

# FP-Block

*Usable web privacy via fingerprint*

Hugo Jonker  
@hugojonker



**Open Universiteit**

[www.ou.nl](http://www.ou.nl)



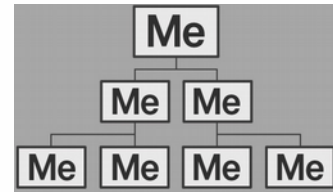
*Joint work with Sjouke Mauw (UL), Christof Ferreira Torres (UL)*

# First

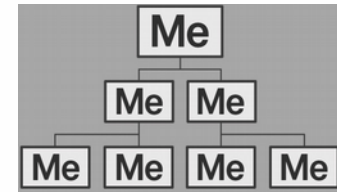
1. Privacy does not need to be motivated.  
Violation of privacy needs to be motivated.
  
2. Privacy of others is necessary for democracy.

# Introducing myself

- A keen interest on picking things apart



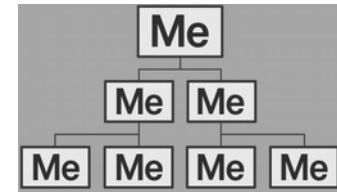
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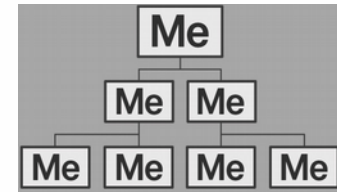


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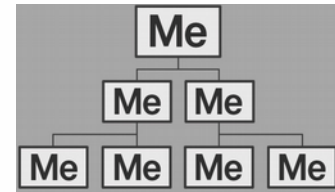
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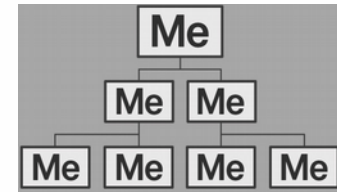
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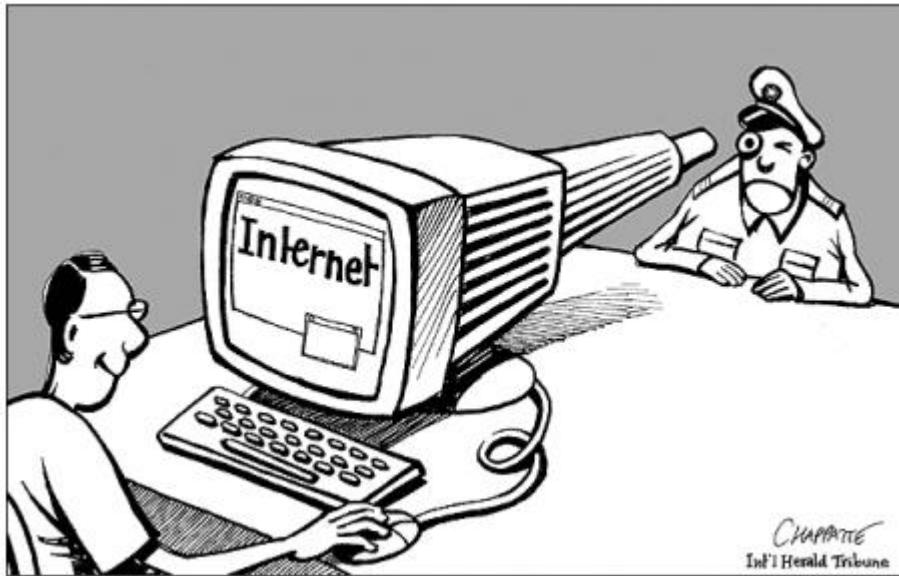


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  - I promise I'll try not to break it!

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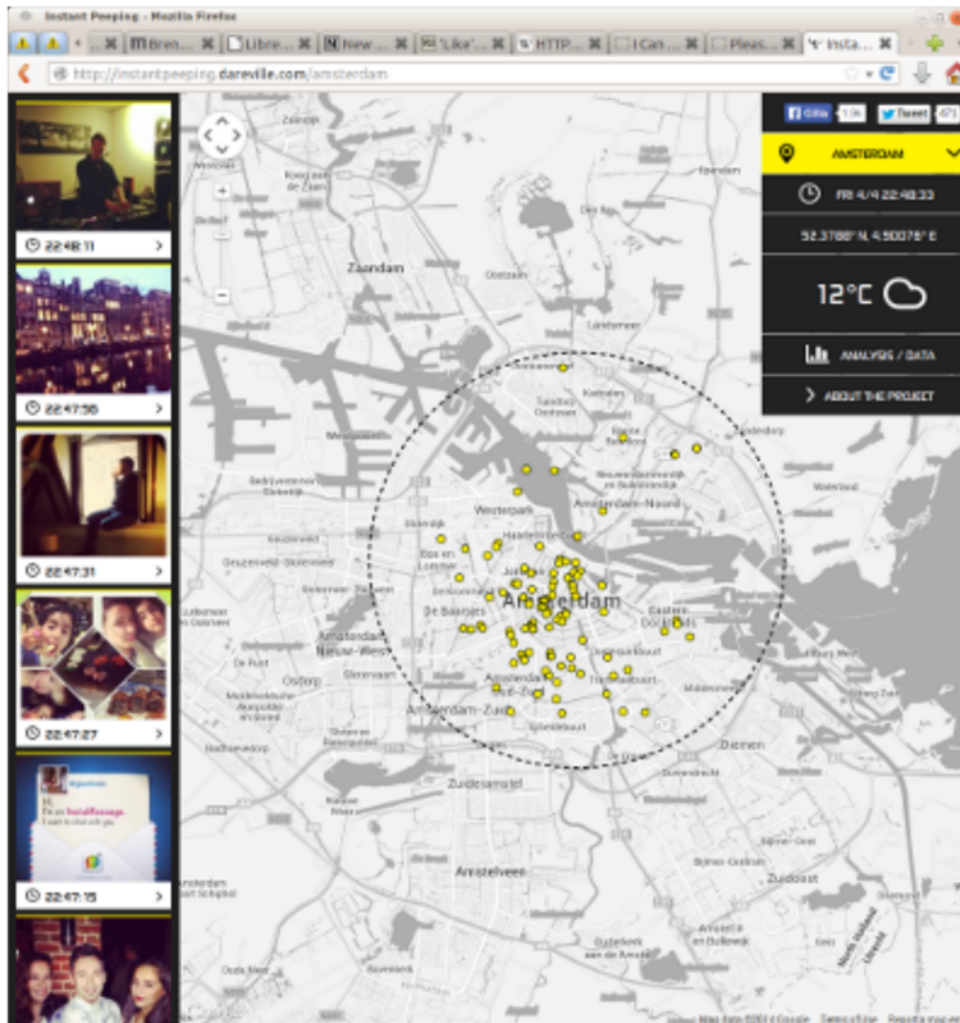


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    - (I)
- Worked
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We're not really good at privacy

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## PLEASE ROB ME

Raising awareness  
about over-sharing

Check out our [quest blog post](#) on the CDT website.

A screenshot of a web browser displaying the 'Instant Peeping' website. The browser's address bar shows 'http://instantpeeping.dareville.com/amsterdam'. The website features a map of Amsterdam with several red location pins marked with a white 'X'. A sidebar on the right shows the location 'AMSTERDAM', the date 'FRI 4/14 22:40:33', and the coordinates '52.3786° N, 4.90078° E'. Below the map, there are social media feeds, including a Twitter post with a timestamp of '22:47:27' and a Facebook post with a timestamp of '22:47:15'. The website also includes navigation links for 'HOME', 'ABOUT', 'CONTACT', and 'FAQ'.

# We're not really good at privacy

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Check out our [quest blog post](#) on the CDT website.

