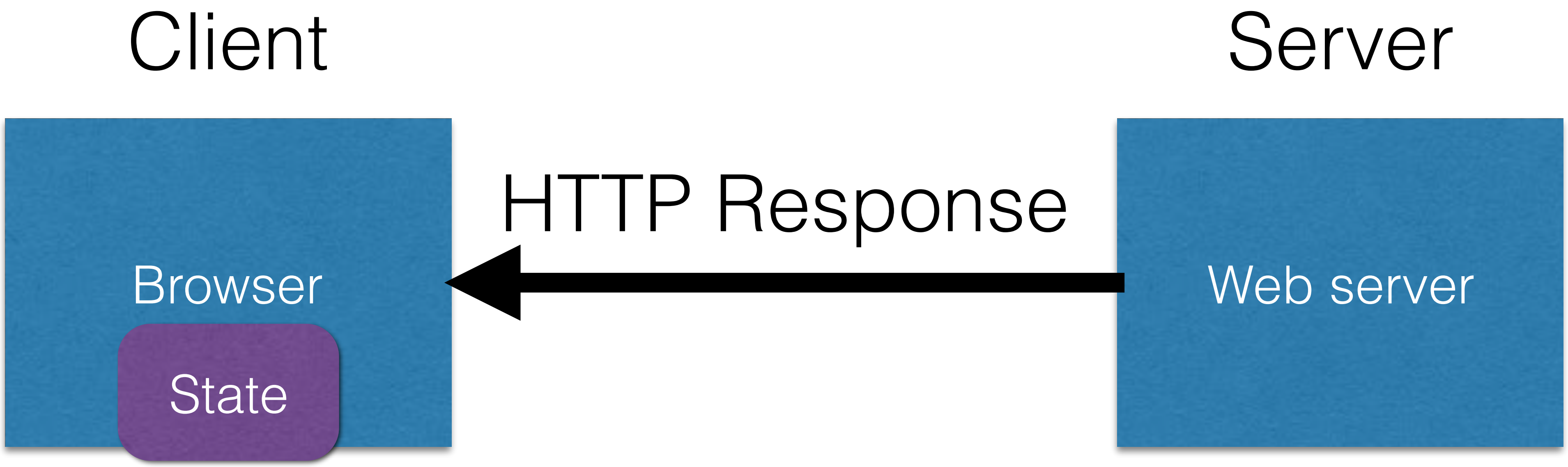
Maintaining state across HTTP sessions



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Maintaining state across HTTP sessions

Client
Server
Browser
State
Web server

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- Send the state to the client in *hidden fields*
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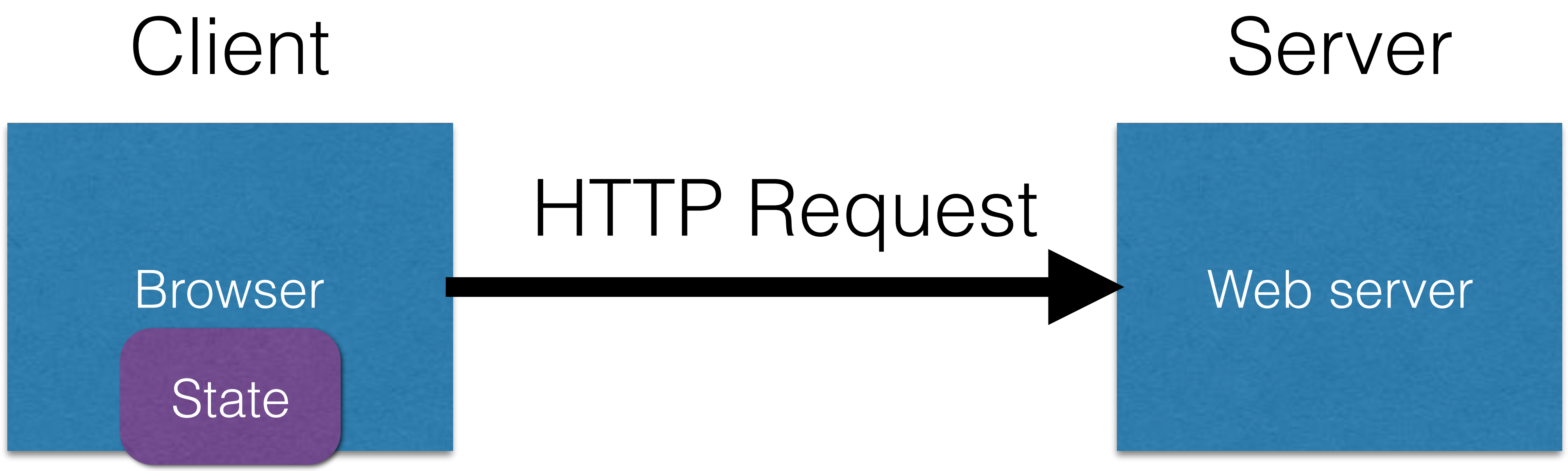
Maintaining state across HTTP sessions



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- Send the state to the client in *hidden fields*
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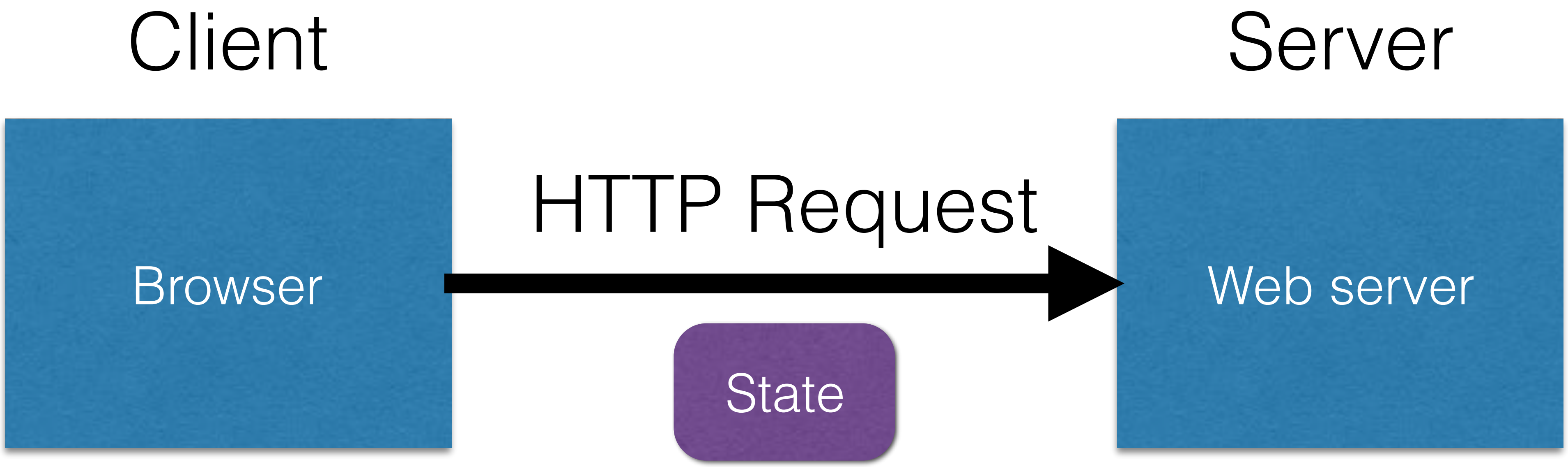
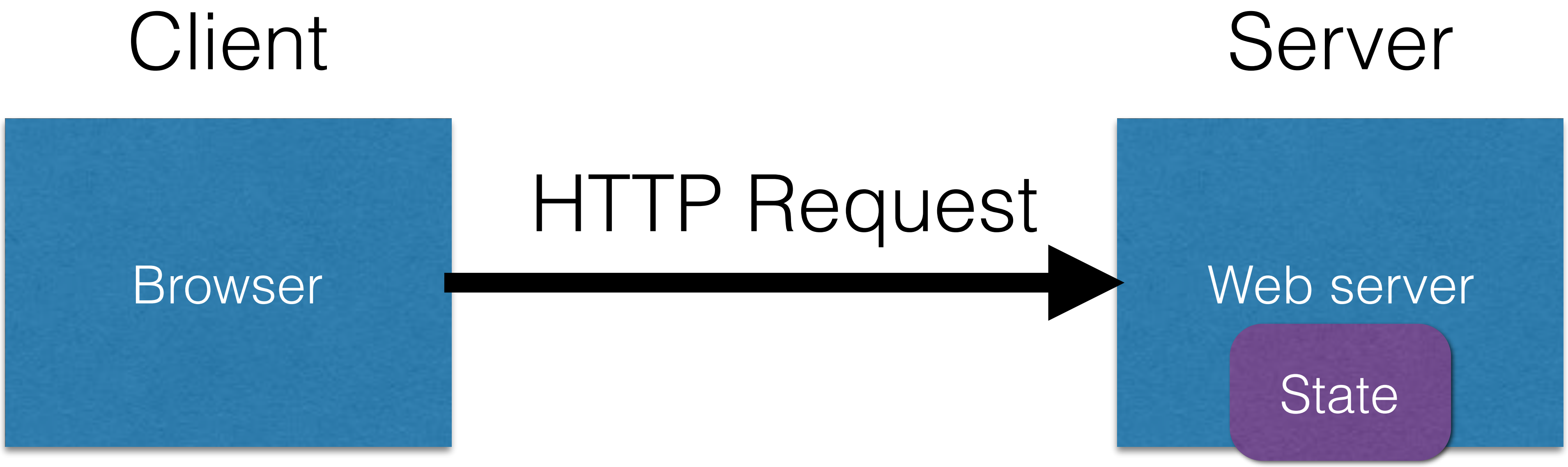
Maintaining state across HTTP sessions



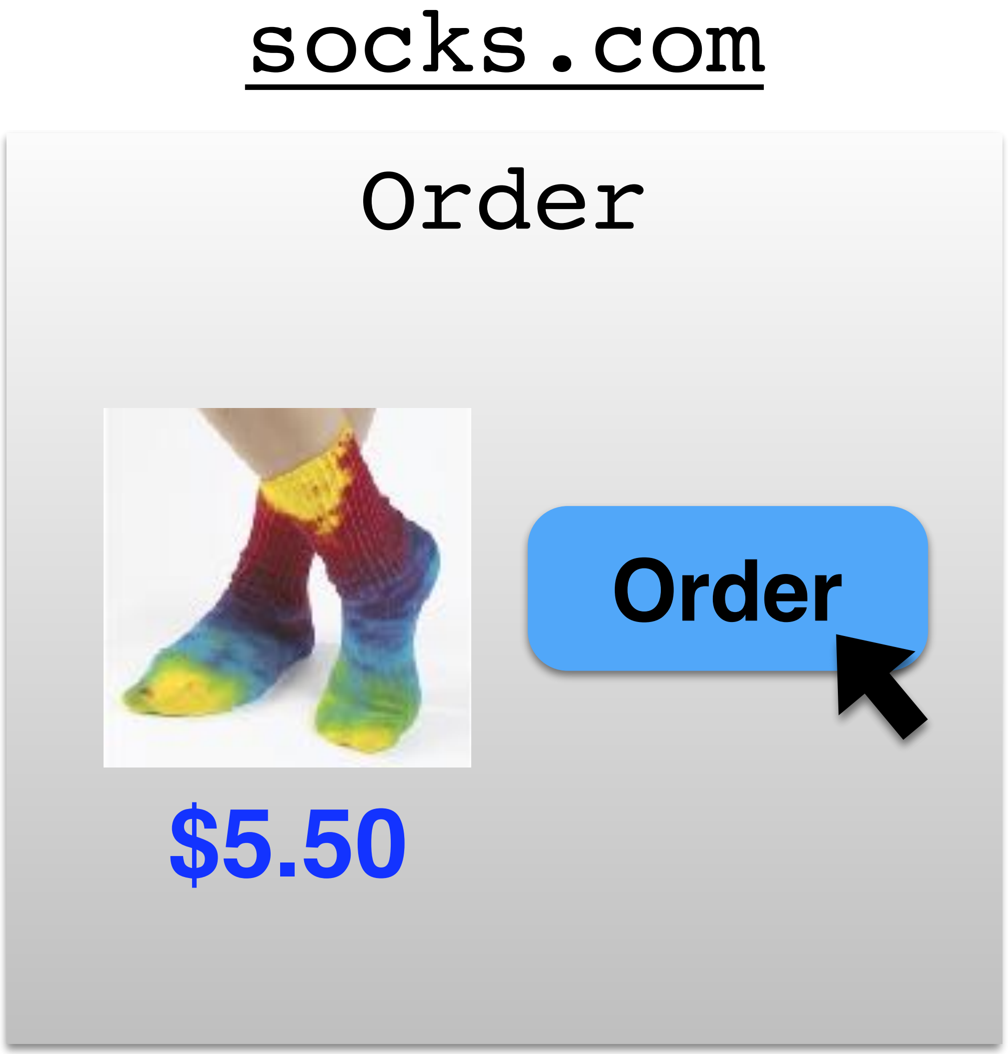
- Server processing results in intermediate state
- Send the state to the client in *hidden fields*
- Client returns the state in subsequent responses

Maintaining state across HTTP sessions

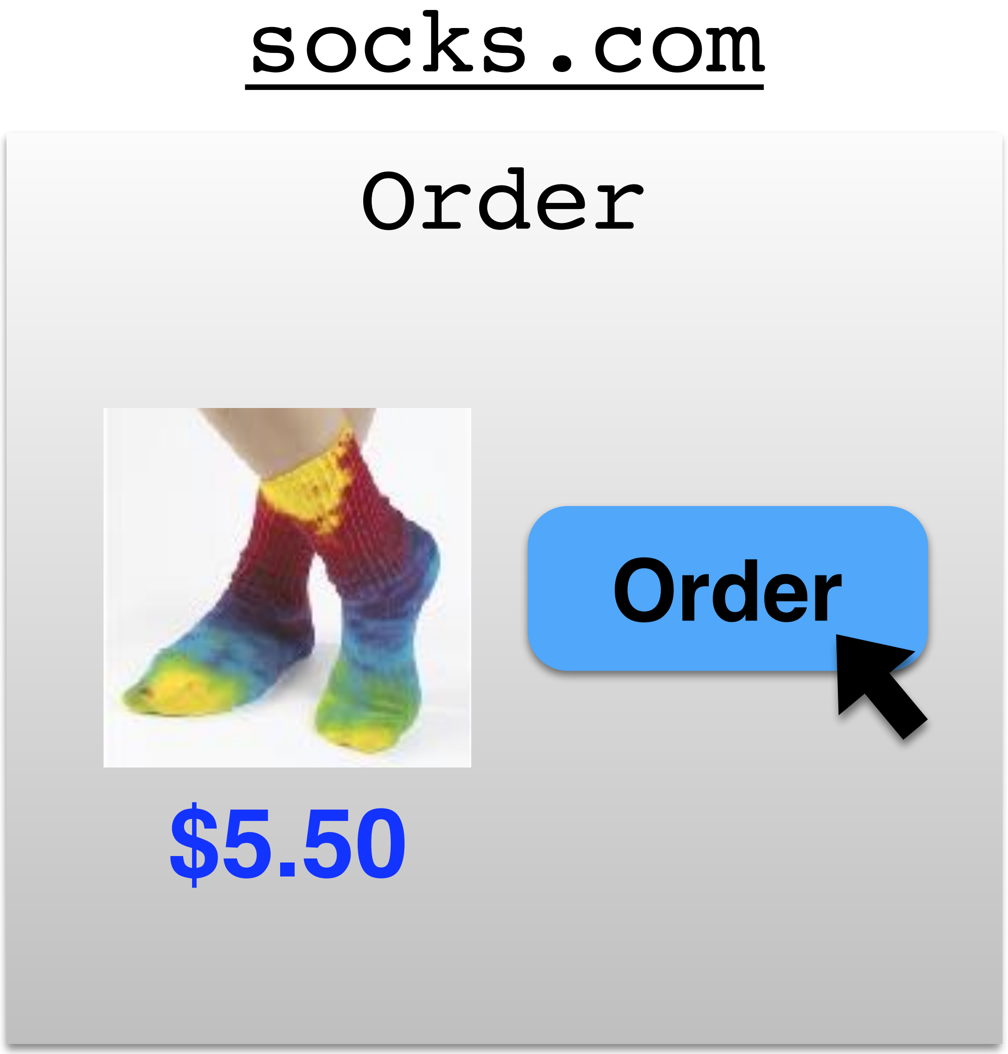


- Server processing results in intermediate state
- Send the state to the client in *hidden fields*
- Client returns the state in subsequent responses

Online ordering

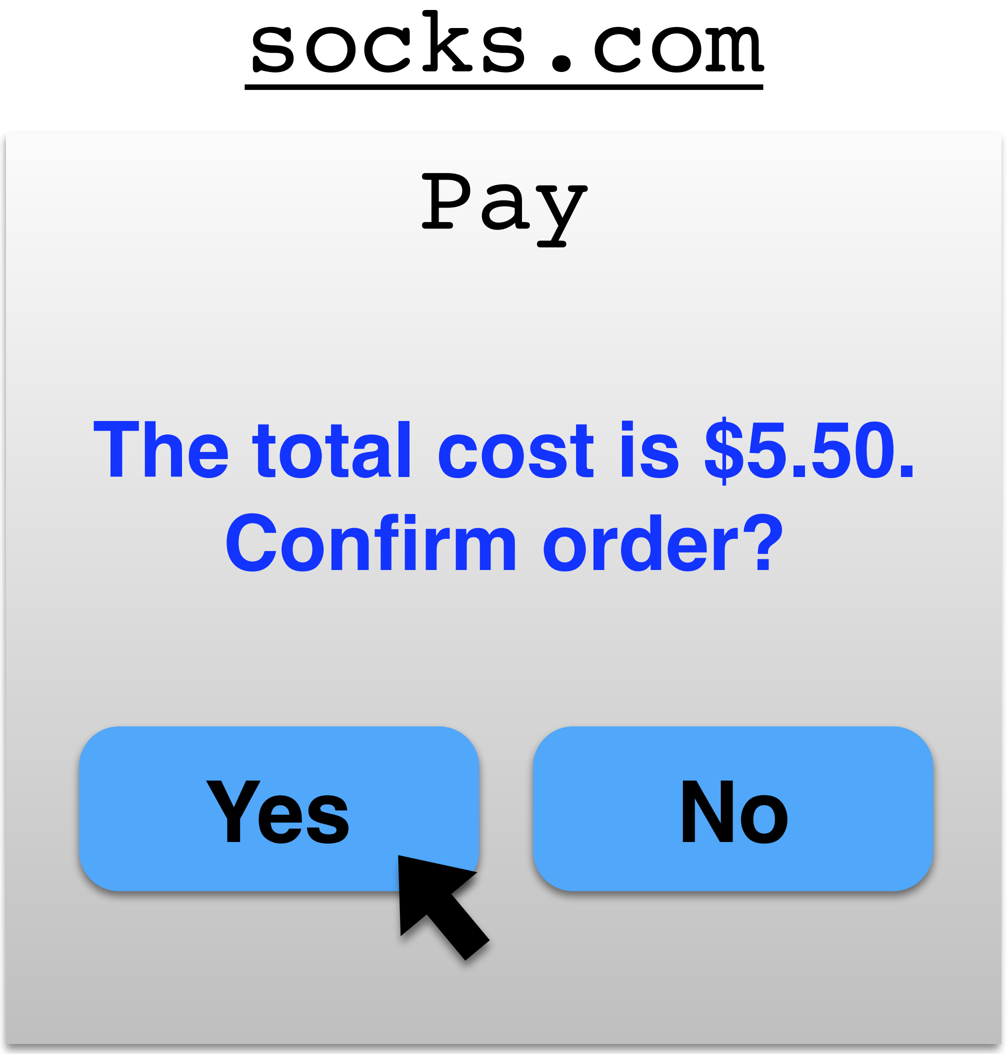


Online ordering


socks.com

Order

$5.50


socks.com

Pay

The total cost is $5.50.
Confirm order?