**I Can Stalk U**  
Raising awareness about inadvertent information sharing



# We're really **not** good at privacy

Retweeted by Debit Card

 **Jewelz** @DakidBrim232 · Jan 30

This bitch cant ever say I dont care or think about her ever bank card I have the pin is your brithday [mh pic.twitter.com/LyJfKIGJMh](https://pic.twitter.com/LyJfKIGJMh)



 Expand  Reply  Retweet  Favorite  More

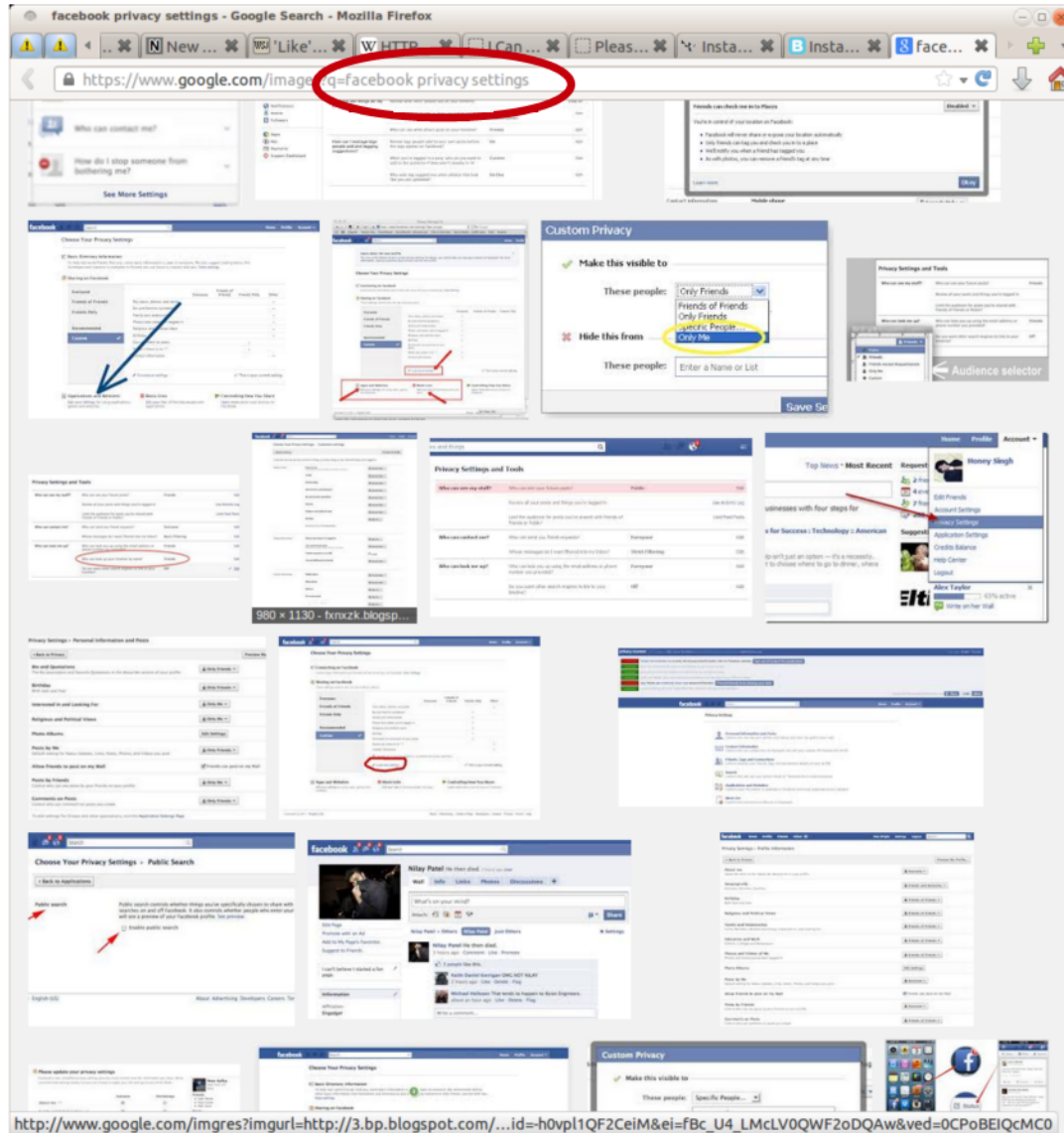
# We're really **not** good at privacy





*Note: account number can suffice for withdrawal*

# Privacy is hard

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## Privacy is **really** hard

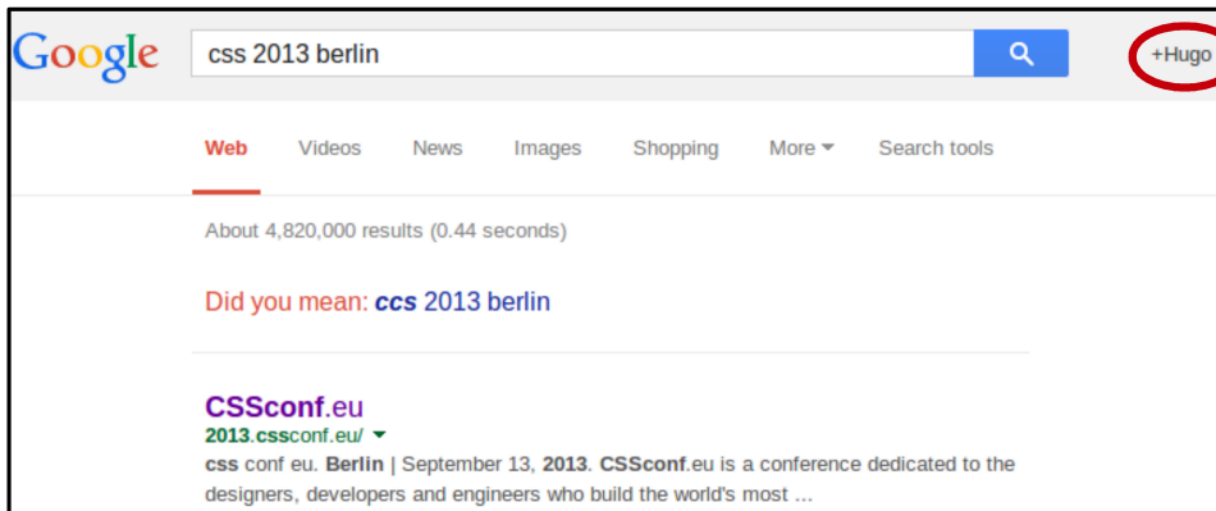
*“Another thing which is just an observation, when I was working on the **blocking of the social plugins**, I always used the  website to test my implementation. Today **Facebook suggested** me on my phone the **group of  .”***

– Bachelor student

# Privacy is **really really** hard

TECH | 2/16/2012 @ 11:02AM | 2,398,698 views

## How Target Figured Out A Teen Girl Was Pregnant Before Her Father Did

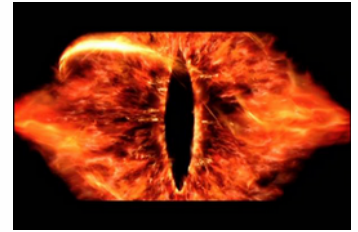


A screenshot of a Google search interface. The search bar contains the text "css 2013 berlin". To the right of the search bar is a blue search button with a magnifying glass icon. Further right, a red circle highlights a "+Hugo" button. Below the search bar, there are tabs for "Web", "Videos", "News", "Images", "Shopping", "More", and "Search tools". The "Web" tab is selected. Below the tabs, it says "About 4,820,000 results (0.44 seconds)". A suggestion is shown: "Did you mean: **css** 2013 berlin". Below that, a search result is displayed for "CSSconf.eu" with the URL "2013.cssconf.eu/". The snippet for the result reads: "css conf eu. Berlin | September 13, 2013. CSSconf.eu is a conference dedicated to the designers, developers and engineers who build the world's most ...".

Actually, what is privacy?

# Actually, what is privacy?

- Privacy is secrecy wrt. **someone**





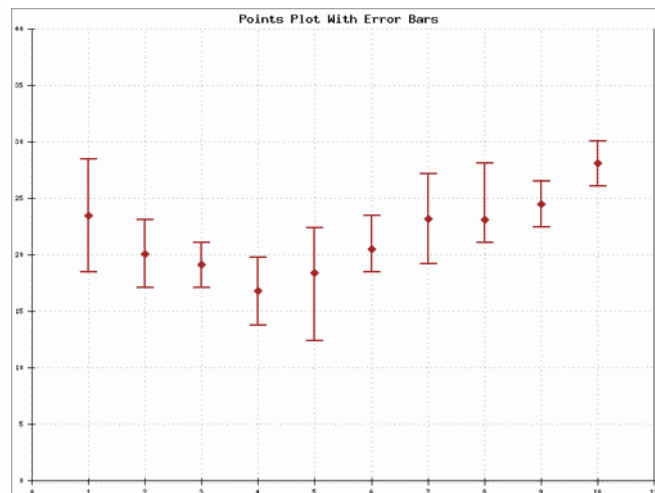
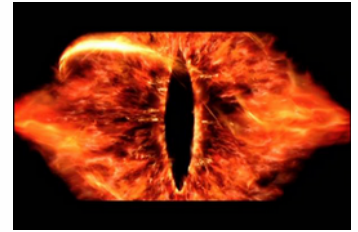
# Actually, what is privacy?