Separate page

Online ordering

What’s presented to the user

```
<html>
<head> <title>Pay</title> </head>
<body>

<form action=“submit_order” method=“GET”>
The total cost is $5.50. Confirm order?
<input type=“hidden” name=“price” value=“5.50”>
<input type=“submit” name=“pay” value=“yes”>
<input type=“submit” name=“pay” value=“no”>

</body>
</html>
```

Online ordering

What’s presented to the user

```
<html>
<head> <title>Pay</title> </head>
<body>

<form action=“submit_order” method=“GET”>
The total cost is $5.50. Confirm order?
<input type=“hidden” name=“price” value=“5.50”>
<input type=“submit” name=“pay” value=“yes”>
<input type=“submit” name=“pay” value=“no”>

</body>
</html>
```

Online ordering

The corresponding backend processing

```
if(pay == yes && price != NULL)
{
   bill_creditcard(price);
   deliver_socks();
}
else
   display_transaction_cancelled_page();
```

Online ordering

The corresponding backend processing

```
if(pay == yes && price != NULL)
{
   bill_creditcard(price);
   deliver_socks();
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Online ordering

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<head> <title>Pay</title> </head>
<body>

<form action=“submit_order” method=“GET”>
The total cost is $5.50. Confirm order?
<input type=“hidden” name=“price” value=“5.50”>
<input type=“submit” name=“pay” value=“yes”>
<input type=“submit” name=“pay” value=“no”>

</body>
</html>
```

Online ordering

What’s presented to the user

```
<html>
<head> <title>Pay</title> </head>
<body>

<form action=“submit_order” method=“GET”>
The total cost is $5.50. Confirm order?
<input type=“hidden” name=“price” value=“0.01”>
<input type=“submit” name=“pay” value=“yes”>
<input type=“submit” name=“pay” value=“no”>

</body>
</html>
```

Minimizing trust in the client

What’s presented to the user

```
<html>
<head> <title>Pay</title> </head>
<body>

<form action=“submit_order” method=“GET”>
The total cost is $5.50. Confirm order?
<input type=“hidden” name=“price” value=“5.50”>
<input type=“submit” name=“pay” value=“yes”>
<input type=“submit” name=“pay” value=“no”>

</body>
</html>
```

Minimizing trust in the client

What’s presented to the user

```
<html>
<head> <title>Pay</title> </head>
<body>

<form action=“submit_order” method=“GET”>
The total cost is $5.50. Confirm order?
<input type=“hidden” name=“sid” value=“781234”>
<input type=“submit” name=“pay” value=“yes”>
<input type=“submit” name=“pay” value=“no”>

</body>
</html>
```

Minimizing trust in the client

The corresponding backend processing

```
price = lookup(sid);
if(pay == yes && price != NULL)
{
  bill_creditcard(price);
  deliver_socks();
}
else
  display_transaction_cancelled_page();
```

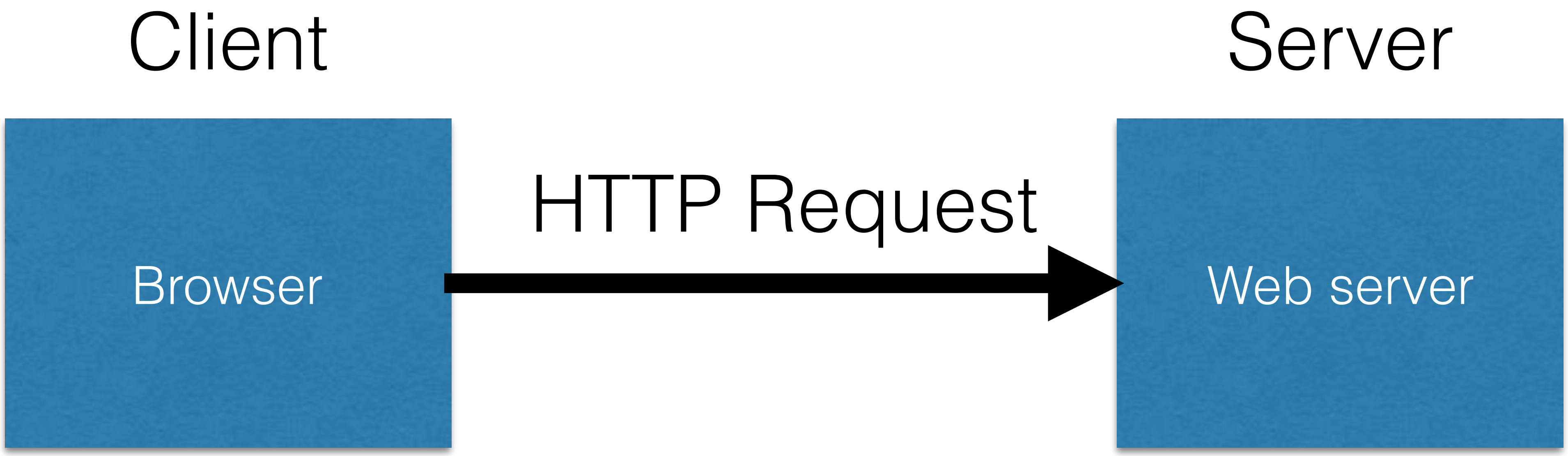
Minimizing trust in the client

The corresponding backend processing

```
price = lookup(sid);
if(pay == yes && price != NULL)
{
   bill_creditcard(price);
   deliver_socks();
}
else
   display_transaction_cancelled_page();
```

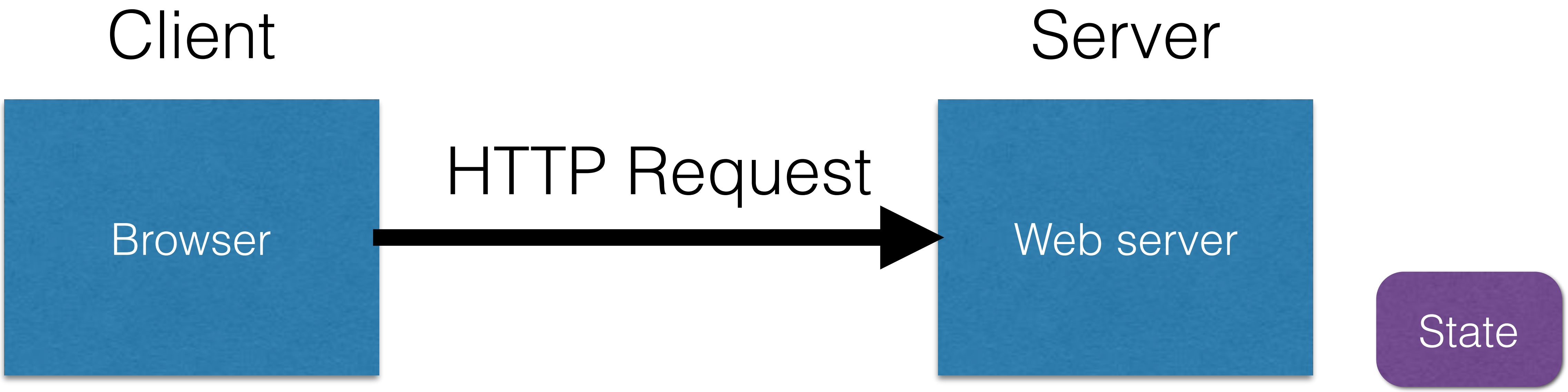
We don’t want to pass hidden fields around all the time

Statefulness with Cookies



- Server stores state, indexes it with a cookie
- Send this cookie to the client
- Client stores the cookie and returns it with subsequent queries to that same server

Statefulness with Cookies



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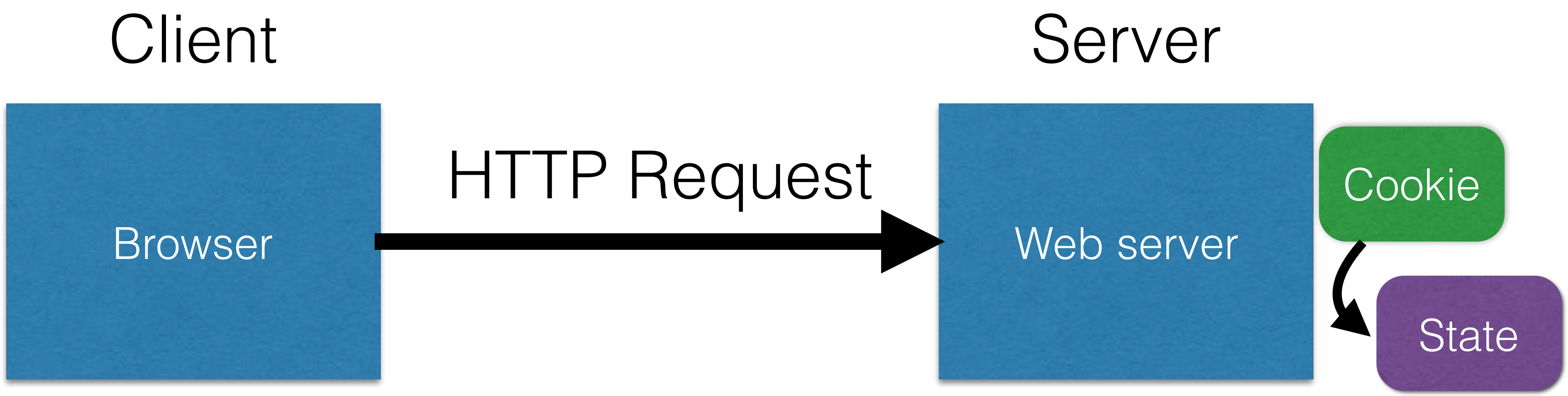
Statefulness with Cookies



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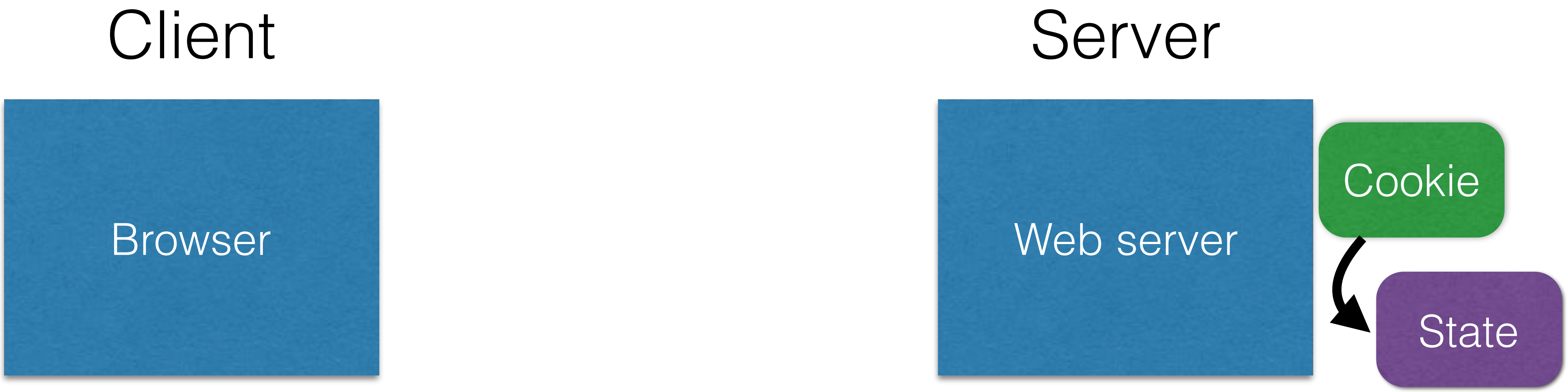
Statefulness with Cookies



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- Send this cookie to the client
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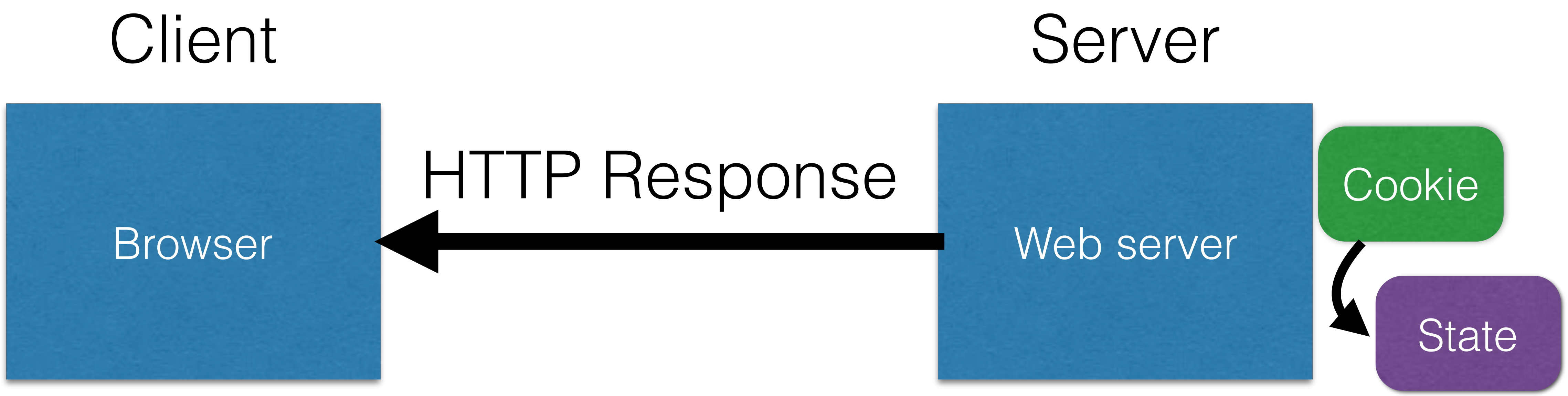
Statefulness with Cookies



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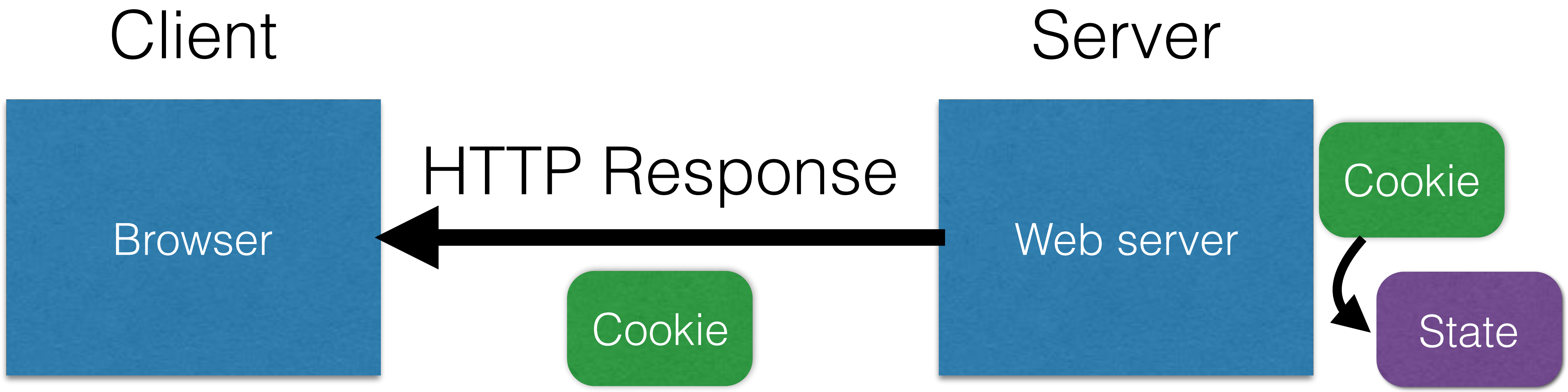
Statefulness with Cookies



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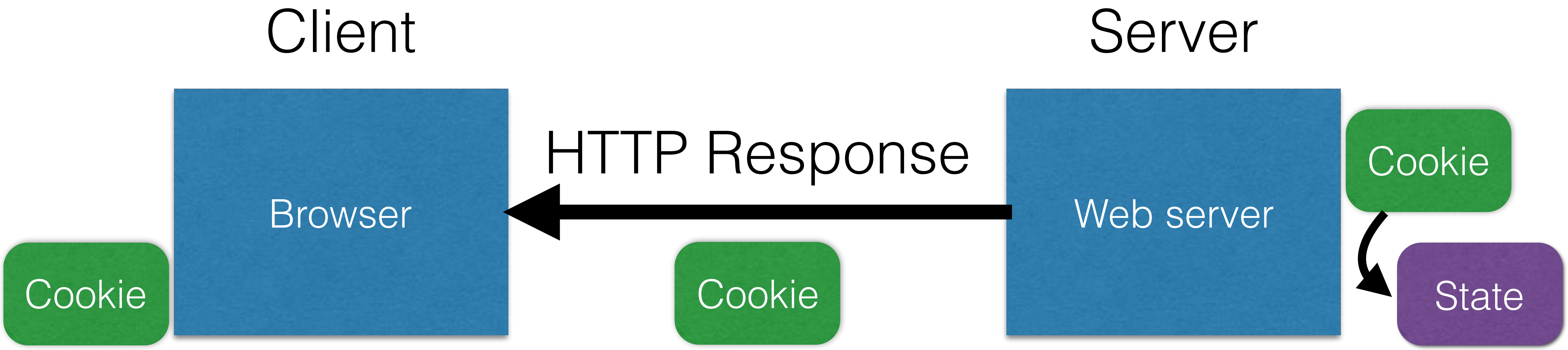
Statefulness with Cookies



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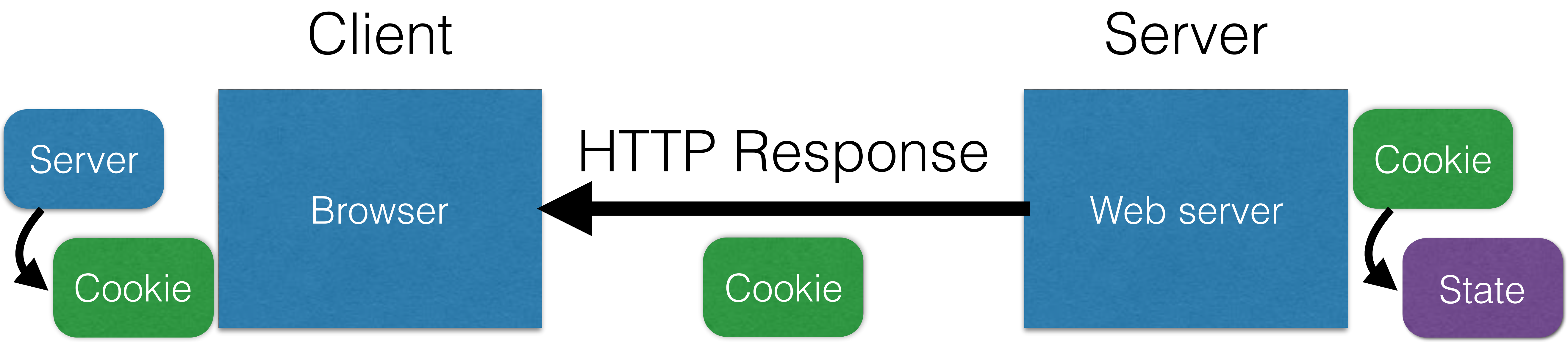