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- Two aspects:
  - (in)distinguishability



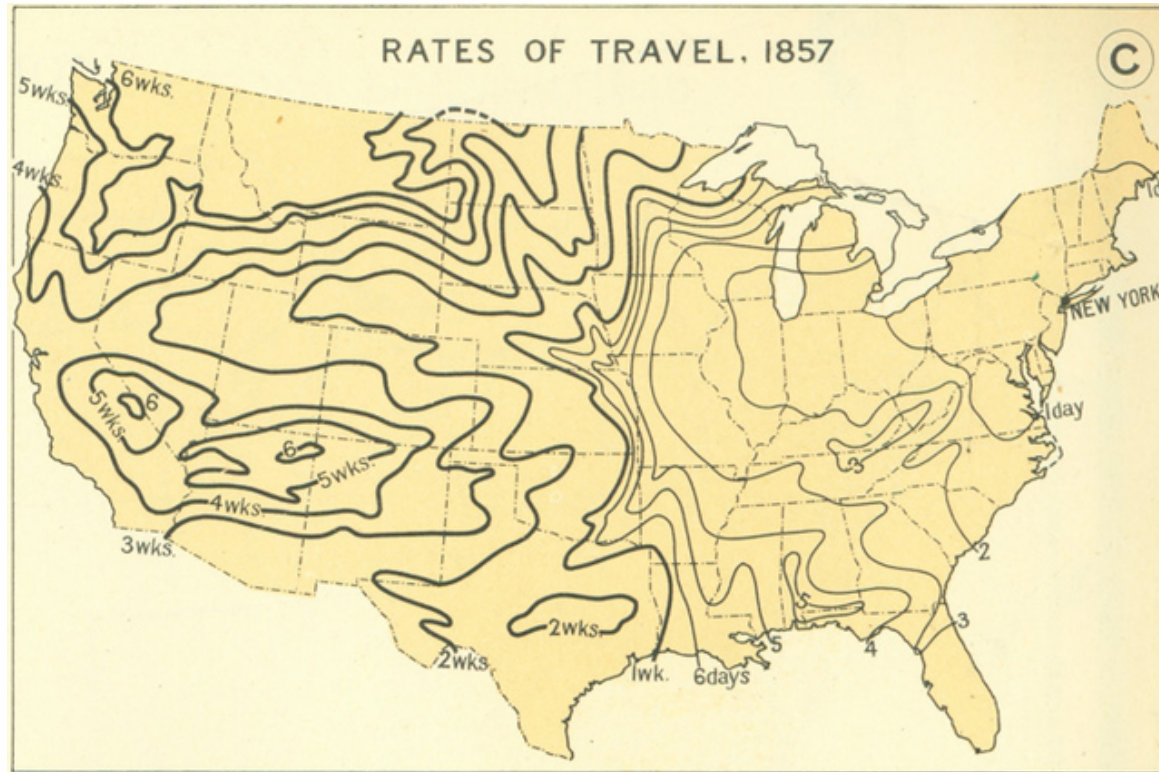
# Actually, what is privacy?

- Privacy is secrecy wrt. **someone**
- Two aspects:
  - (in)distinguishability
  - (un)certainty

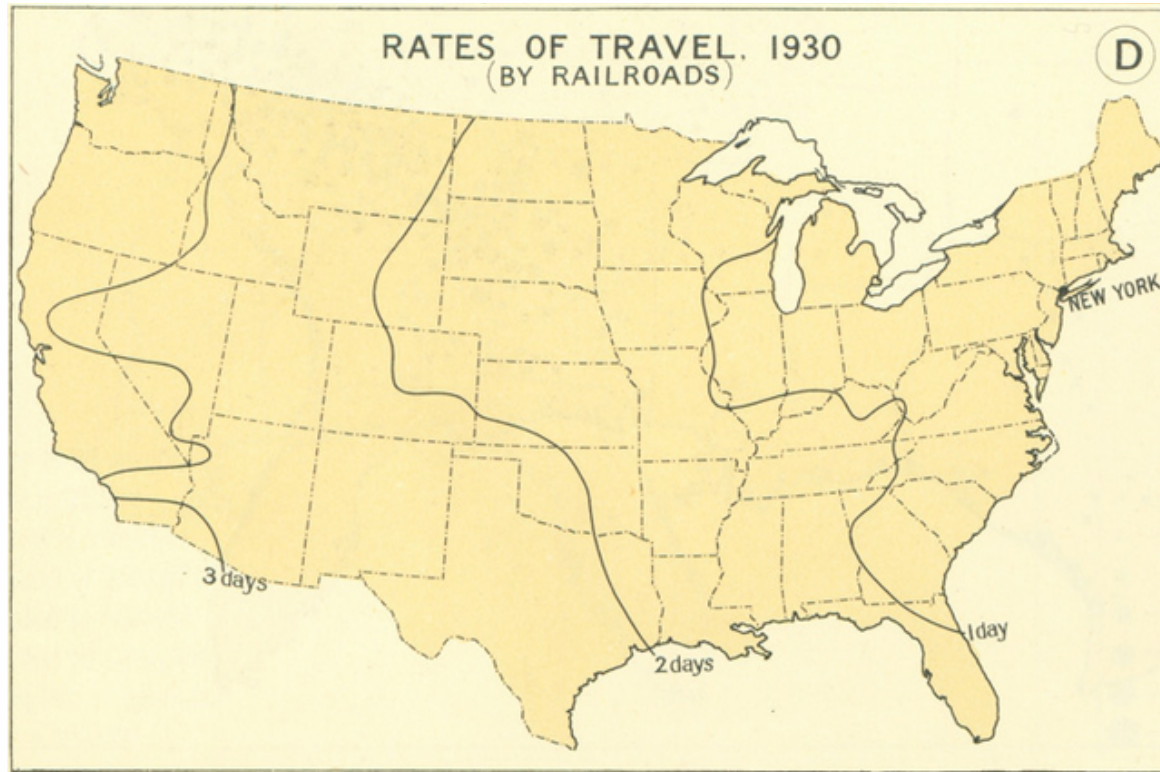


# Did privacy become harder?

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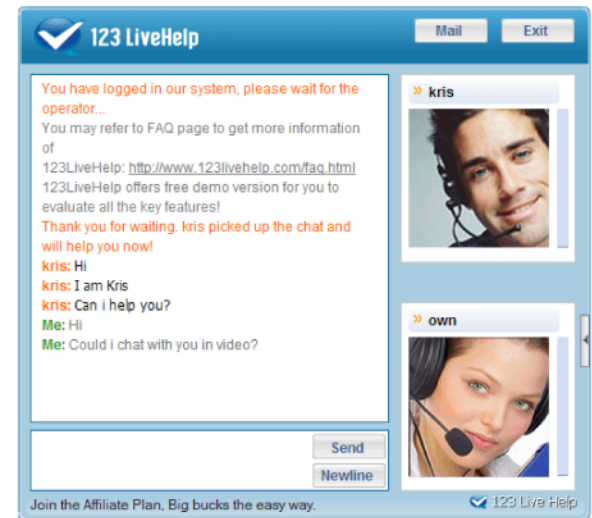
# In a nutshell

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# In a nutshell



≈



# Contributions

- New paradigm for online privacy
- Distinguish between local and cross-domain tracking
- Fingerprint privacy via separating web identities
  - Consistent, believable, distinguishable identities
- Determined common fingerprint vectors
- Proof-of-concept implementation
  - <https://github.com/ChristofTorres/FP-Block>
  - **effective** against commercial fingerprinters

# Web tracking

Tracking is good!

- Fraud prevention
- Improving web site usability
  - Finding common browsing “errors”
  - Related items of interest
  - ...

However...

**B B C**

DIE  ZEIT



*Le Monde*

**EL PAÍS**

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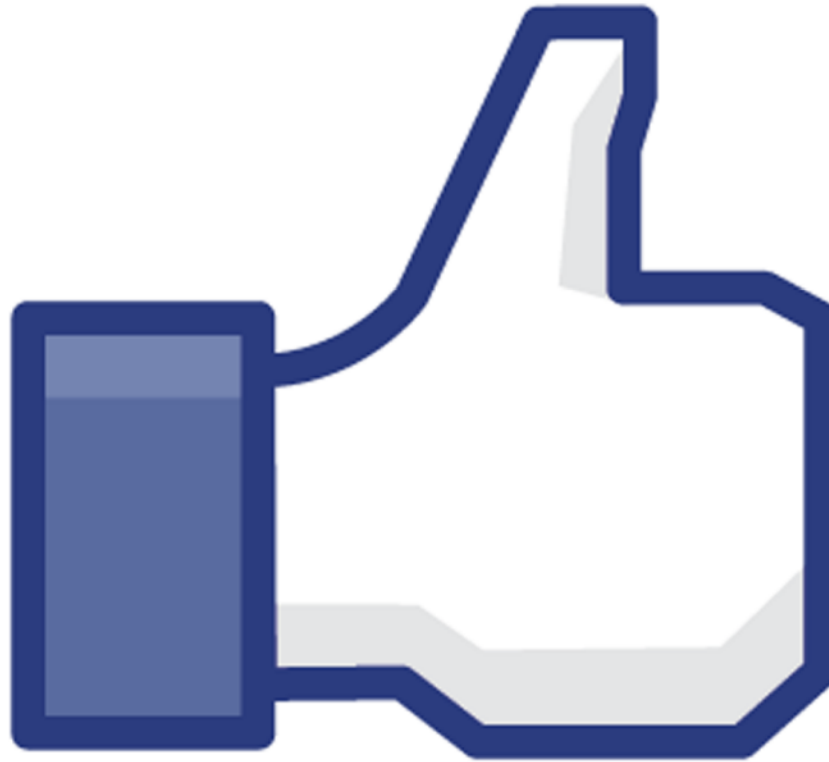


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**EL PAÍS**

However...



# Embedded content

1. Content delivery networks
2. Advertising
3. Analytics and tracking
4. Embedded media
5. Social plugins
6. Payment
7. Libraries
8. ....



	Top 10k	Top 1mil
1. Akamai	17%	11%
2. Doubleclick	10%	20%
3. Google Analytics	19%	44%
4. YouTube	26%	47%
5. Facebook Like*	20%	16%
6. PayPal button	33%	44%
7. JQuery	18%	20%





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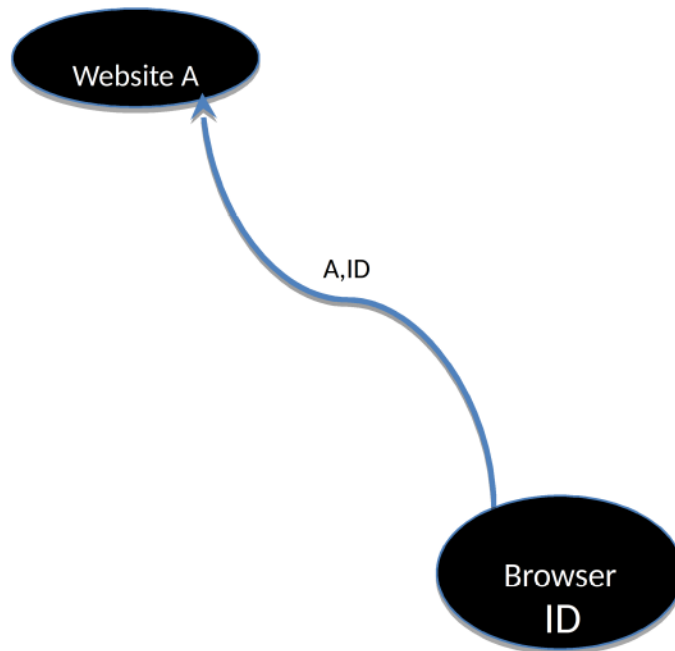
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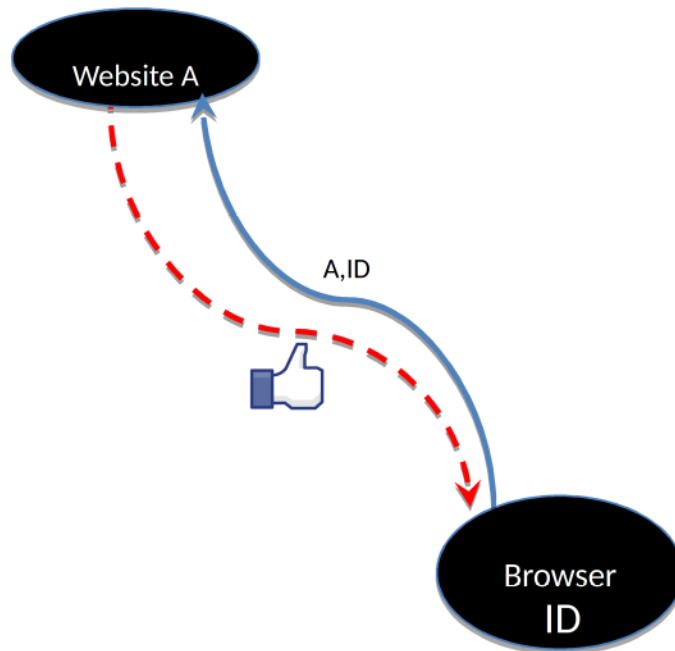
Data from September 2015.

\* aggregated numbers from builtwith.com.  
numbers by similartech.com are higher.