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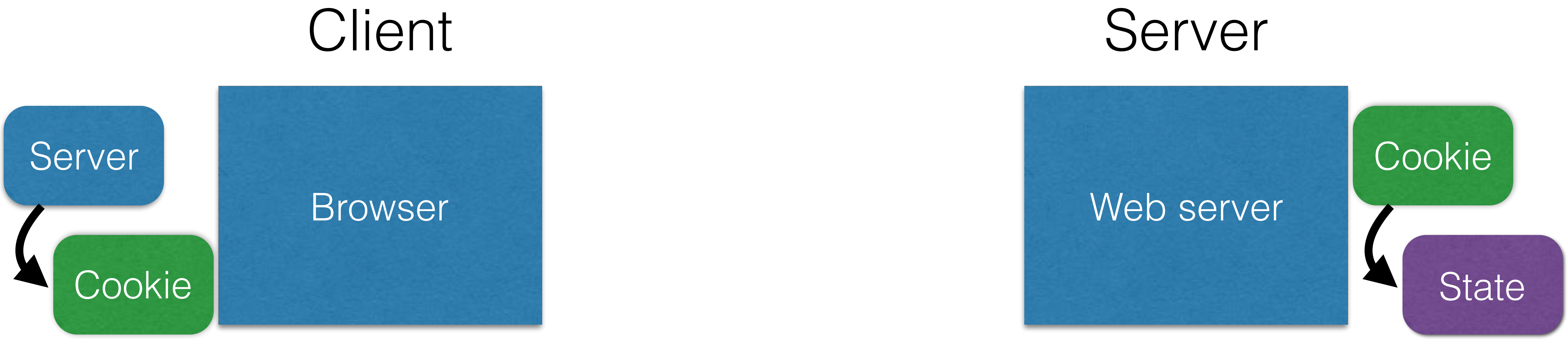
Statefulness with Cookies



- Server stores state, indexes it with a cookie
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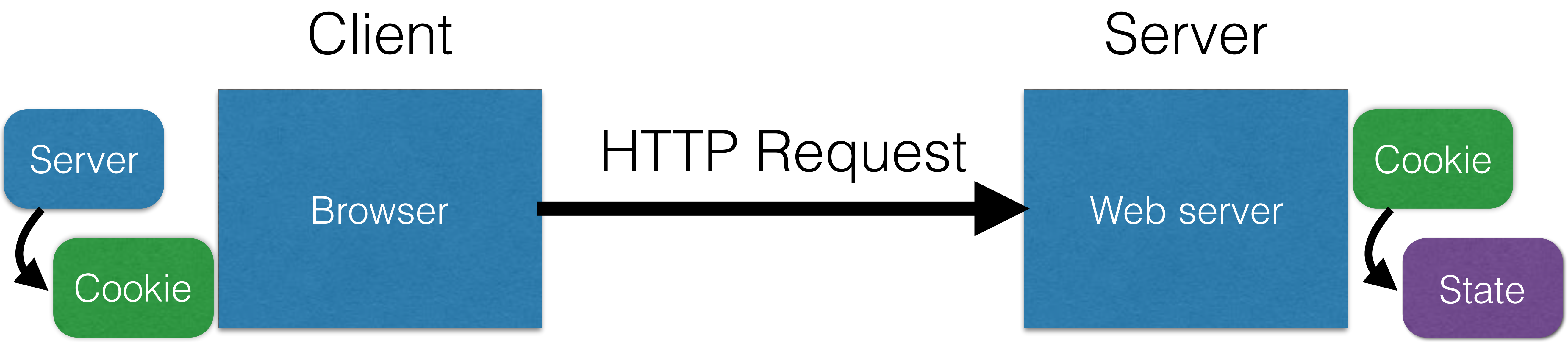
Statefulness with Cookies



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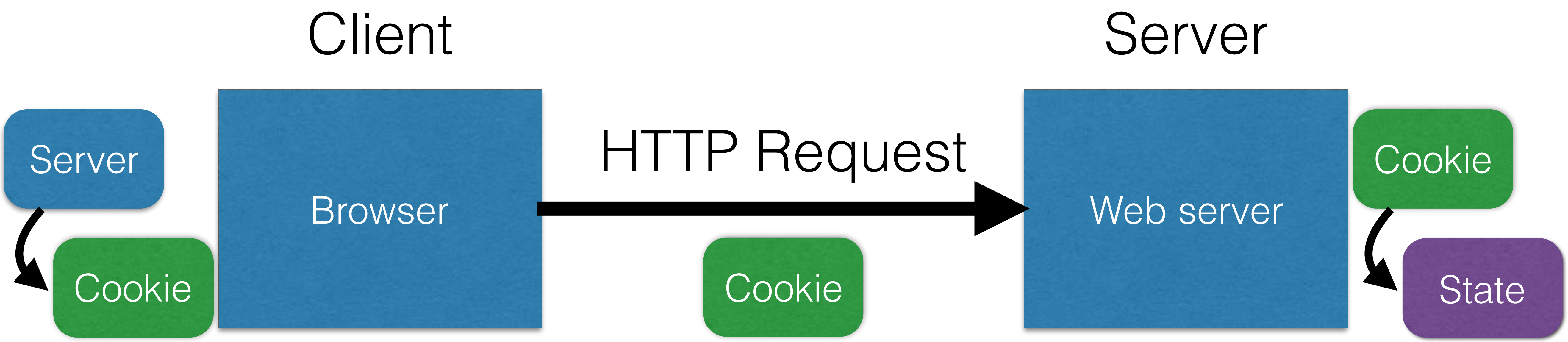
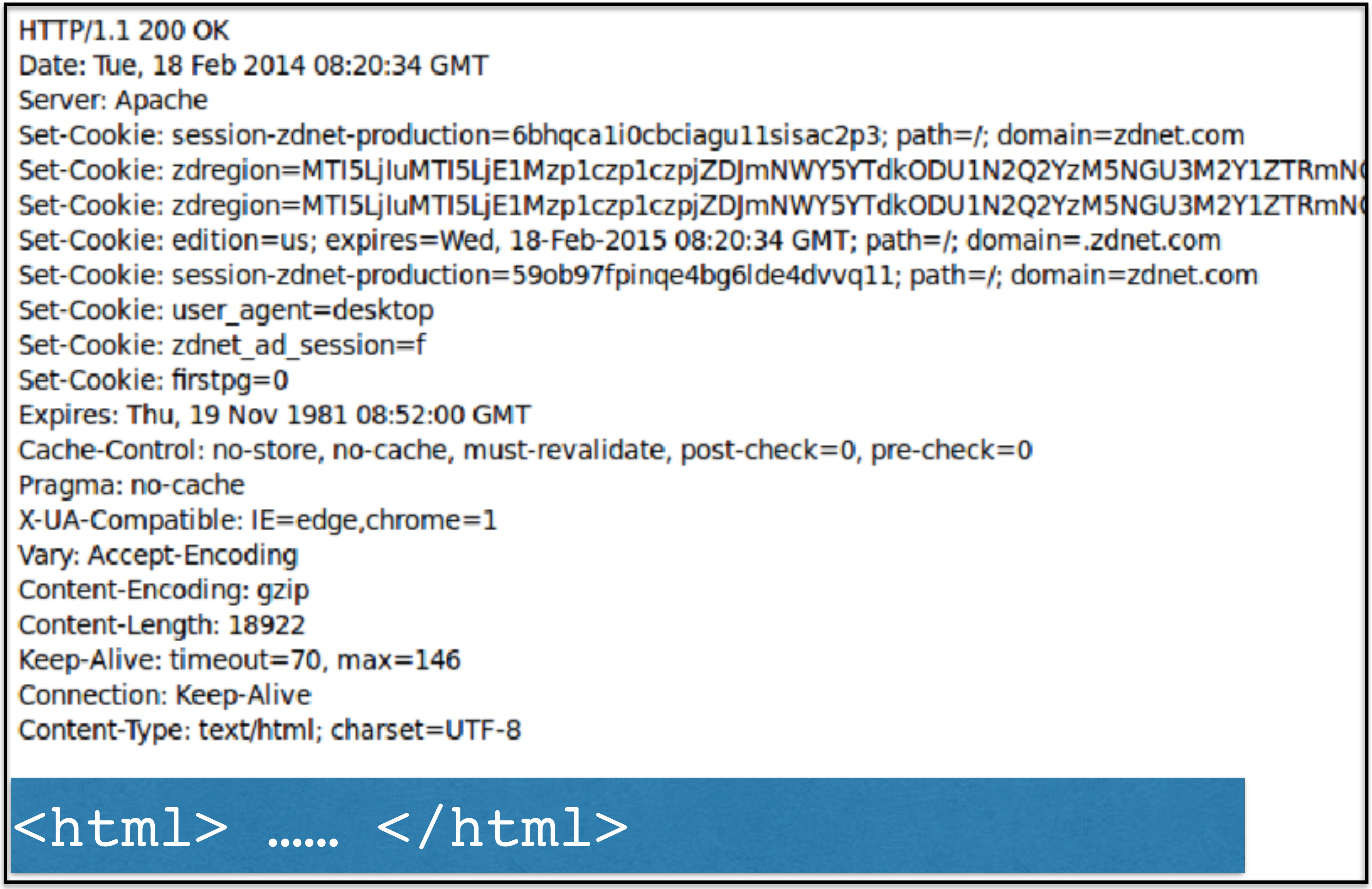
Statefulness with Cookies



- Server stores state, indexes it with a cookie
- Send this cookie to the client
- Client stores the cookie and returns it with subsequent queries to that same server

Cookies are key-value pairs

Set-Cookie:key=value; options; ….

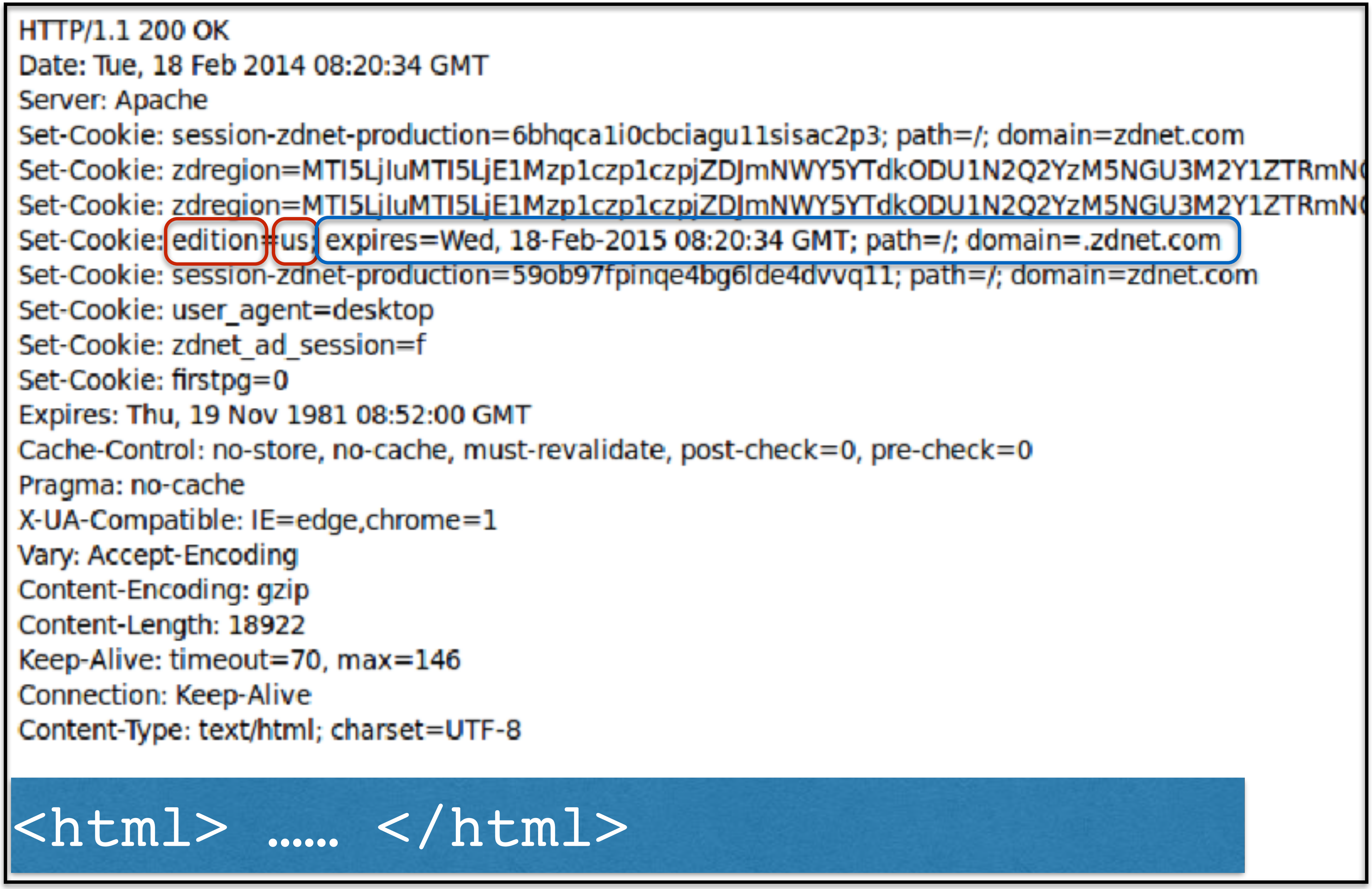


```
HTTP/1.1 200 OK
Date: Tue, 18 Feb 2014 08:20:34 GMT
Server: Apache
Set-Cookie: session-zdnet-production=6bhqca1i0cbciagu11sisac2p3; path=/; domain=zdnet.com
Set-Cookie: zdregion=MTI5LjluMTI5LjE1Mzp1czp1czpjZDJmNWY5YTdkODU1N2Q2YzM5NGU3M2Y1ZTRmN
Set-Cookie: zdregion=MTI5LjluMTI5LjE1Mzp1czp1czpjZDJmNWY5YTdkODU1N2Q2YzM5NGU3M2Y1ZTRmN
Set-Cookie: edition=us; expires=Wed, 18-Feb-2015 08:20:34 GMT; path=/; domain=.zdnet.com
Set-Cookie: session-zdnet-production=59ob97fpinqe4bg6lde4dvvq11; path=/; domain=zdnet.com
Set-Cookie: user_agent=desktop
Set-Cookie: zdnet_ad_session=f
Set-Cookie: firstpg=0
Expires: Thu, 19 Nov 1981 08:52:00 GMT
Cache-Control: no-store, no-cache, must-revalidate, post-check=0, pre-check=0
Pragma: no-cache
X-UA-Compatible: IE=edge,chrome=1
Vary: Accept-Encoding
Content-Encoding: gzip
Content-Length: 18922
Keep-Alive: timeout=70, max=146
Connection: Keep-Alive
Content-Type: text/html; charset=UTF-8

<html> …… </html>
```

Cookies are key-value pairs

Set-Cookie:key=value; options; ….



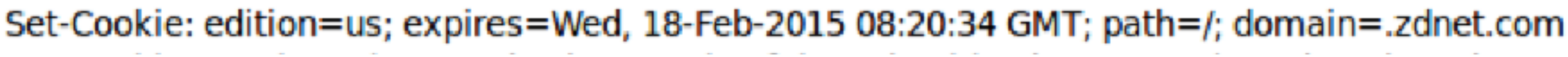
Headers

```
HTTP/1.1 200 OK
Date: Tue, 18 Feb 2014 08:20:34 GMT
Server: Apache
Set-Cookie: session-zdnet-production=6bhqca1i0cbciagu11sisac2p3; path=/; domain=zdnet.com
Set-Cookie: zdregion=MTI5LjIuMTI5LjE1Mzp1czp1czpjZDJmNWY5YTdkODU1N2Q2YzM5NGU3M2Y1ZTRmN
Set-Cookie: zdregion=MTI5LjIuMTI5LjE1Mzp1czp1czpjZDJmNWY5YTdkODU1N2Q2YzM5NGU3M2Y1ZTRmN
Set-Cookie: edition=us; expires=Wed, 18-Feb-2015 08:20:34 GMT; path=/; domain=.zdnet.com
Set-Cookie: session-zdnet-production=59ob97fpinqe4bg6lde4dvvq11; path=/; domain=zdnet.com
Set-Cookie: user_agent=desktop
Set-Cookie: zdnet_ad_session=f
Set-Cookie: firstpg=0
Expires: Thu, 19 Nov 1981 08:52:00 GMT
Cache-Control: no-store, no-cache, must-revalidate, post-check=0, pre-check=0
Pragma: no-cache
X-UA-Compatible: IE=edge,chrome=1
Vary: Accept-Encoding
Content-Encoding: gzip
Content-Length: 18922
Keep-Alive: timeout=70, max=146
Connection: Keep-Alive
Content-Type: text/html; charset=UTF-8
```