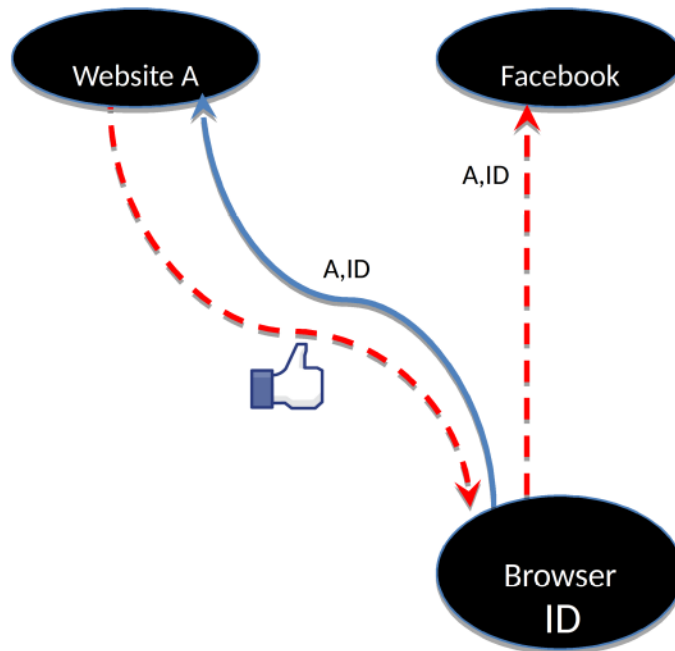
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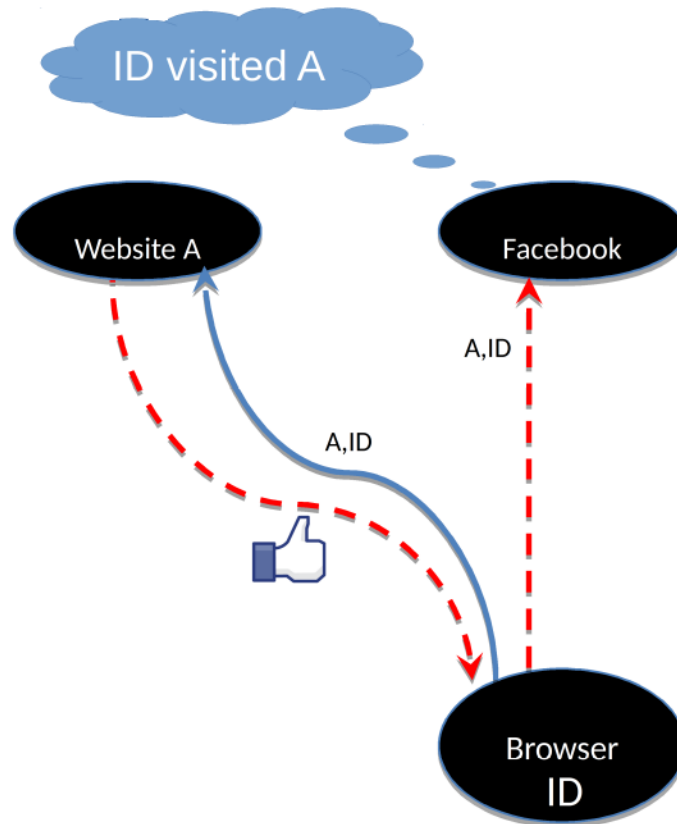
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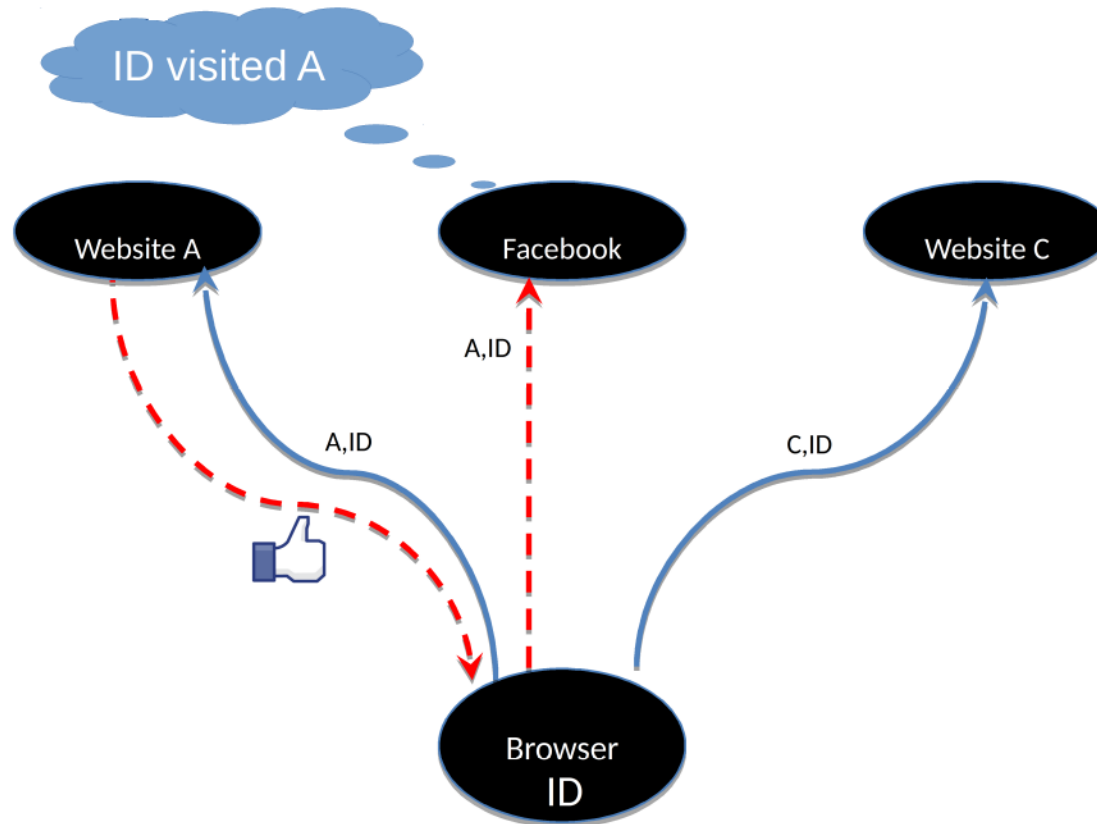
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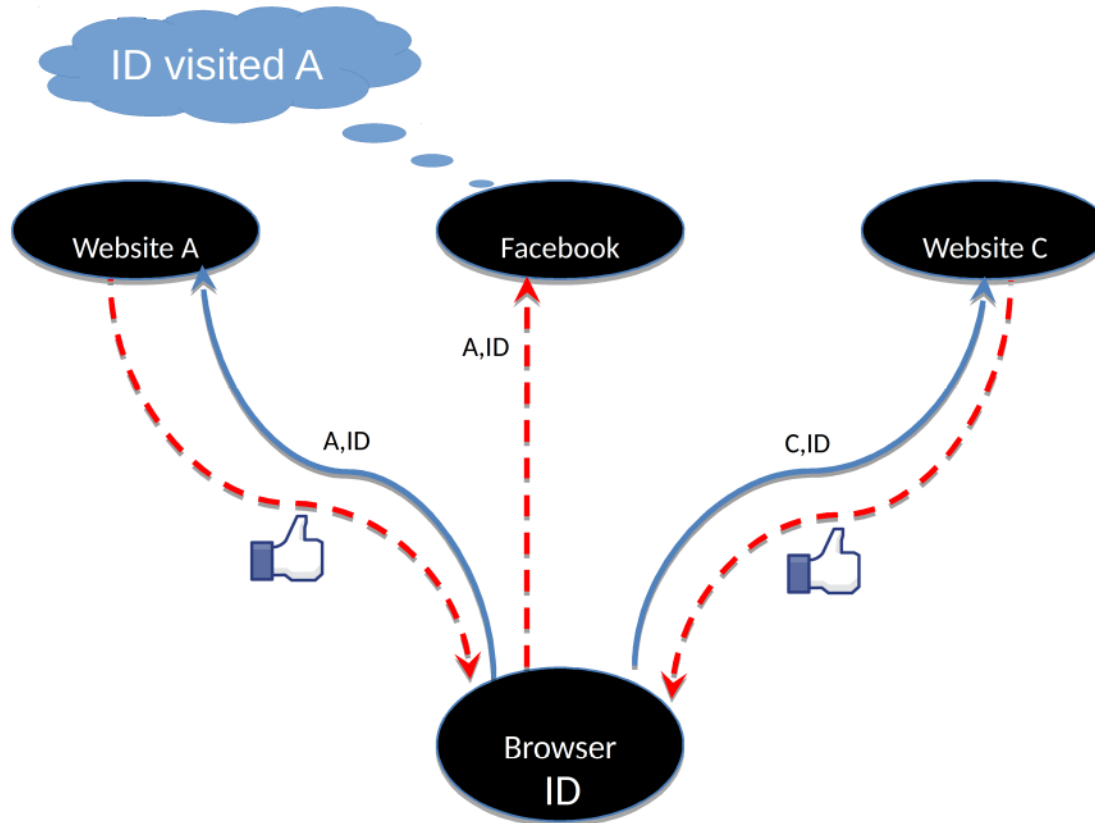
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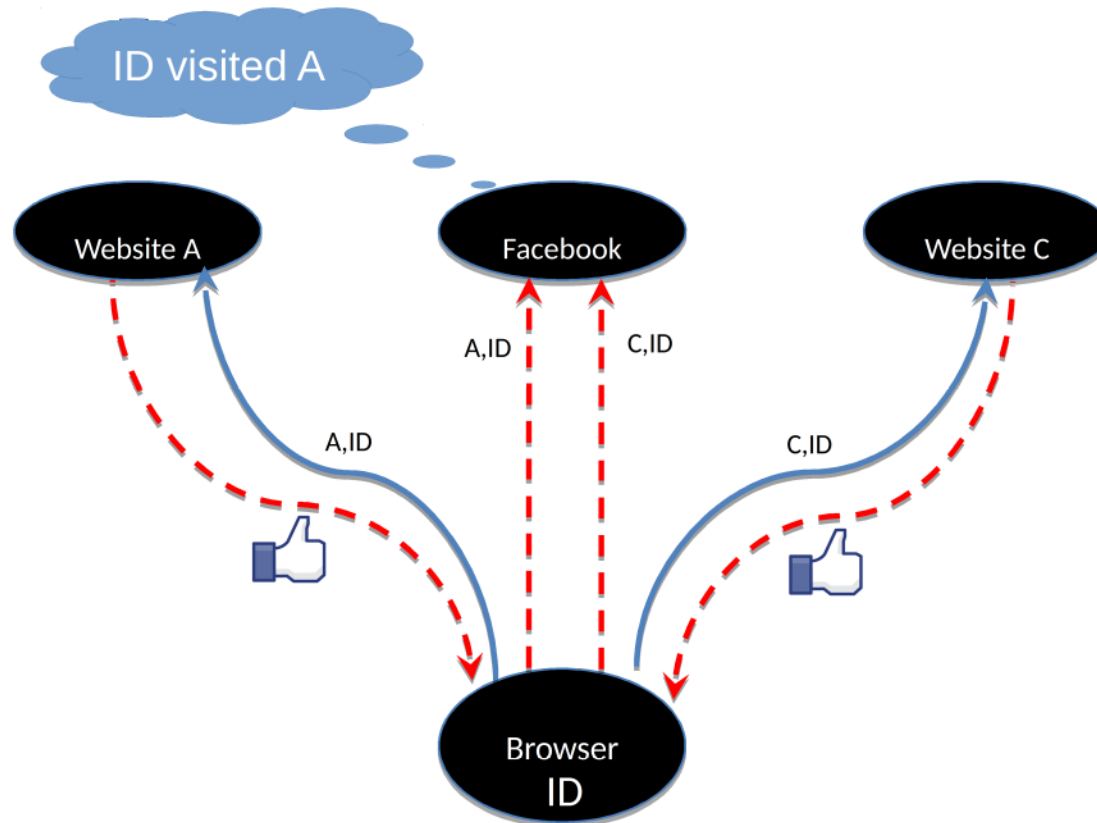


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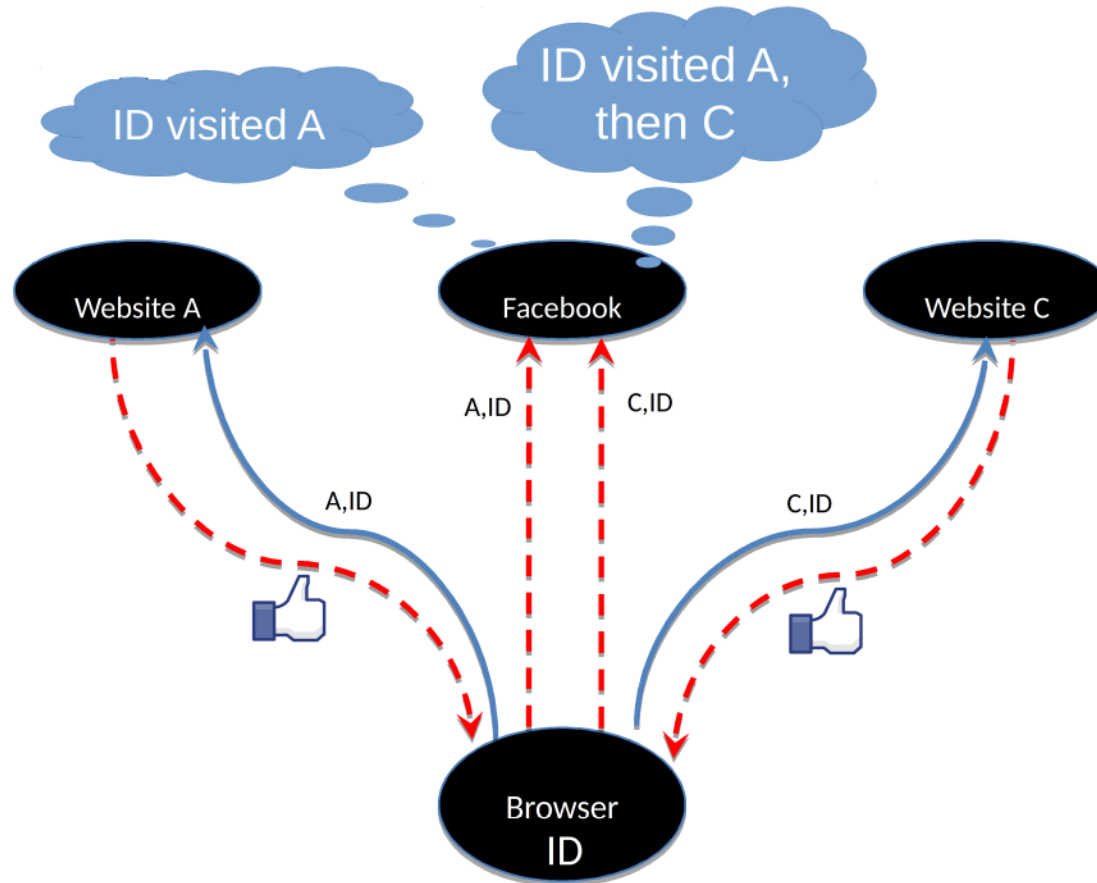




# Tracking via embedded content



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# How to track

- Client-side
  - Cookies / evercookies / zombiecookies / ...
  - History exploit / CSS tricks / ...
  - active **fingerprinting**
  
- Server-side only
  - Web bugs
  - Path tracking
  - passive **fingerprinting**

# Why fingerprinting?

- Cookies: client-side **storage**.
- Fingerprinting:
  - Passive: infer info from server side.
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- Actually in use?
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  - **Firefox 42 Beta added “tracking protection”**

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- Research by **one** academic associated with EFF

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- Revealing: order of fonts, order of plugins
- Defensive paradox

# Lots of ways to fingerprint

E.g.

- [PETS10] – User-agent
- [W2SP11] – fingerprinting JavaScript implementations
- [W2SP12] – fingerprinting HTML5 font rendering
- [W2SP13] – fingerprinting JS engine errors
- TCP/IP clock skew can be **passively** detected (proxies don't help)
- HTTP header order
- ...

## Fighting fingerprinting

- Do Not Track header? [NSDI12]: **X**
- Blacklisting fingerprinters? [W2SP11]: **X**
- FireGloves [NordSec11]? [CCS13]: **X**
- Tor Browser? [CCS13]: **X**

Any countermeasure can be broken if **specifically** targetted.

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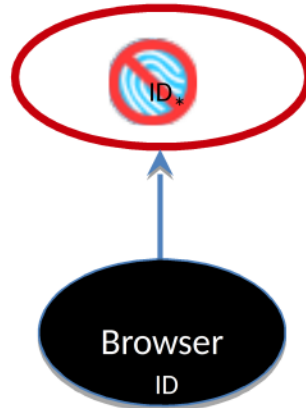
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Idea:

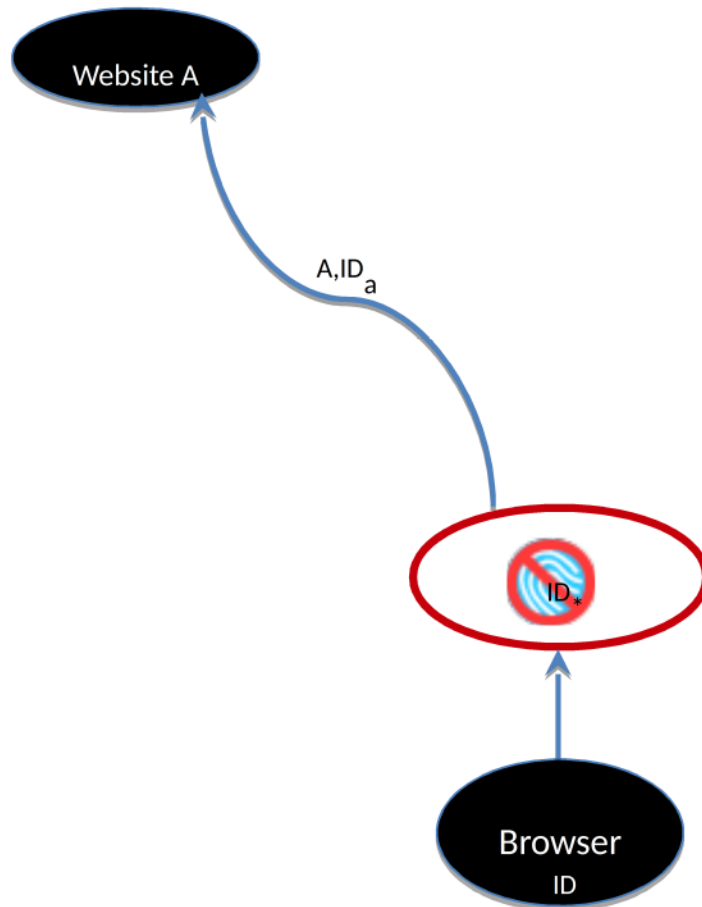
- local tracking okay,
- 3<sup>rd</sup> party tracking not