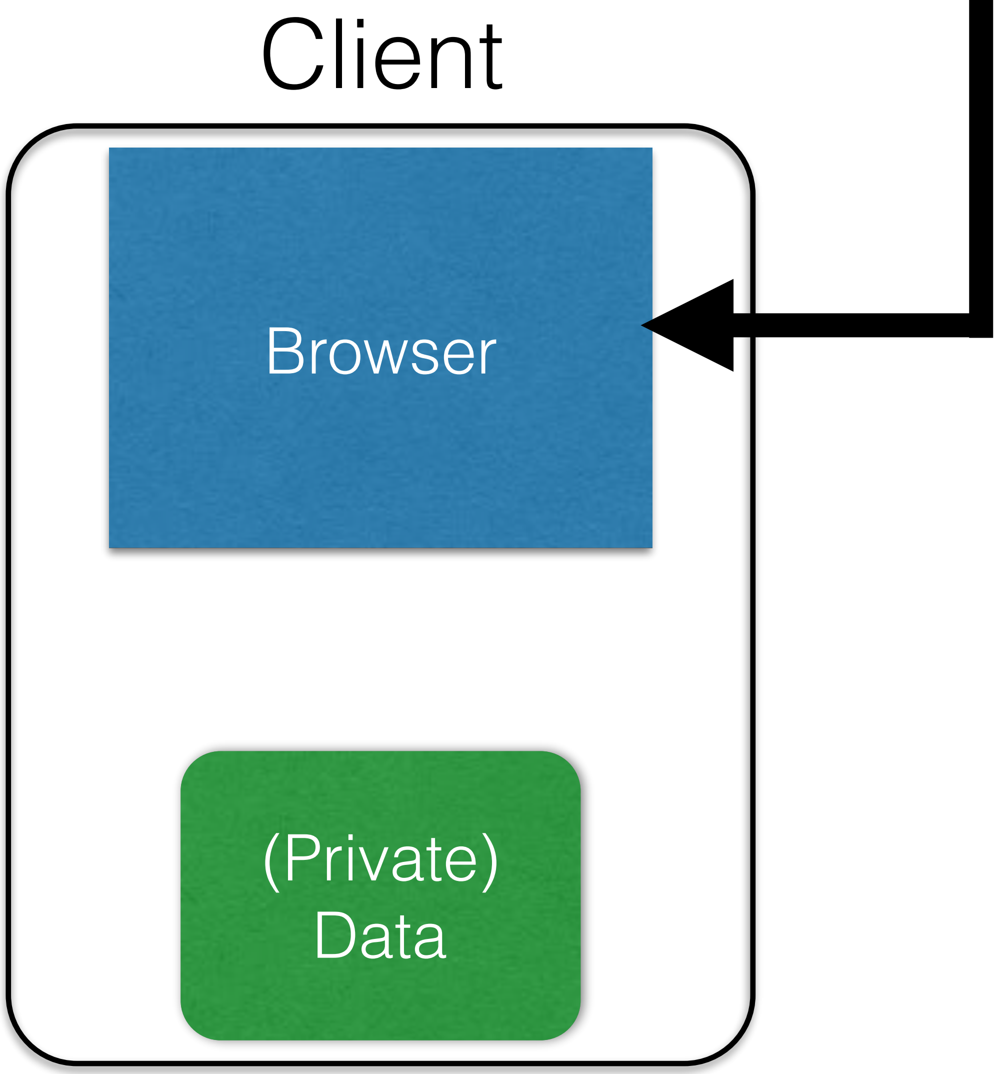
Data

```
<html> …… </html>
```

Cookies

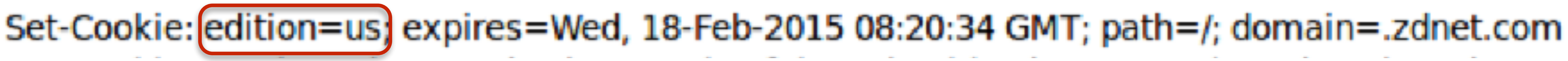


```
Set-Cookie: edition=us; expires=Wed, 18-Feb-2015 08:20:34 GMT; path=/; domain=.zdnet.com
```

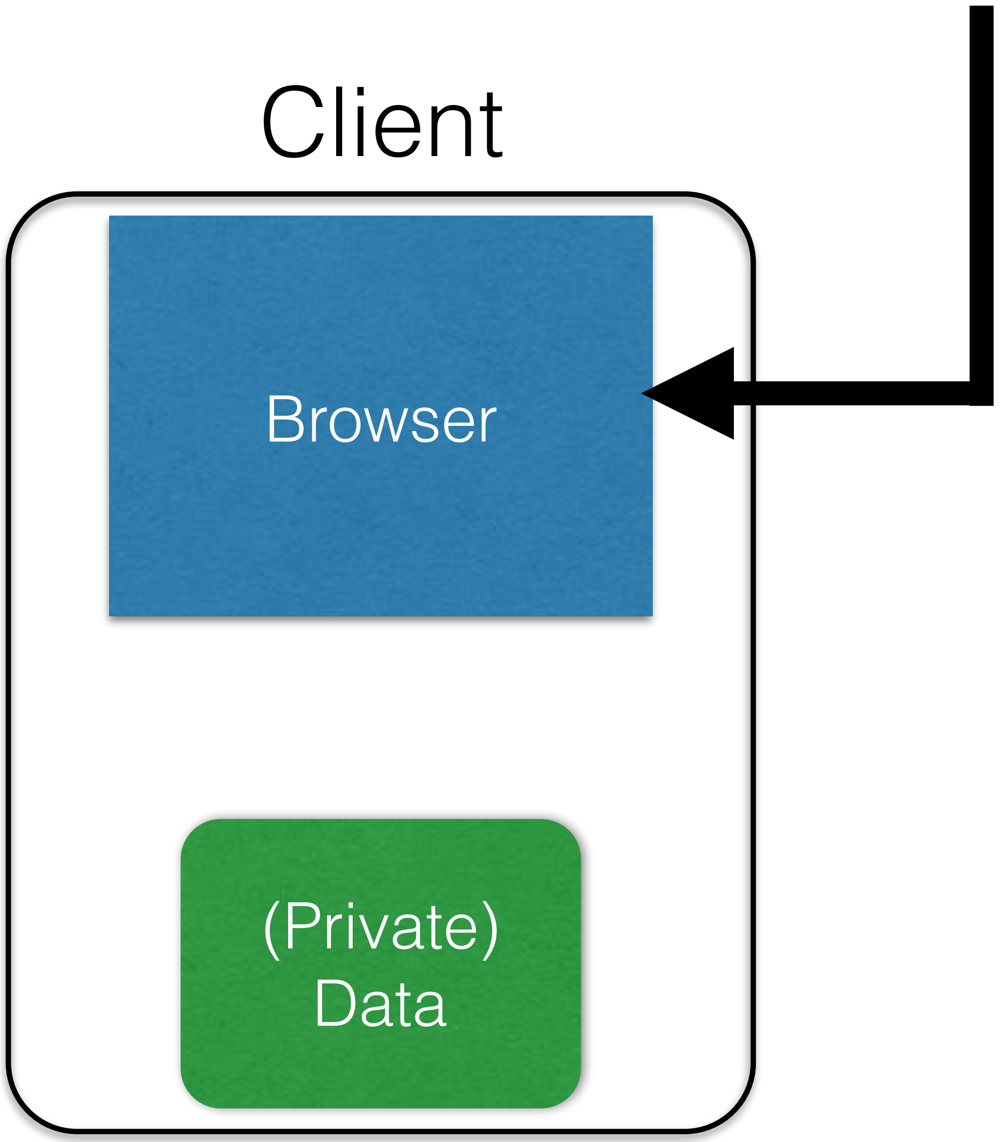


Semantics

Cookies



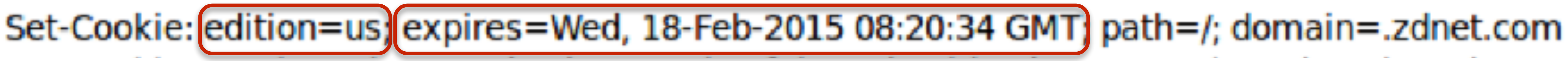
```
Set-Cookie: edition=us; expires=Wed, 18-Feb-2015 08:20:34 GMT; path=/; domain=.zdnet.com
```



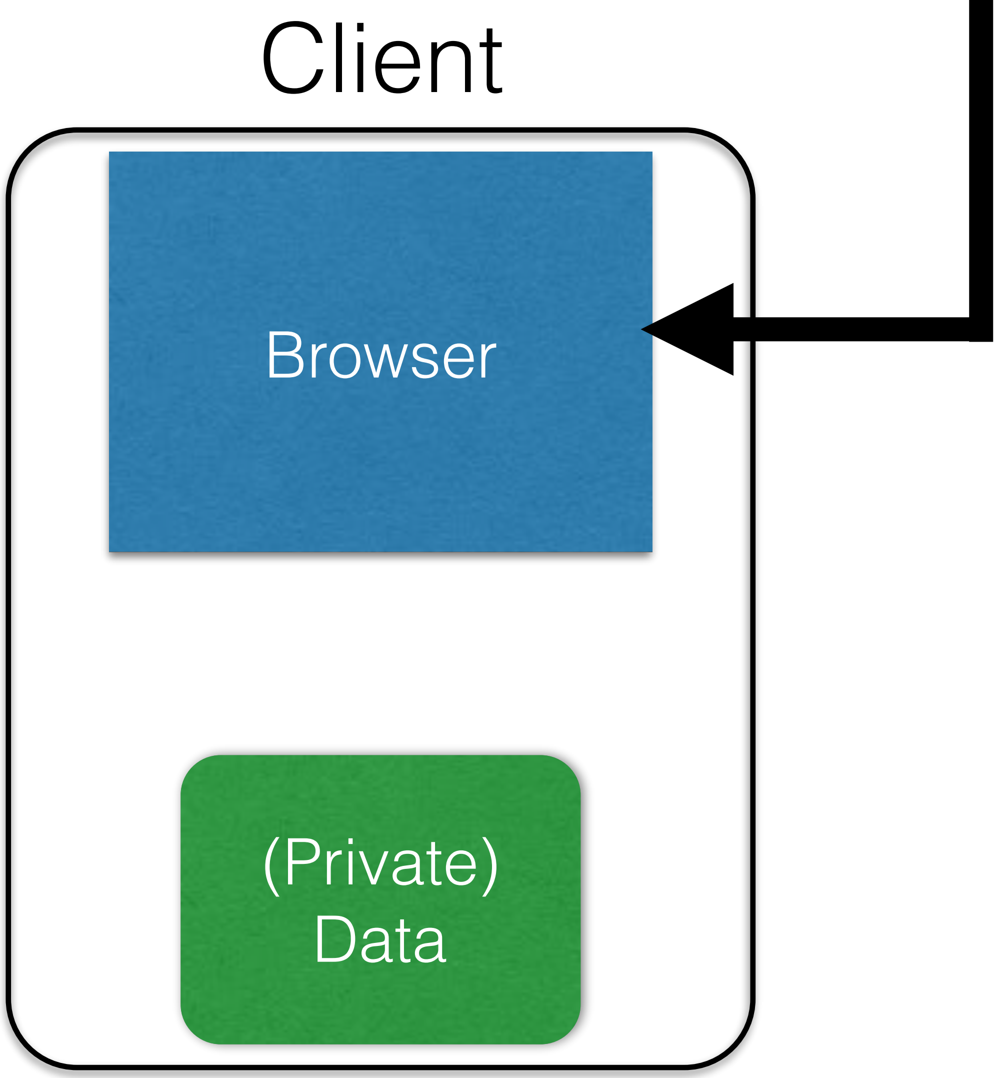
Semantics

- Store "us" under the key "edition" (think of it like one big hash table)

Cookies



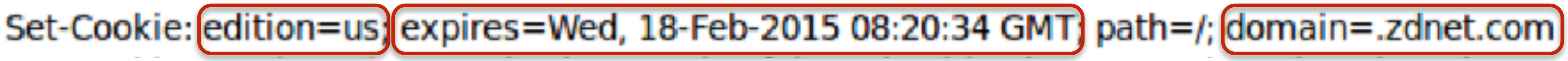
```
Set-Cookie: edition=us; expires=Wed, 18-Feb-2015 08:20:34 GMT; path=/; domain=.zdnet.com
```



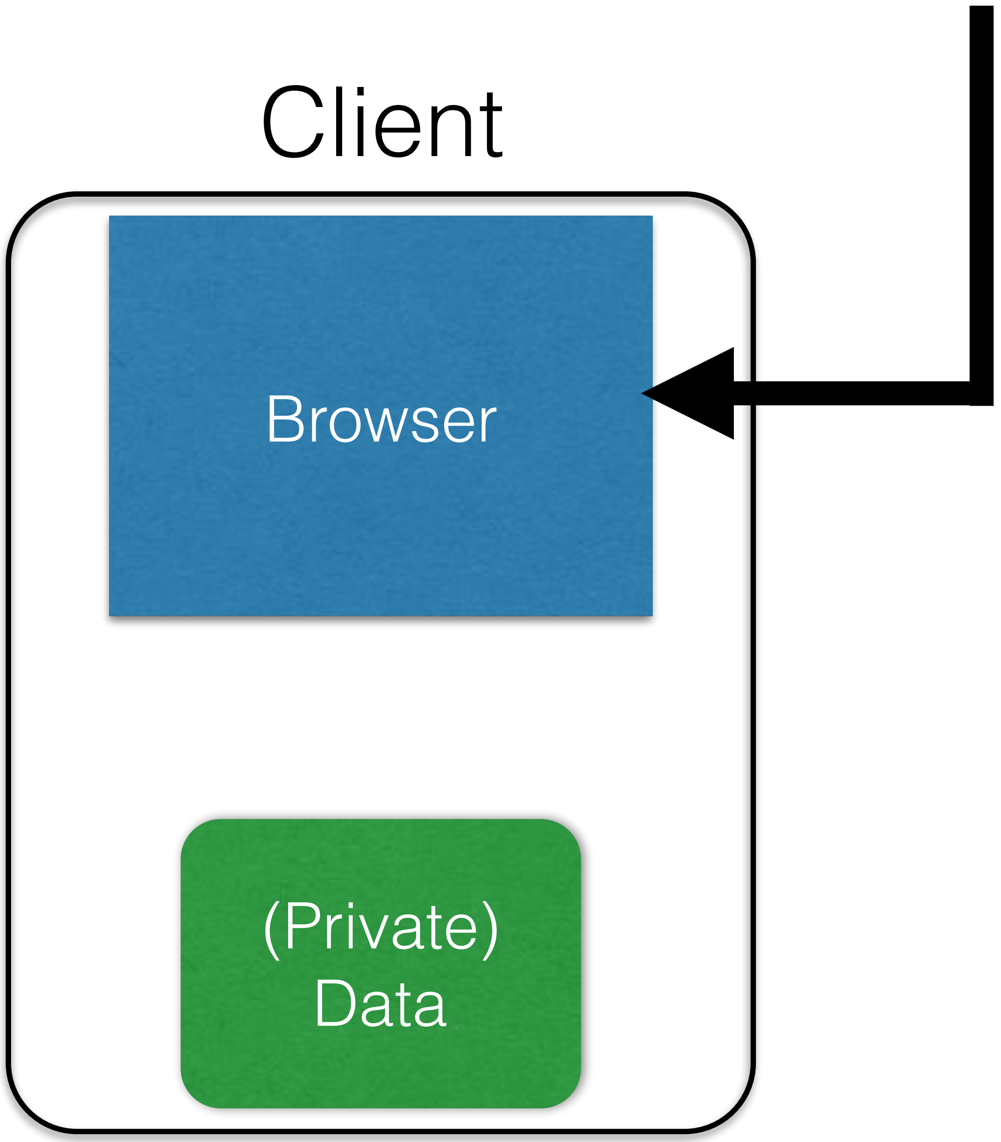
Semantics

- Store “us” under the key “edition” (think of it like one big hash table)
- This value is no good as of Wed Feb 18…

Cookies



```
Set-Cookie: edition=us; expires=Wed, 18-Feb-2015 08:20:34 GMT; path=/; domain=.zdnet.com
```



Semantics

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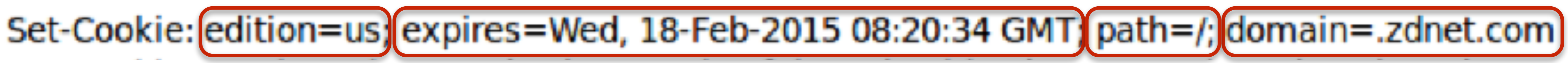
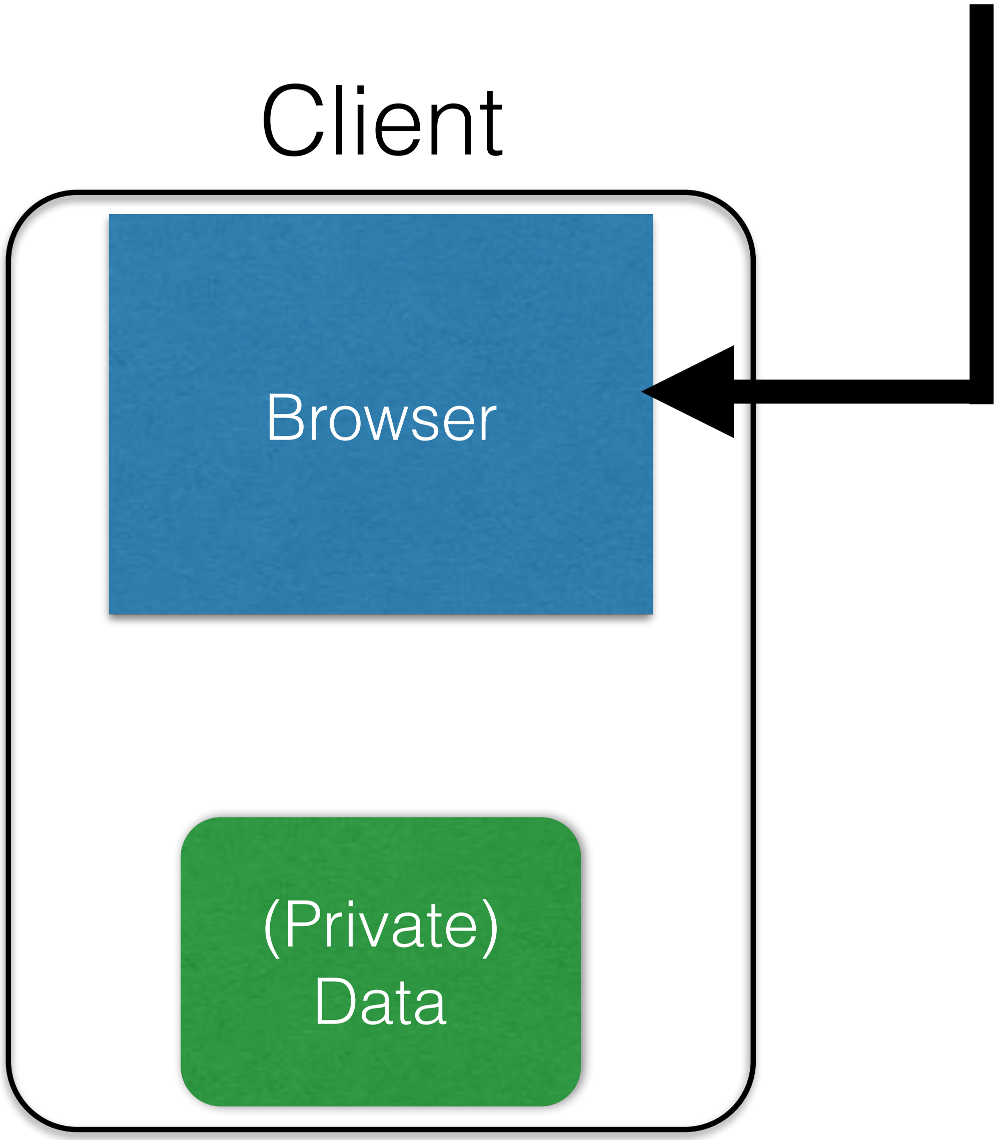
- This value should only be readable by any domain ending in `.zdnet.com`

Cookies



```
Set-Cookie: edition=us; expires=Wed, 18-Feb-2015 08:20:34 GMT; path=/; domain=.zdnet.com
```



Semantics

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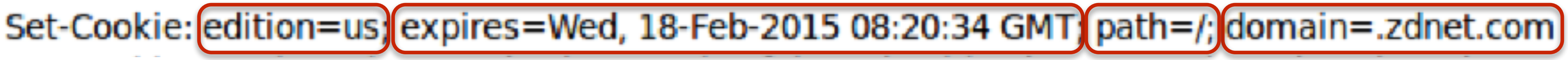
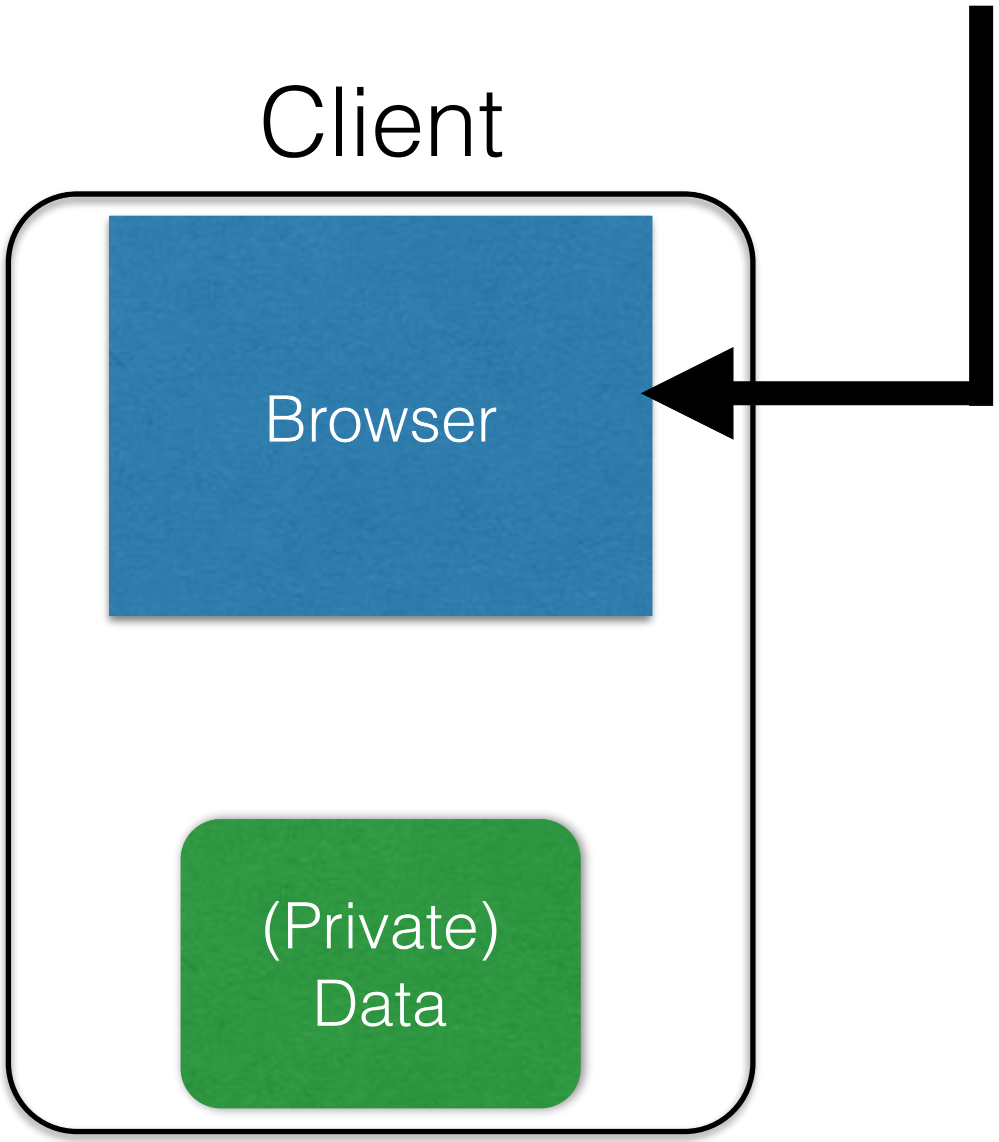
- This should be available to any resource within a subdirectory of /

Cookies



```
Set-Cookie: edition=us; expires=Wed, 18-Feb-2015 08:20:34 GMT; path=/; domain=.zdnet.com
```



Semantics

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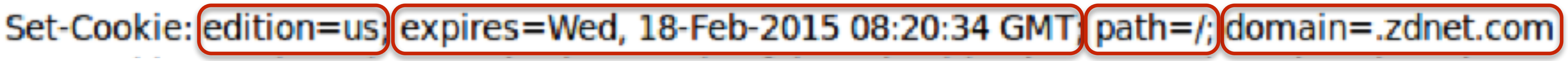
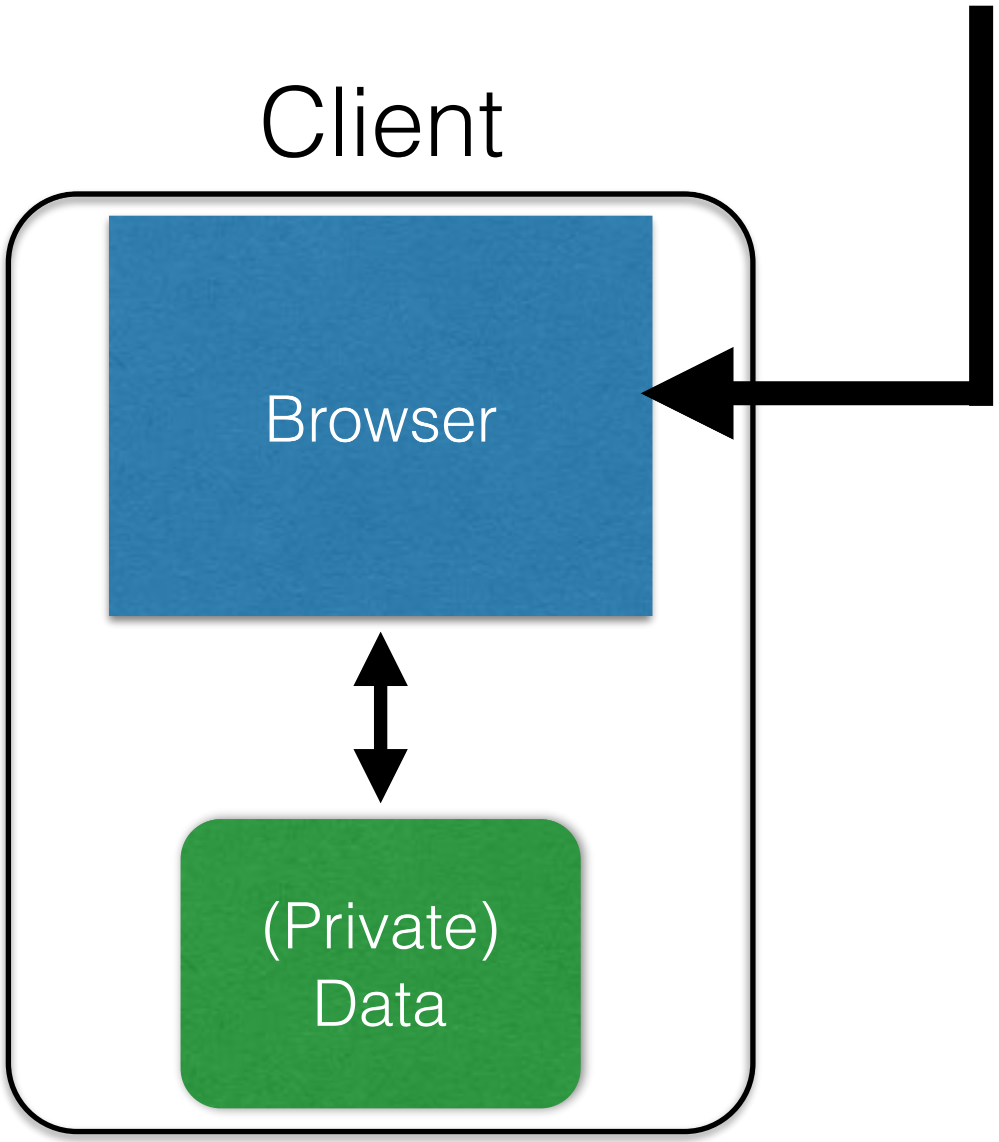
- Send the cookie to any future requests to `<domain>/<path>`

Cookies



Set-Cookie: edition=us; expires=Wed, 18-Feb-2015 08:20:34 GMT; path=/; domain=.zdnet.com



Semantics

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- This value is no good as of Wed Feb 18…
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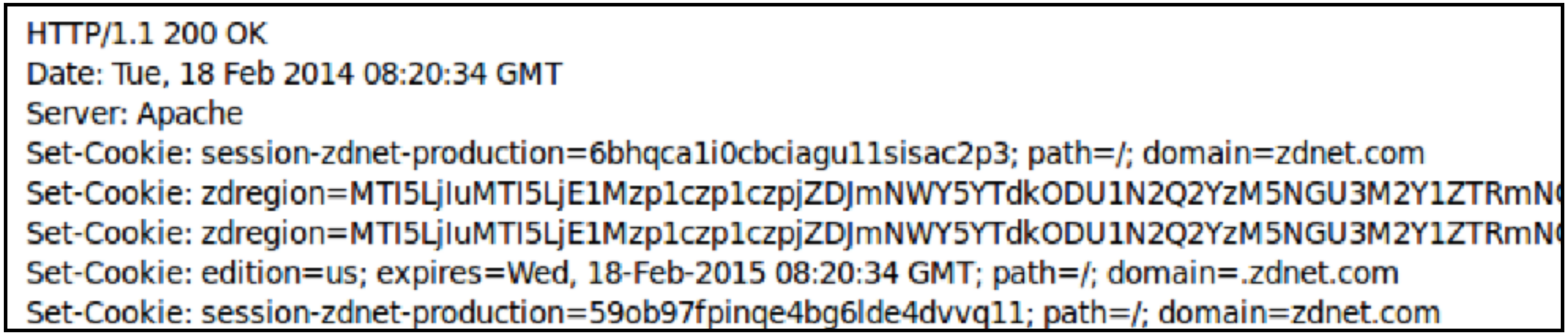
- This should be available to any resource within a subdirectory of /
- Send the cookie to any future requests to `<domain>/<path>`

Requests with cookies



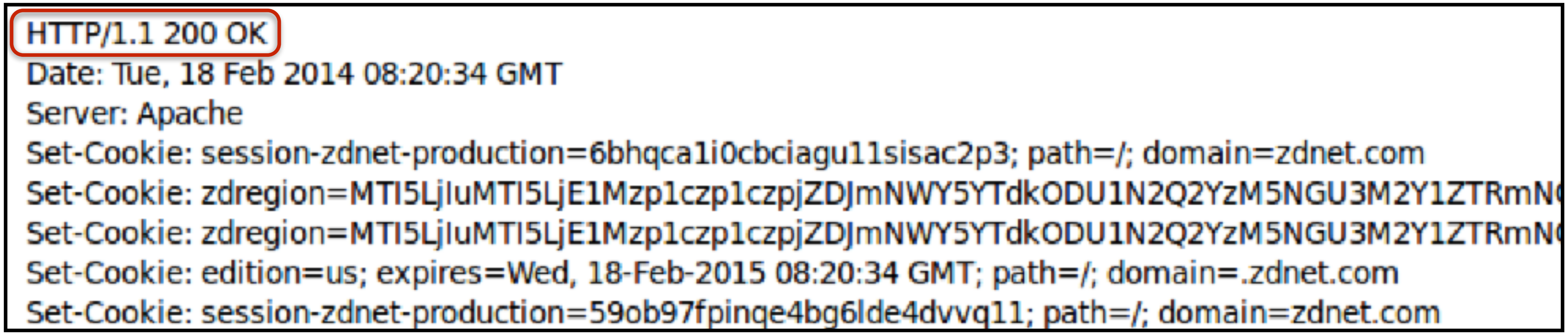
```
HTTP/1.1 200 OK
Date: Tue, 18 Feb 2014 08:20:34 GMT
Server: Apache
Set-Cookie: session-zdnet-production=6bhqca1i0cbciagu11sisac2p3; path=/; domain=zdnet.com
Set-Cookie: zdregion=MTI5LjIuMTI5LjE1Mzp1czp1czpjZDJmNWY5YTdkODU1N2Q2YzM5NGU3M2Y1ZTRmN
Set-Cookie: zdregion=MTI5LjIuMTI5LjE1Mzp1czp1czpjZDJmNWY5YTdkODU1N2Q2YzM5NGU3M2Y1ZTRmN
Set-Cookie: edition=us; expires=Wed, 18-Feb-2015 08:20:34 GMT; path=/; domain=.zdnet.com
Set-Cookie: session-zdnet-production=59ob97fpinqe4bg6lde4dvvq11; path=/; domain=zdnet.com
```

Subsequent visit

...

Requests with cookies

Response



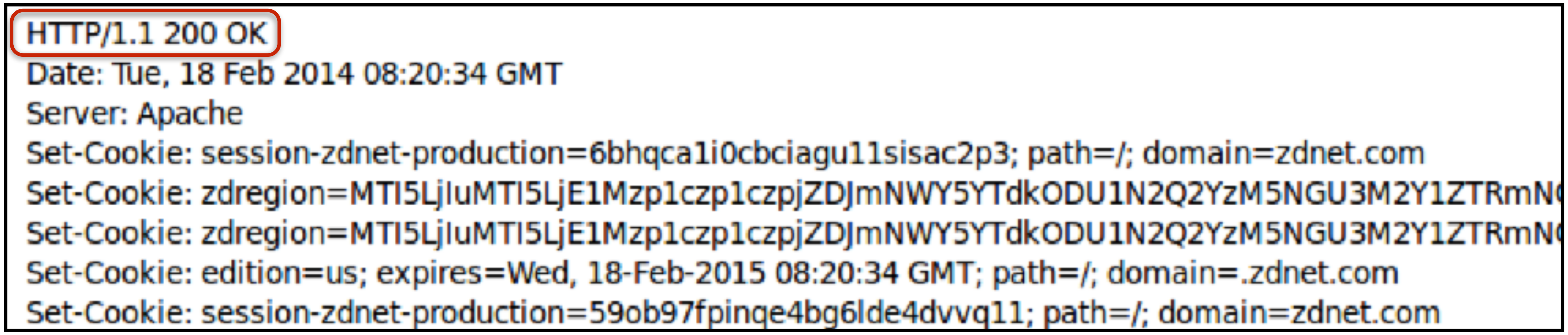
```
HTTP/1.1 200 OK
Date: Tue, 18 Feb 2014 08:20:34 GMT
Server: Apache
Set-Cookie: session-zdnet-production=6bhqca1i0cbciagu11sisac2p3; path=/; domain=zdnet.com
Set-Cookie: zdregion=MTI5LjIuMTI5LjE1Mzp1czp1czpjZDJmNWY5YTdkODU1N2Q2YzM5NGU3M2Y1ZTRmN
Set-Cookie: zdregion=MTI5LjIuMTI5LjE1Mzp1czp1czpjZDJmNWY5YTdkODU1N2Q2YzM5NGU3M2Y1ZTRmN
Set-Cookie: edition=us; expires=Wed, 18-Feb-2015 08:20:34 GMT; path=/; domain=.zdnet.com
Set-Cookie: session-zdnet-production=59ob97fpinqe4bg6lde4dvvq11; path=/; domain=zdnet.com
```

Subsequent visit

...

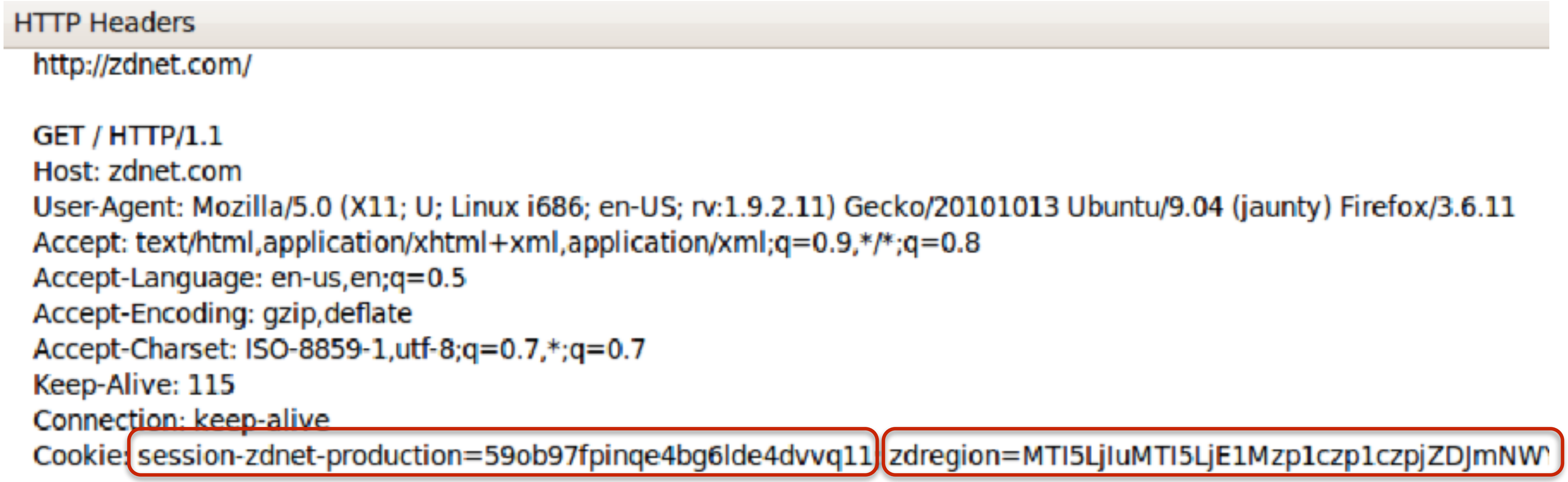
Requests with cookies

Response



```
HTTP/1.1 200 OK
Date: Tue, 18 Feb 2014 08:20:34 GMT
Server: Apache
Set-Cookie: session-zdnet-production=6bhqca1i0cbciagu11sisac2p3; path=/; domain=zdnet.com
Set-Cookie: zdregion=MTI5LjIuMTI5LjE1Mzp1czp1czpjZDJmNWY5YTdkODU1N2Q2YzM5NGU3M2Y1ZTRmN
Set-Cookie: zdregion=MTI5LjIuMTI5LjE1Mzp1czp1czpjZDJmNWY5YTdkODU1N2Q2YzM5NGU3M2Y1ZTRmN
Set-Cookie: edition=us; expires=Wed, 18-Feb-2015 08:20:34 GMT; path=/; domain=.zdnet.com
Set-Cookie: session-zdnet-production=59ob97fpinqe4bg6lde4dvvq11; path=/; domain=zdnet.com
```

Subsequent visit



HTTP Headers

```
http://zdnet.com/

GET / HTTP/1.1
Host: zdnet.com
User-Agent: Mozilla/5.0 (X11; U; Linux i686; en-US; rv:1.9.2.11) Gecko/20101013 Ubuntu/9.04 (jaunty) Firefox/3.6.11
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 115
Connection: keep-alive
Cookie: session-zdnet-production=59ob97fpinqe4bg6lde4dvvq11 zdregion=MTI5LjIuMTI5LjE1Mzp1czp1czpjZDJmNW
```

...

Why use cookies?

- Personalization
  - Let an anonymous user customize your site
  - Store font choice, etc., in the cookie

Why use cookies?

- Tracking users
  - Advertisers want to know your behavior
  - Ideally build a profile *across different websites*
    - Read about iPad on CNN, then see ads on Amazon?!
  - How can an advertiser (A) know what you did on another site (S)?