# Separate web identities

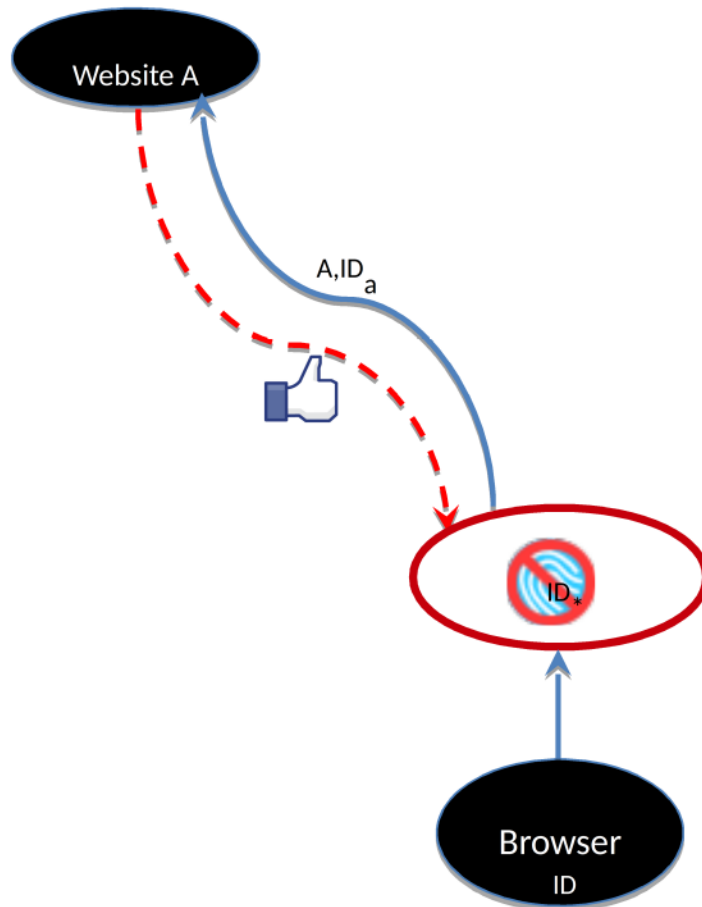




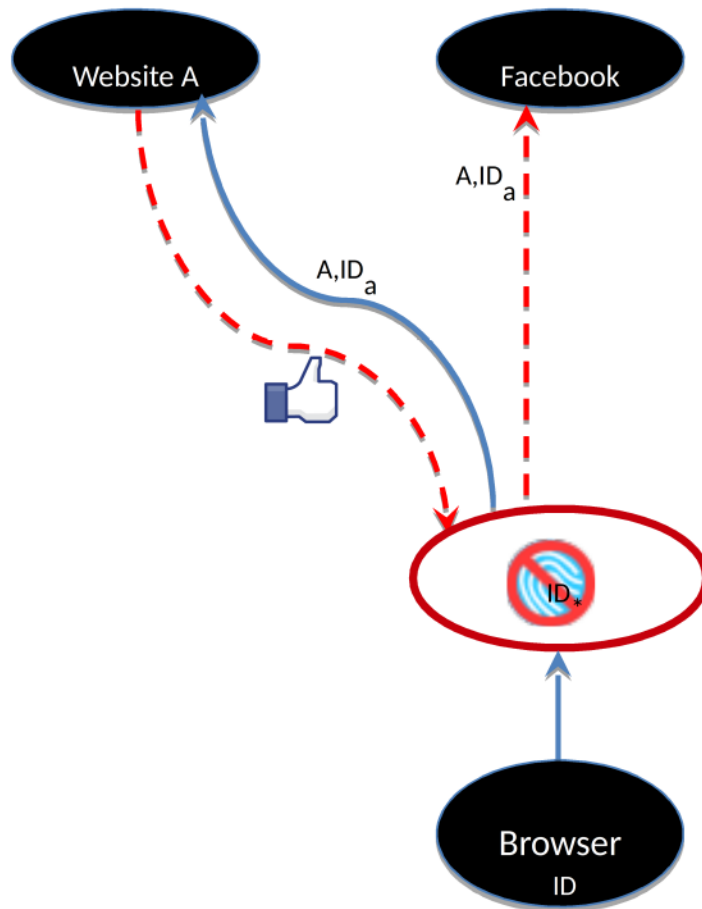
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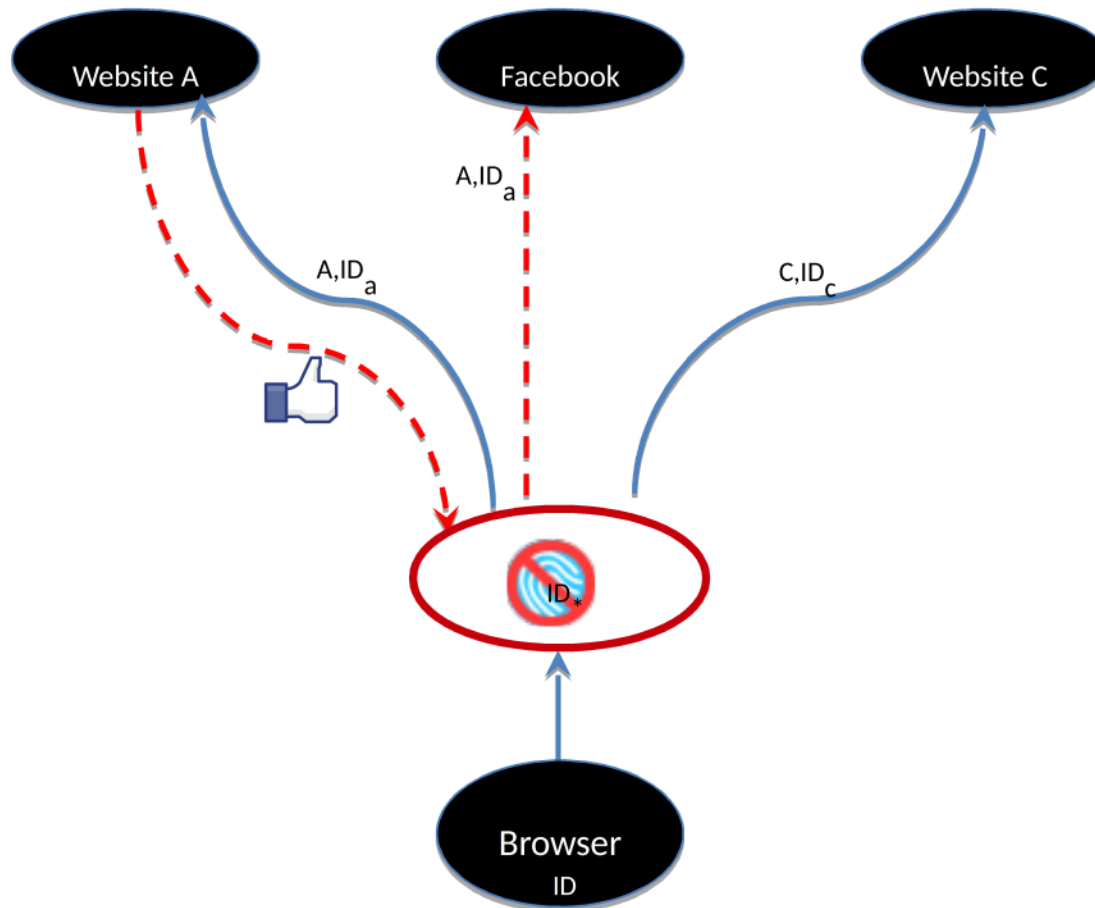
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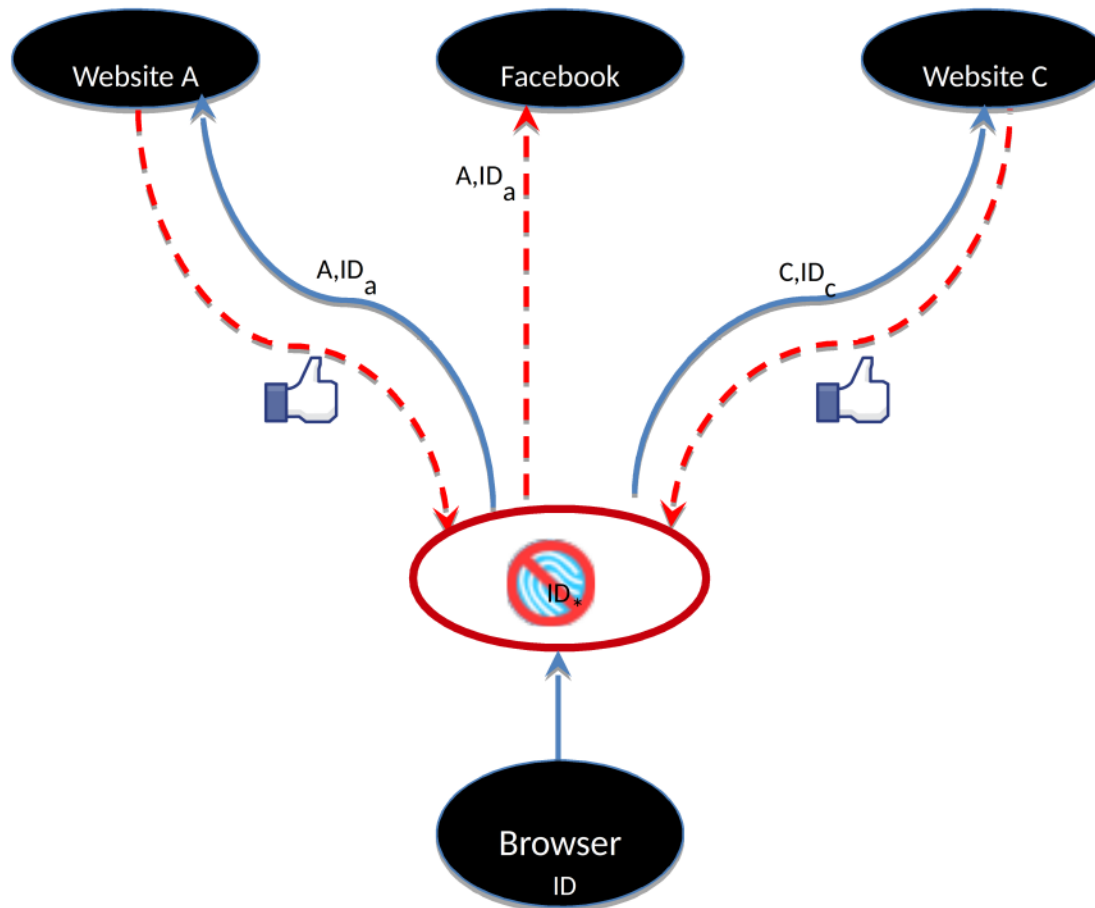