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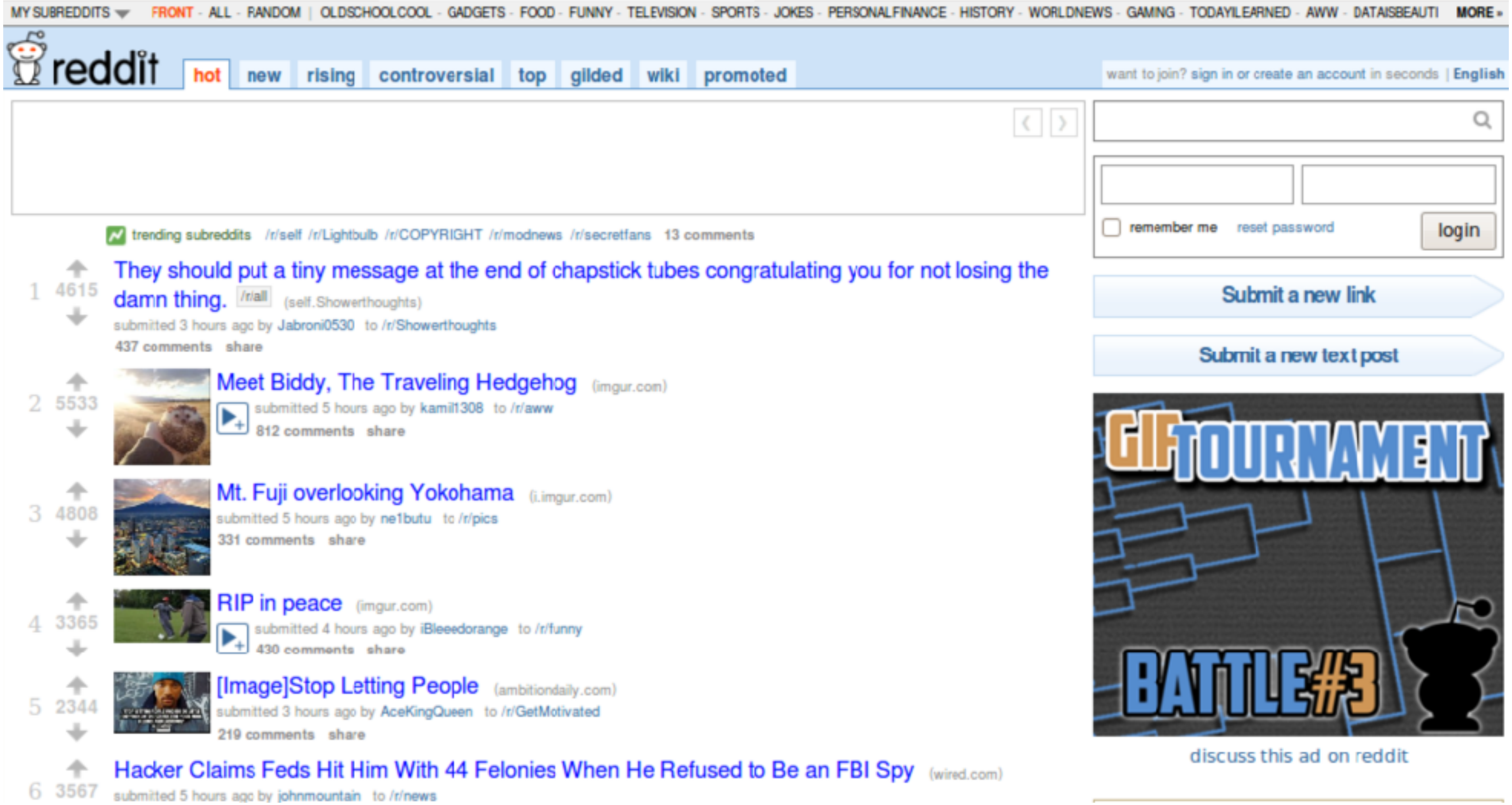
Problem: IP addrs change

Option 2: A maintains a DB indexed by a *cookie*

- **"Third-party cookie"**
- **Commonly used by large ad networks (doubleclick)**


MY SUBREDDITS
FRONT - ALL - RANDOM | OLDSCHOOLCOOL - GADGETS - FOOD - FUNNY - TELEVISION - SPORTS - JOKES - PERSONALFINANCE - HISTORY - WORLDNEWS - GAMING - TODAYILEARNED - AWW - DATAISBEAUTI
MORE »
reddit
hot
new
rising
controversial
top
gilded
wiki
promoted
want to join? sign in or create an account in seconds | English
remember me
reset password
login
Submit a new link
Submit a new text post
GIF TOURNAMENT
BATTLE #3
discuss this ad on reddit

trending subreddits /r/self /r/Lightbulb /r/COPYRIGHT /r/modnews /r/secretfans 13 comments

1 4615 They should put a tiny message at the end of chapstick tubes congratulating you for not losing the damn thing. /r/all (self.Showerthoughts)
submitted 3 hours ago by Jabroni0530 to /r/Showerthoughts
437 comments share

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submitted 4 hours ago by iBleeedorange to /r/funny
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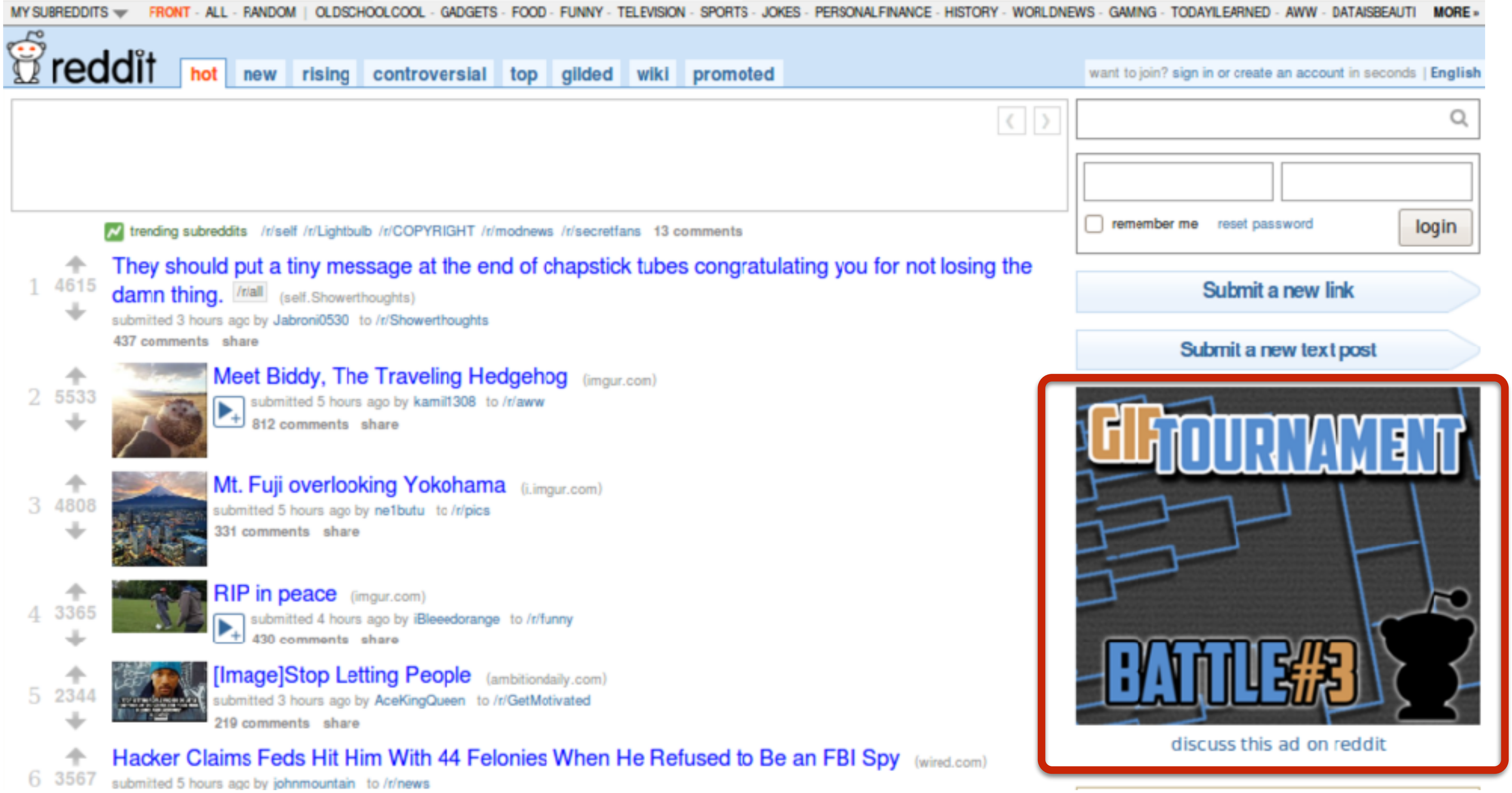
submitted 3 hours ago by AceKingQueen to /r/GetMotivated
219 comments share

6 3567 Hacker Claims Feds Hit Him With 44 Felonies When He Refused to Be an FBI Spy (wired.com)
submitted 5 hours ago by johnmountain to /r/news



MY SUBREDDITS FRONT - ALL - RANDOM | OLDSCHOOLCOOL - GADGETS - FOOD - FUNNY - TELEVISION - SPORTS - JOKES - PERSONALFINANCE - HISTORY - WORLDNEWS - GAMING - TODAYILEARNED - AWW - DATAISBEAUTI MORE »

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trending subreddits /r/self /r/Lightbulb /r/COPYRIGHT /r/modnews /r/secretfans 13 comments

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□ remember me reset password login

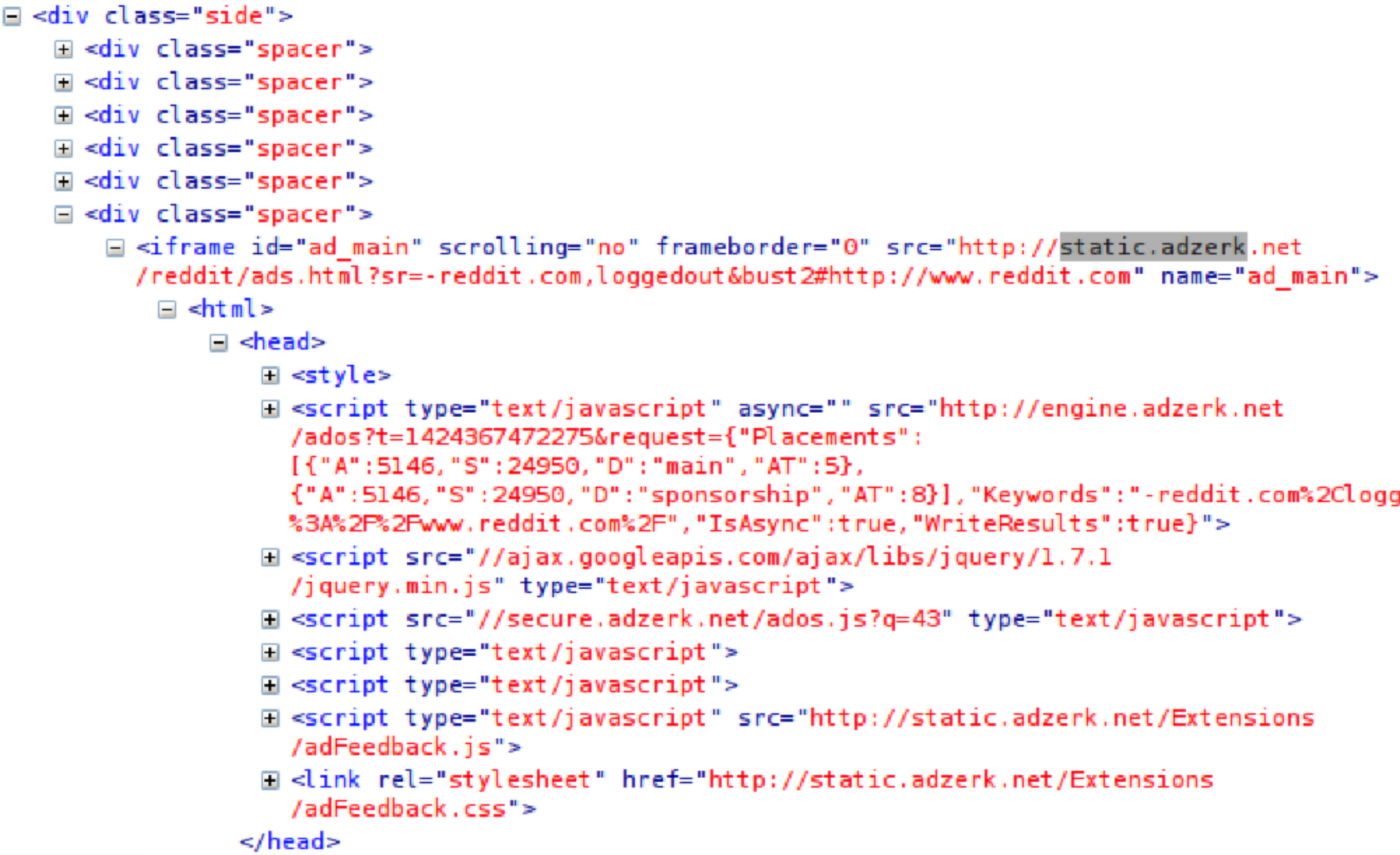
Submit a new link

Submit a new text post

discuss this ad on reddit

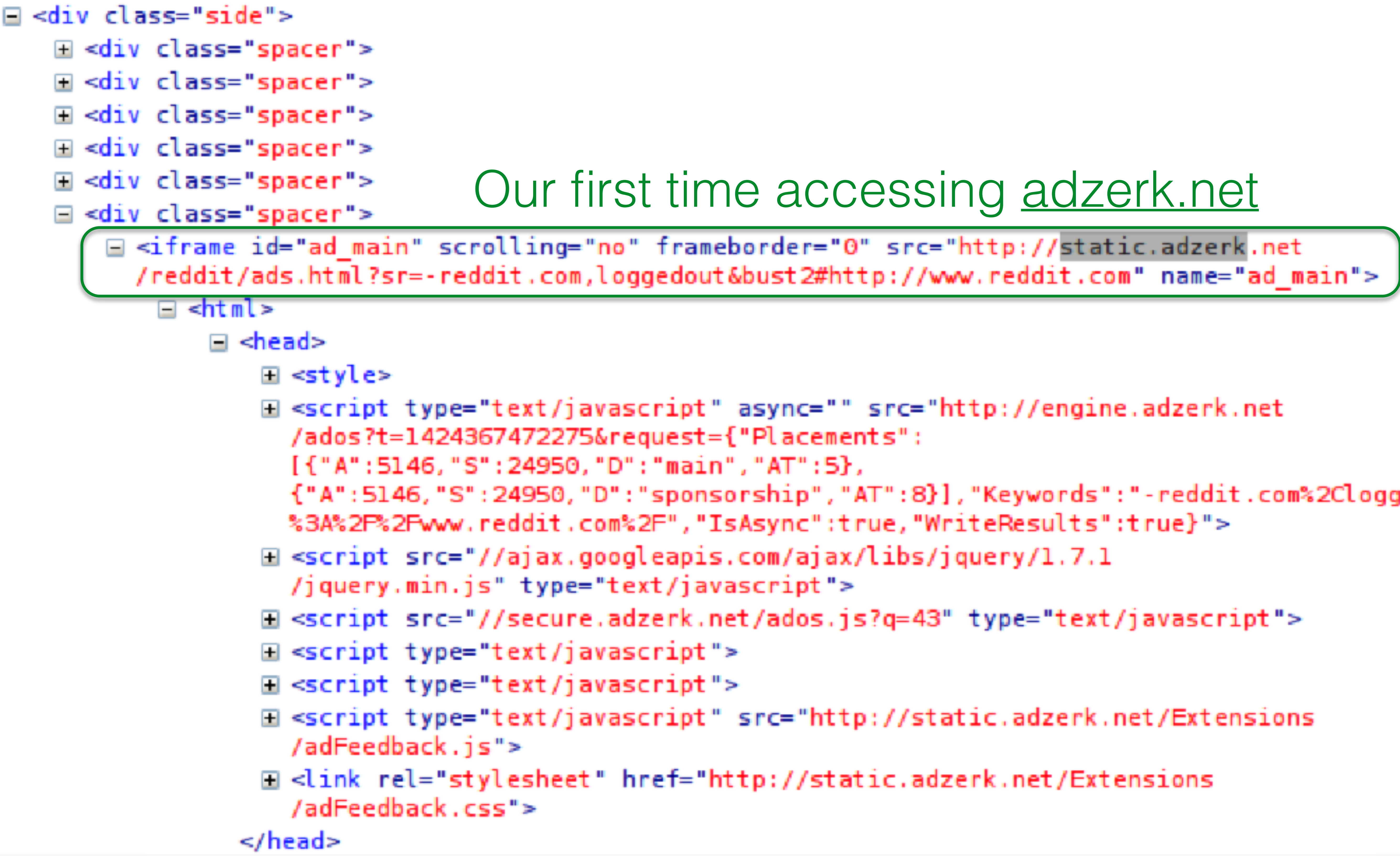
Ad provided by an ad network

Snippet of reddit.com source



```
⊟ <div class="side">
    ⊞ <div class="spacer">
    ⊞ <div class="spacer">
    ⊞ <div class="spacer">
    ⊞ <div class="spacer">
    ⊞ <div class="spacer">
    ⊟ <div class="spacer">
        ⊟ <iframe id="ad_main" scrolling="no" frameborder="0" src="http://static.adzerk.net
          /reddit/ads.html?sr=-reddit.com,loggedout&bust2#http://www.reddit.com" name="ad_main">
            ⊟ <html>
                ⊟ <head>
                    ⊞ <style>
                    ⊞ <script type="text/javascript" async="" src="http://engine.adzerk.net
                      /ados?t=1424367472275&request={"Placements":
                      [{"A":5146,"S":24950,"D":"main","AT":5},
                      {"A":5146,"S":24950,"D":"sponsorship","AT":8}],"Keywords":"-reddit.com%2Clogg
                      %3A%2F%2Fwww.reddit.com%2F","IsAsync":true,"WriteResults":true}">
                    ⊞ <script src="//ajax.googleapis.com/ajax/libs/jquery/1.7.1
                      /jquery.min.js" type="text/javascript">
                    ⊞ <script src="//secure.adzerk.net/ados.js?q=43" type="text/javascript">
                    ⊞ <script type="text/javascript">
                    ⊞ <script type="text/javascript">
                    ⊞ <script type="text/javascript" src="http://static.adzerk.net/Extensions
                      /adFeedback.js">
                    ⊞ <link rel="stylesheet" href="http://static.adzerk.net/Extensions
                      /adFeedback.css">
                  </head>
```

Snippet of reddit.com source



Our first time accessing adzerk.net

```
⊟ <div class="side">
    ⊞ <div class="spacer">
    ⊞ <div class="spacer">
    ⊞ <div class="spacer">
    ⊞ <div class="spacer">
    ⊞ <div class="spacer">
    ⊟ <div class="spacer">
        ⊟ <iframe id="ad_main" scrolling="no" frameborder="0" src="http://static.adzerk.net
          /reddit/ads.html?sr=-reddit.com,loggedout&bust2#http://www.reddit.com" name="ad_main">
            ⊟ <html>
                ⊟ <head>
                    ⊞ <style>
                    ⊞ <script type="text/javascript" async="" src="http://engine.adzerk.net
                      /ados?t=1424367472275&request={"Placements":
                      [{"A":5146,"S":24950,"D":"main","AT":5},
                      {"A":5146,"S":24950,"D":"sponsorship","AT":8}],"Keywords":"-reddit.com%2Clogg
                      %3A%2F%2Fwww.reddit.com%2F","IsAsync":true,"WriteResults":true}">
                    ⊞ <script src="//ajax.googleapis.com/ajax/libs/jquery/1.7.1
                      /jquery.min.js" type="text/javascript">
                    ⊞ <script src="//secure.adzerk.net/ados.js?q=43" type="text/javascript">
                    ⊞ <script type="text/javascript">
                    ⊞ <script type="text/javascript">
                    ⊞ <script type="text/javascript" src="http://static.adzerk.net/Extensions
                      /adFeedback.js">
                    ⊞ <link rel="stylesheet" href="http://static.adzerk.net/Extensions
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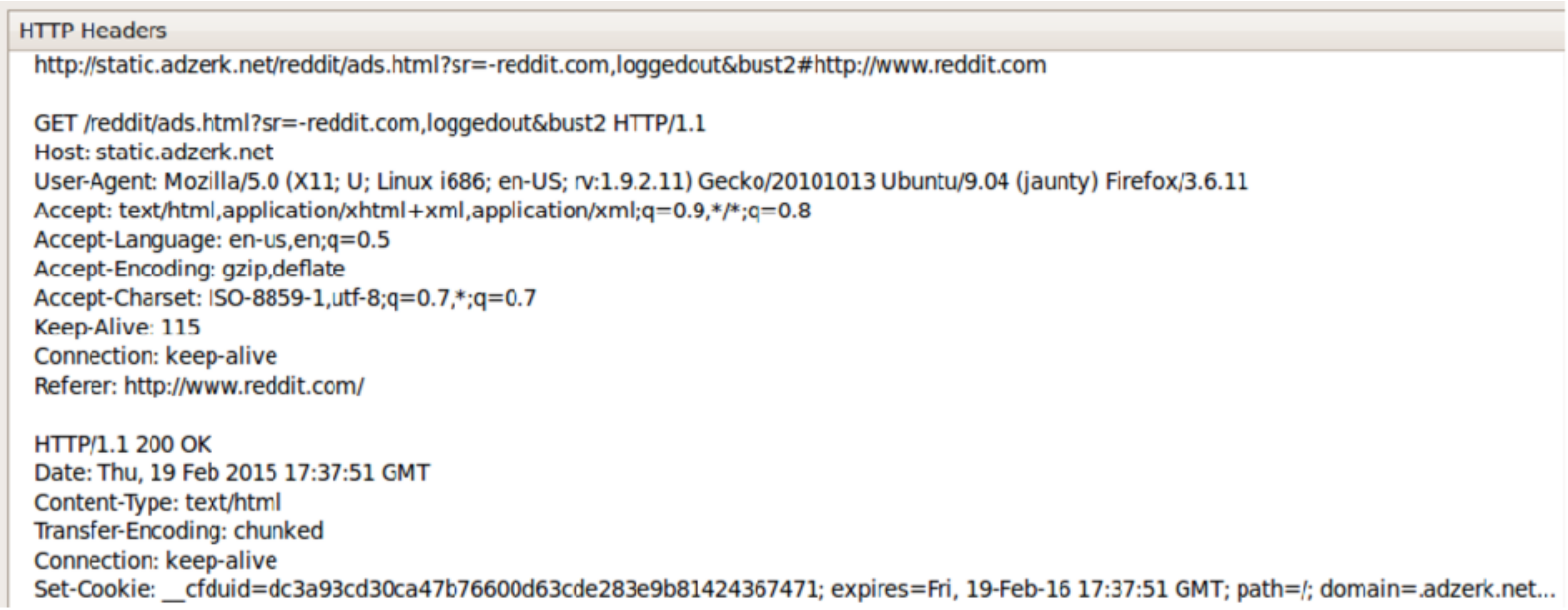
                  </head>
```

I visit reddit.com

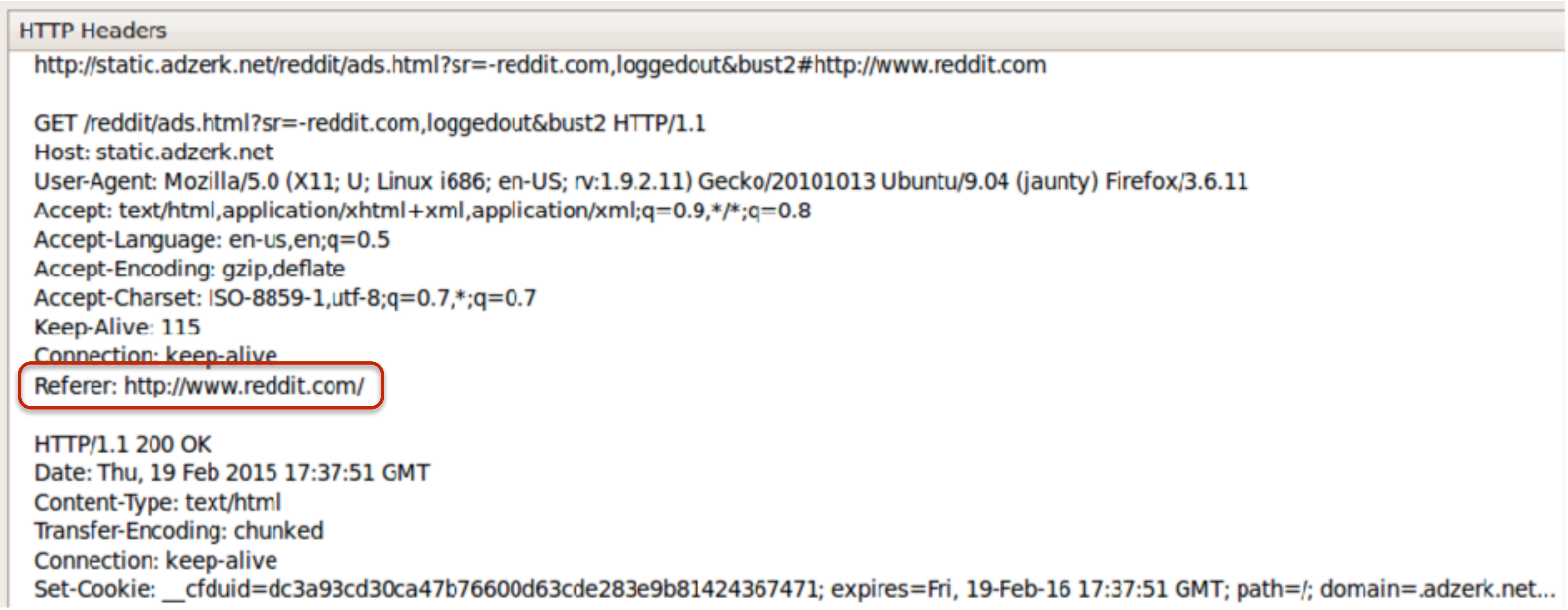


```
http://static.adzerk.net/reddit/ads.html?sr=-reddit.com,loggedout&bust2#http://www.reddit.com

GET /reddit/ads.html?sr=-reddit.com,loggedout&bust2 HTTP/1.1
Host: static.adzerk.net
User-Agent: Mozilla/5.0 (X11; U; Linux i686; en-US; rv:1.9.2.11) Gecko/20101013 Ubuntu/9.04 (jaunty) Firefox/3.6.11
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 115
Connection: keep-alive
Referer: http://www.reddit.com/

HTTP/1.1 200 OK
Date: Thu, 19 Feb 2015 17:37:51 GMT
Content-Type: text/html
Transfer-Encoding: chunked
Connection: keep-alive
Set-Cookie: __cfduid=dc3a93cd30ca47b76600d63cde283e9b81424367471; expires=Fri, 19-Feb-16 17:37:51 GMT; path=/; domain=.adzerk.net...
```

I visit reddit.com

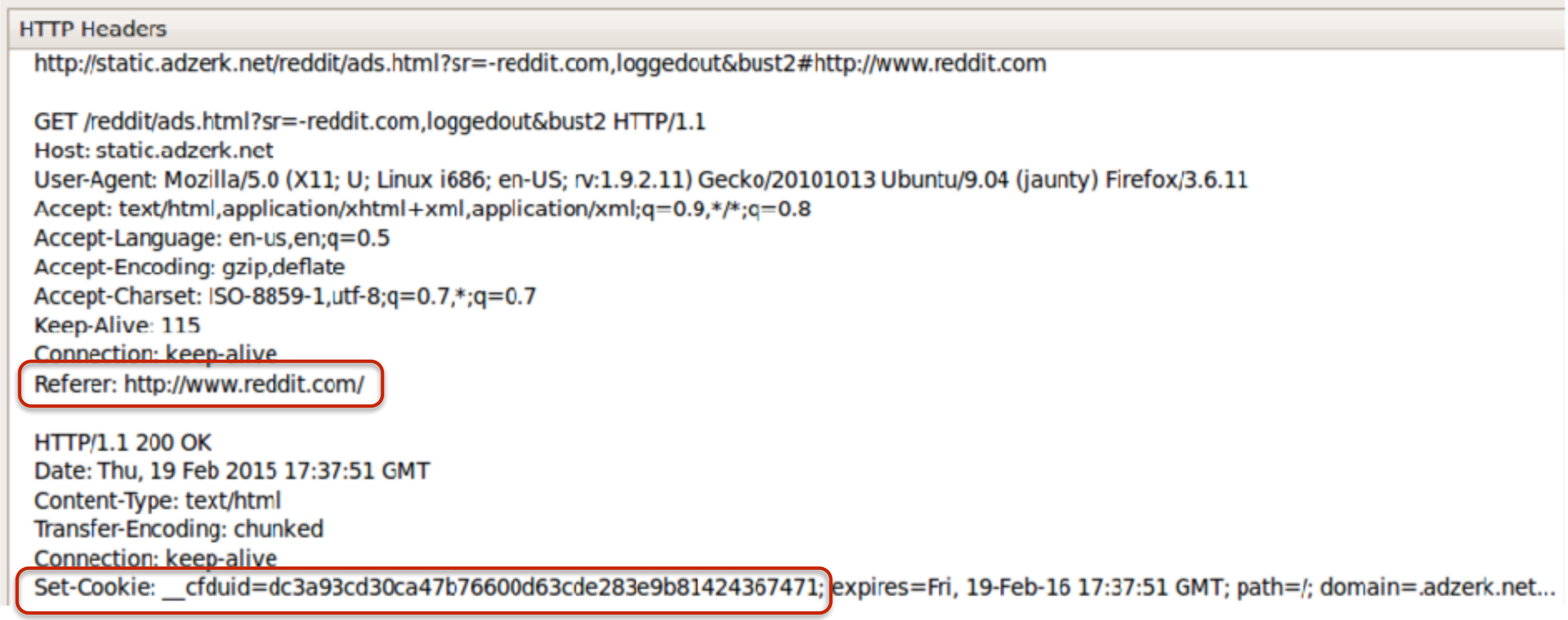


```
http://static.adzerk.net/reddit/ads.html?sr=-reddit.com,loggedout&bust2#http://www.reddit.com

GET /reddit/ads.html?sr=-reddit.com,loggedout&bust2 HTTP/1.1
Host: static.adzerk.net
User-Agent: Mozilla/5.0 (X11; U; Linux i686; en-US; rv:1.9.2.11) Gecko/20101013 Ubuntu/9.04 (jaunty) Firefox/3.6.11
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 115
Connection: keep-alive
Referer: http://www.reddit.com/

HTTP/1.1 200 OK
Date: Thu, 19 Feb 2015 17:37:51 GMT
Content-Type: text/html
Transfer-Encoding: chunked
Connection: keep-alive
Set-Cookie: __cfduid=dc3a93cd30ca47b76600d63cde283e9b81424367471; expires=Fri, 19-Feb-16 17:37:51 GMT; path=/; domain=.adzerk.net...
```

I visit reddit.com



```
http://static.adzerk.net/reddit/ads.html?sr=-reddit.com,loggedout&bust2#http://www.reddit.com

GET /reddit/ads.html?sr=-reddit.com,loggedout&bust2 HTTP/1.1
Host: static.adzerk.net
User-Agent: Mozilla/5.0 (X11; U; Linux i686; en-US; rv:1.9.2.11) Gecko/20101013 Ubuntu/9.04 (jaunty) Firefox/3.6.11
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 115
Connection: keep-alive
Referer: http://www.reddit.com/

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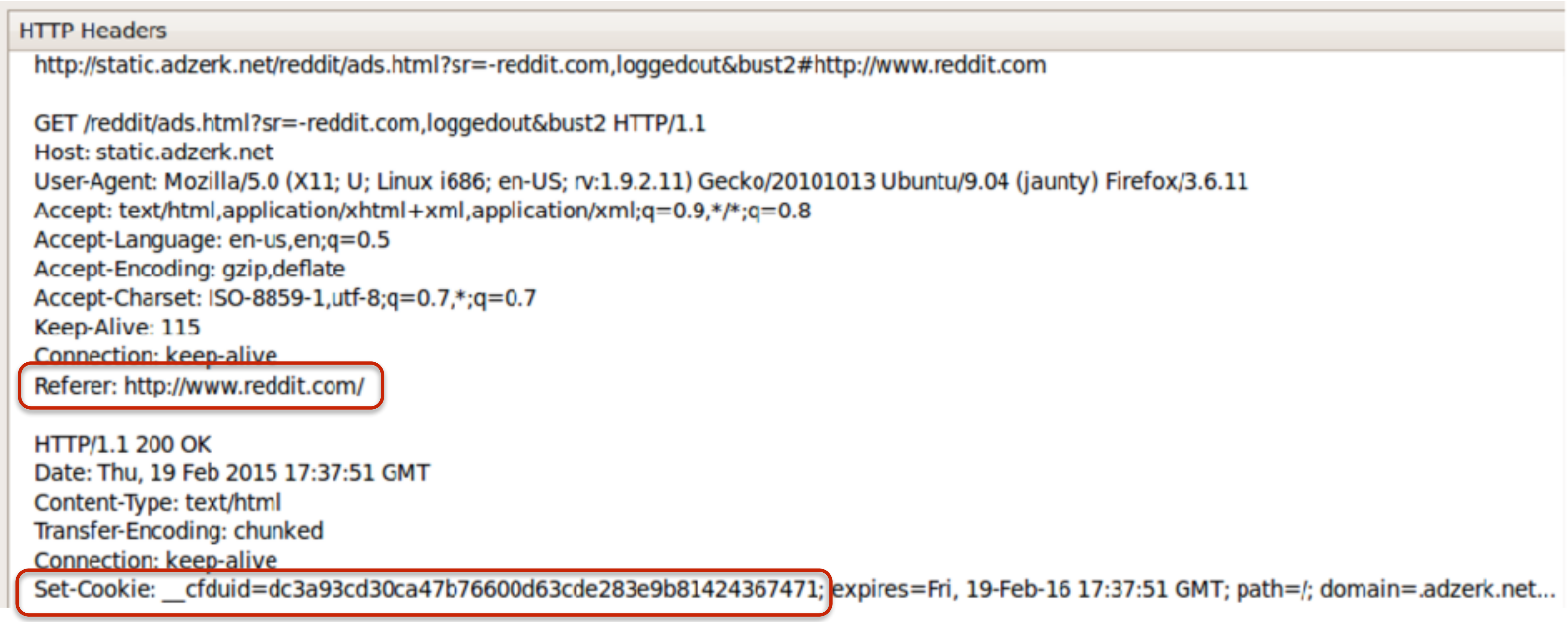
Date: Thu, 19 Feb 2015 17:37:51 GMT
Content-Type: text/html
Transfer-Encoding: chunked
Connection: keep-alive
Set-Cookie: __cfduid=dc3a93cd30ca47b76600d63cde283e9b81424367471; expires=Fri, 19-Feb-16 17:37:51 GMT; path=/; domain=.adzerk.net...
```

I visit reddit.com

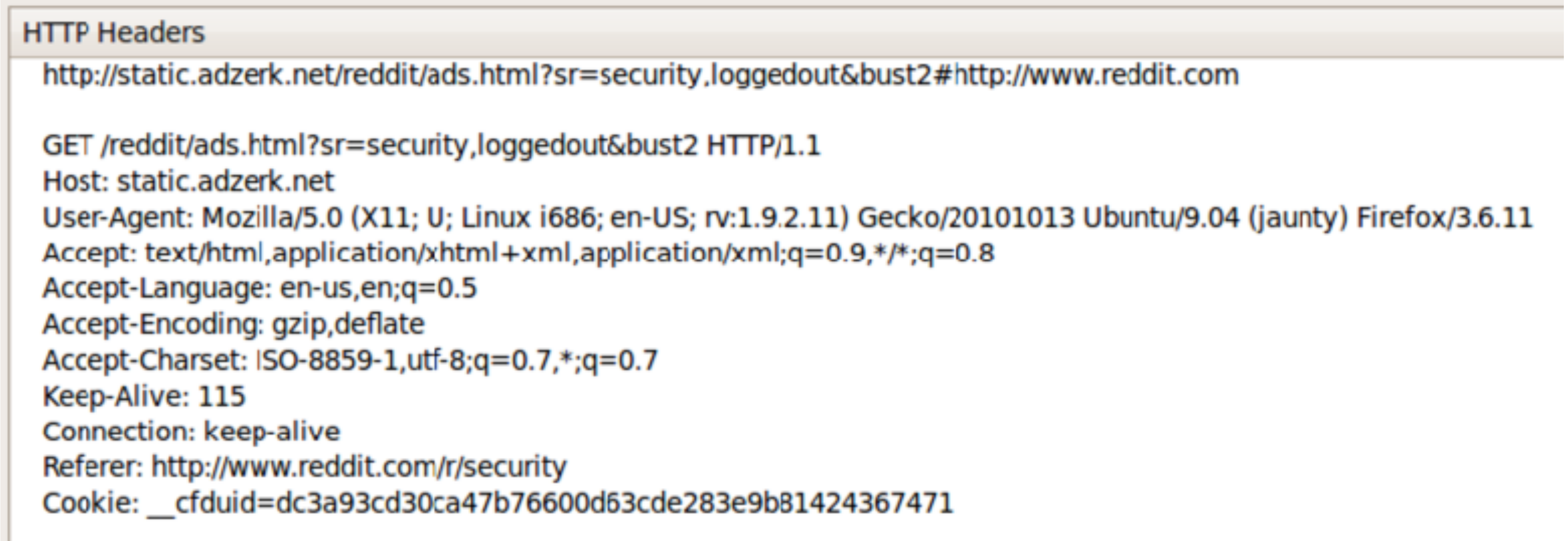


```
HTTP Headers
http://static.adzerk.net/reddit/ads.html?sr=-reddit.com,loggedout&bust2#http://www.reddit.com

GET /reddit/ads.html?sr=-reddit.com,loggedout&bust2 HTTP/1.1
Host: static.adzerk.net
User-Agent: Mozilla/5.0 (X11; U; Linux i686; en-US; rv:1.9.2.11) Gecko/20101013 Ubuntu/9.04 (jaunty) Firefox/3.6.11
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 115
Connection: keep-alive
Referer: http://www.reddit.com/

HTTP/1.1 200 OK
Date: Thu, 19 Feb 2015 17:37:51 GMT
Content-Type: text/html
Transfer-Encoding: chunked
Connection: keep-alive
Set-Cookie: __cfduid=dc3a93cd30ca47b76600d63cde283e9b81424367471; expires=Fri, 19-Feb-16 17:37:51 GMT; path=/; domain=.adzerk.net...
```

Later, I go to reddit.com/r/security



```
HTTP Headers
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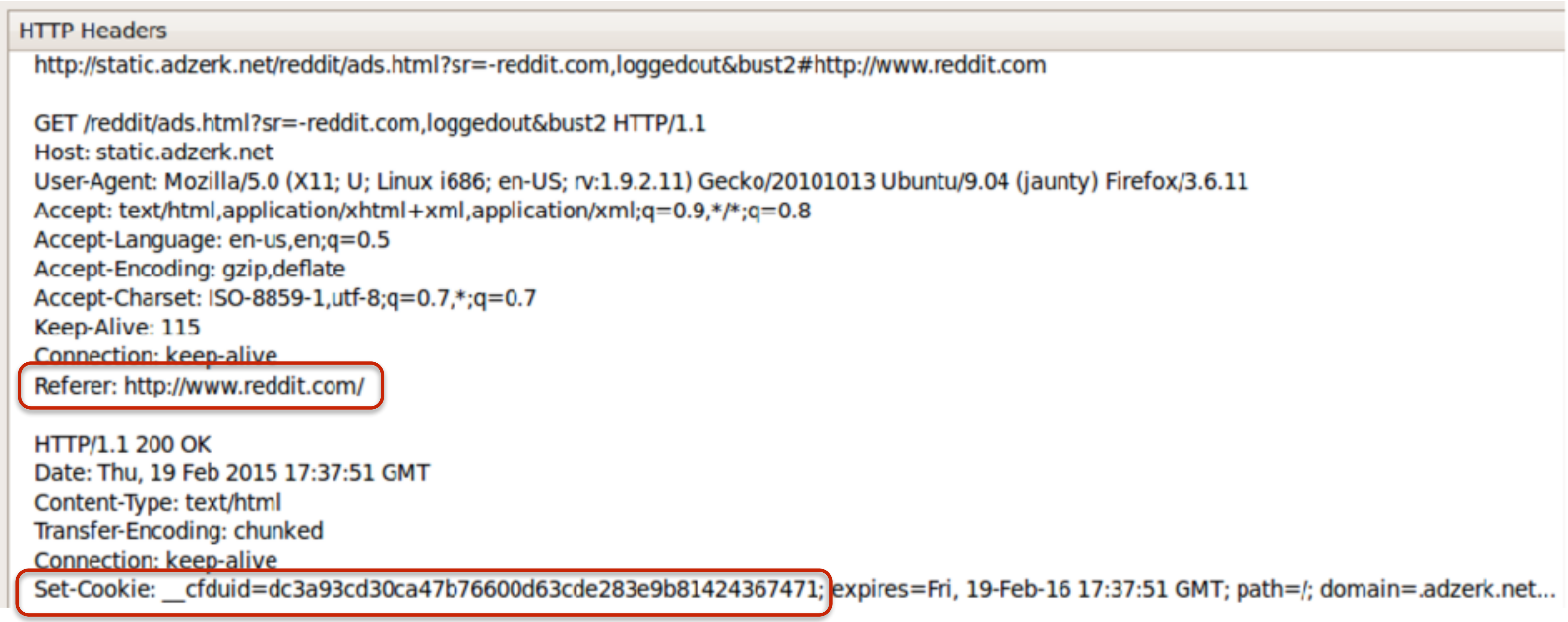
Keep-Alive: 115
Connection: keep-alive
Referer: http://www.reddit.com/r/security
Cookie: __cfduid=dc3a93cd30ca47b76600d63cde283e9b81424367471
```

I visit reddit.com



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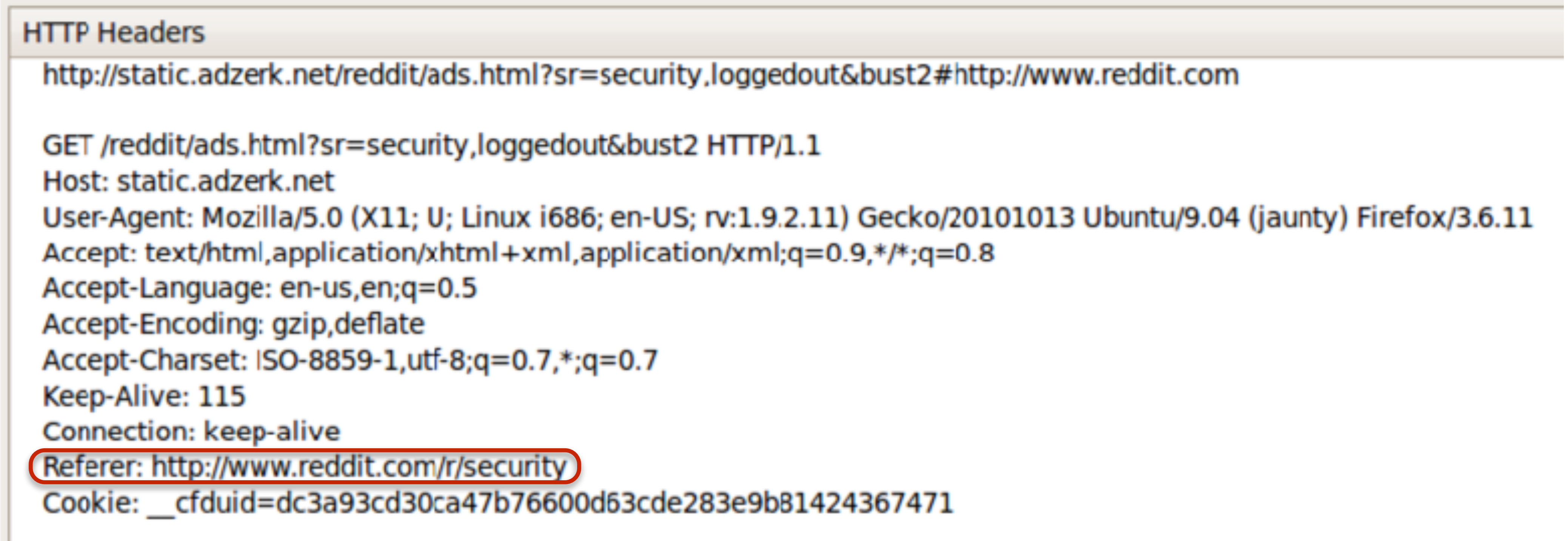

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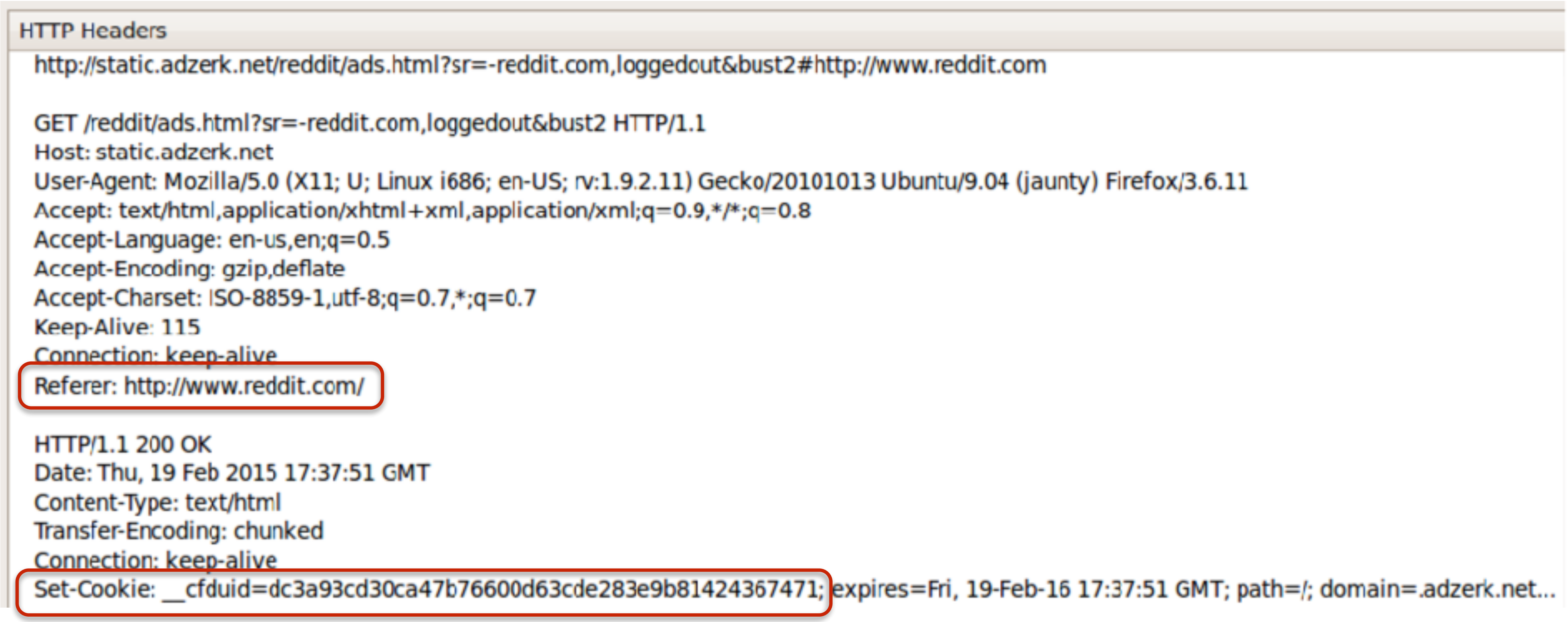

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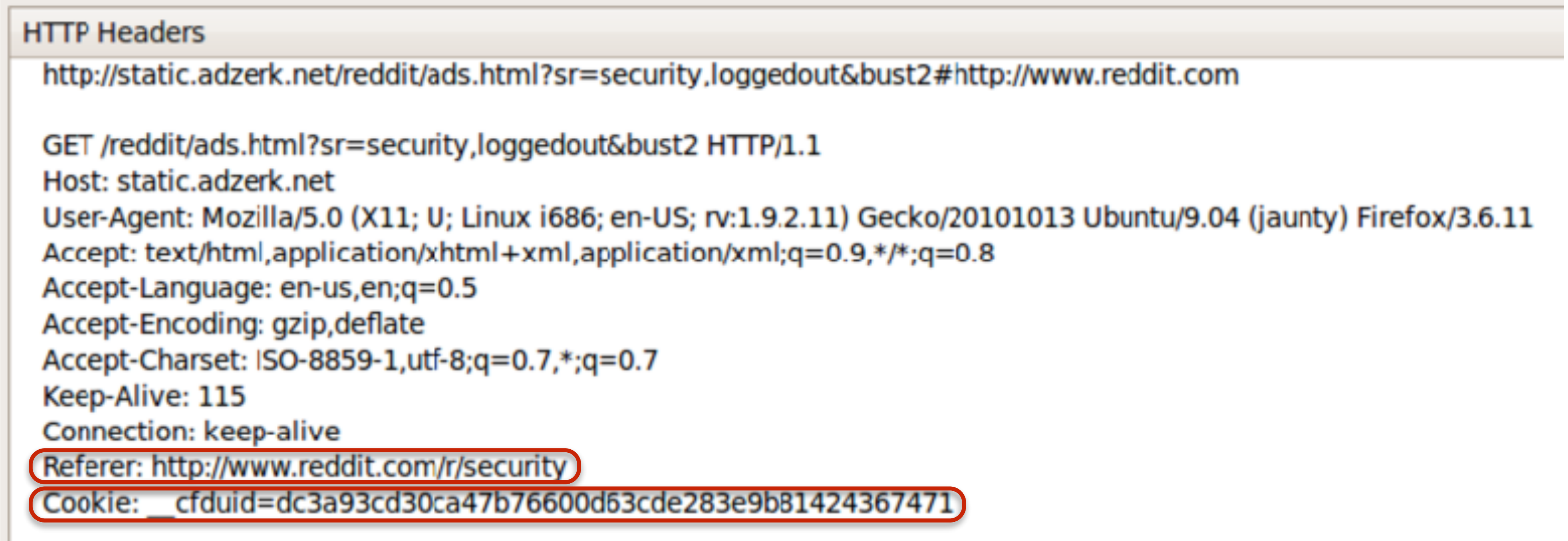

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Referer: http://www.reddit.com/r/security
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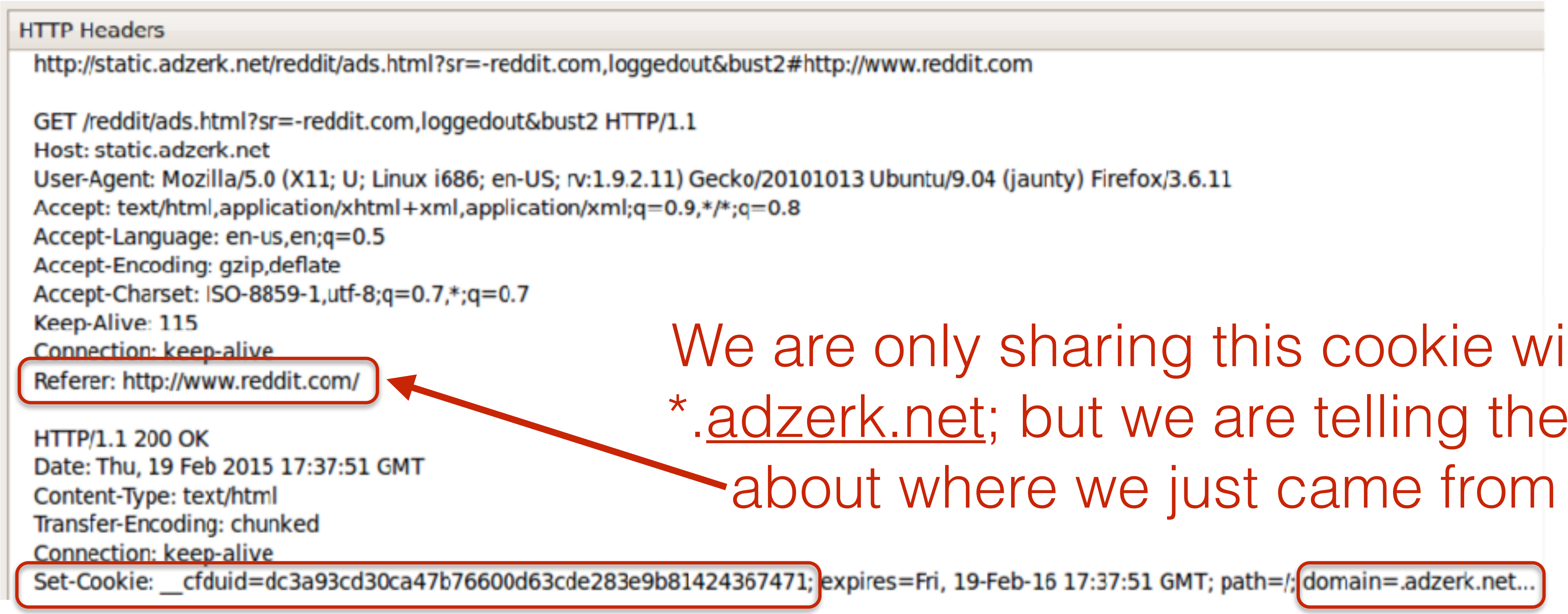

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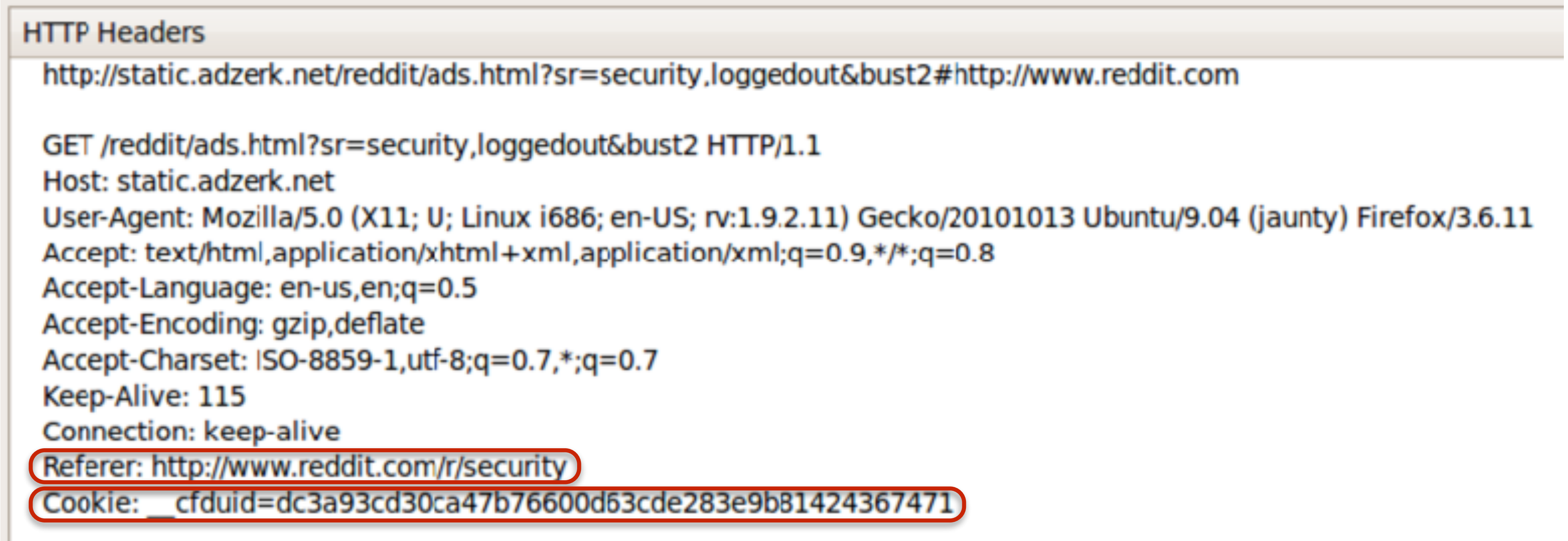
```

We are only sharing this cookie with *.adzerk.net; but we are telling them about where we just came from

Later, I go to reddit.com/r/security



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Cookies and web authentication

- An *extremely common* use of cookies is to track users who have already authenticated

- If the user already visited `http://website.com/login.html?user=alice&pass=secret` with the correct password, then the server associates a *"session cookie"* with the logged-in user's info

- Subsequent requests (GET and POST) include the cookie in the request *headers* and/or as one of the *fields*: `http://website.com/doStuff.html?sid=81asf98as8eak`

- The idea is for the server to be able to say "I am talking to the same browser that authenticated Alice earlier."

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Attacks?