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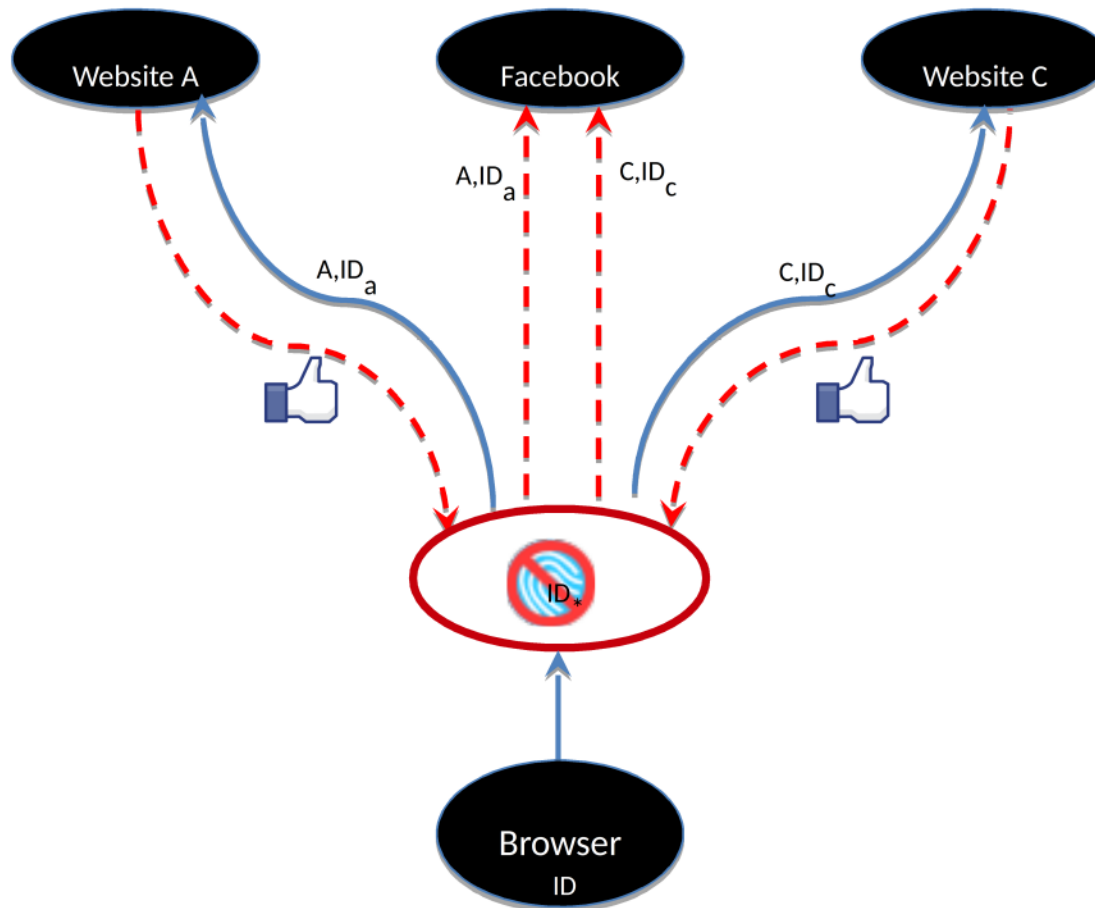
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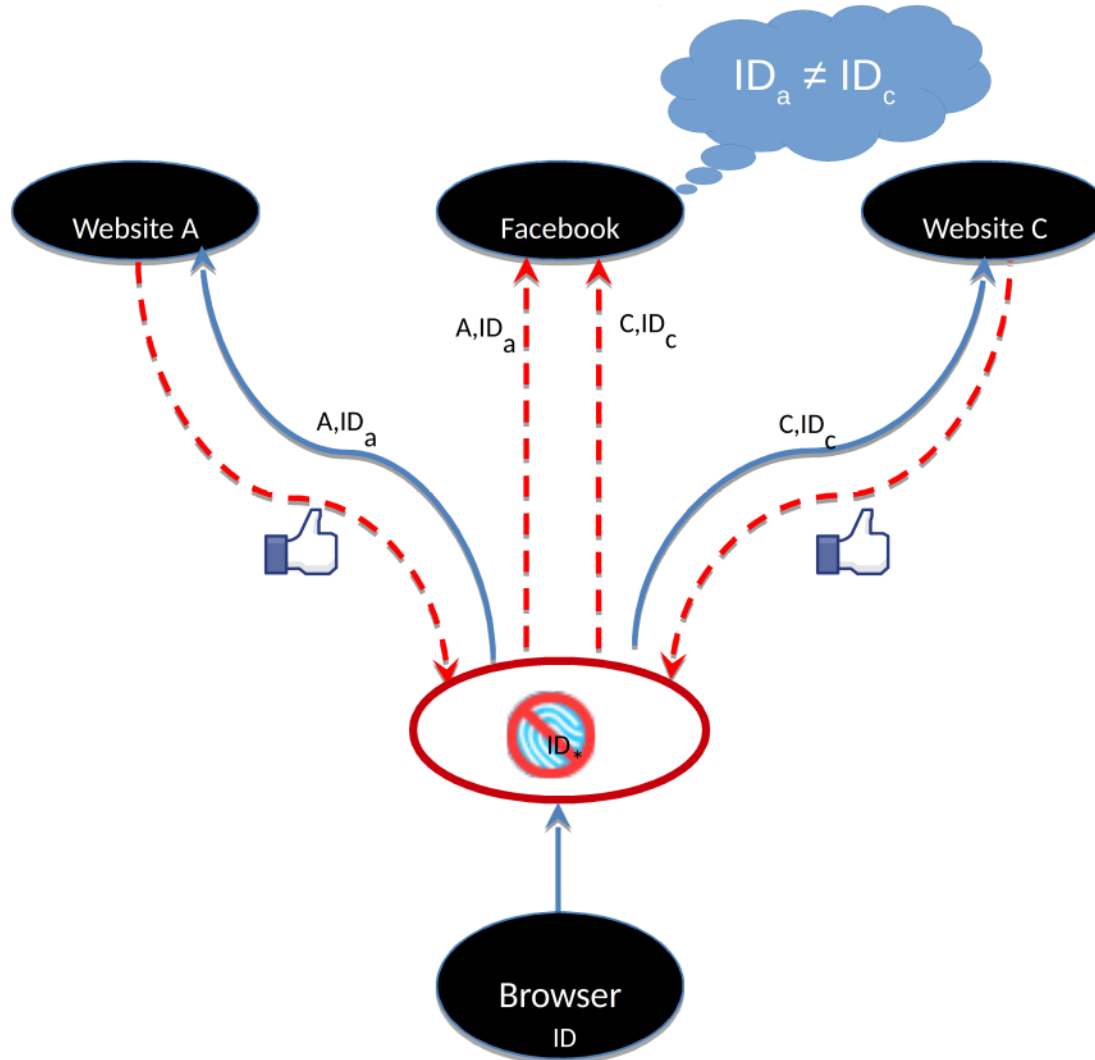
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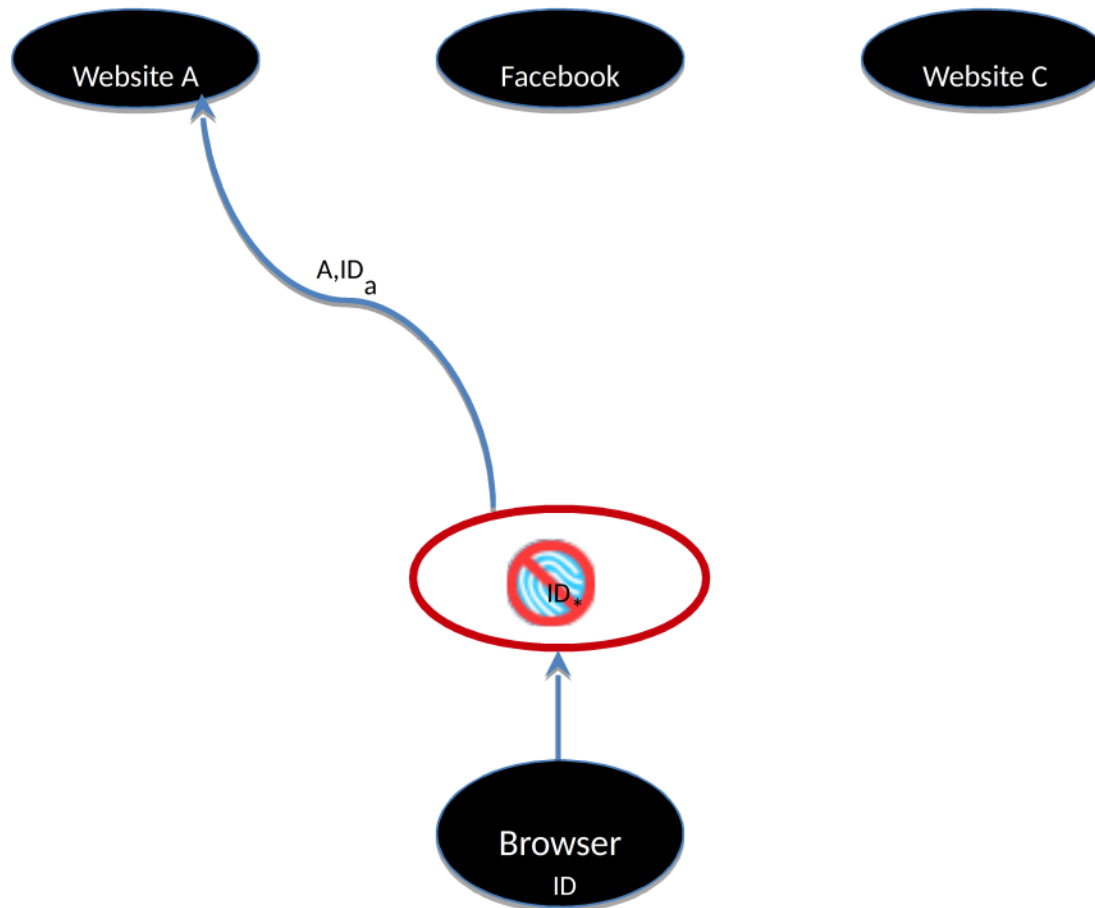
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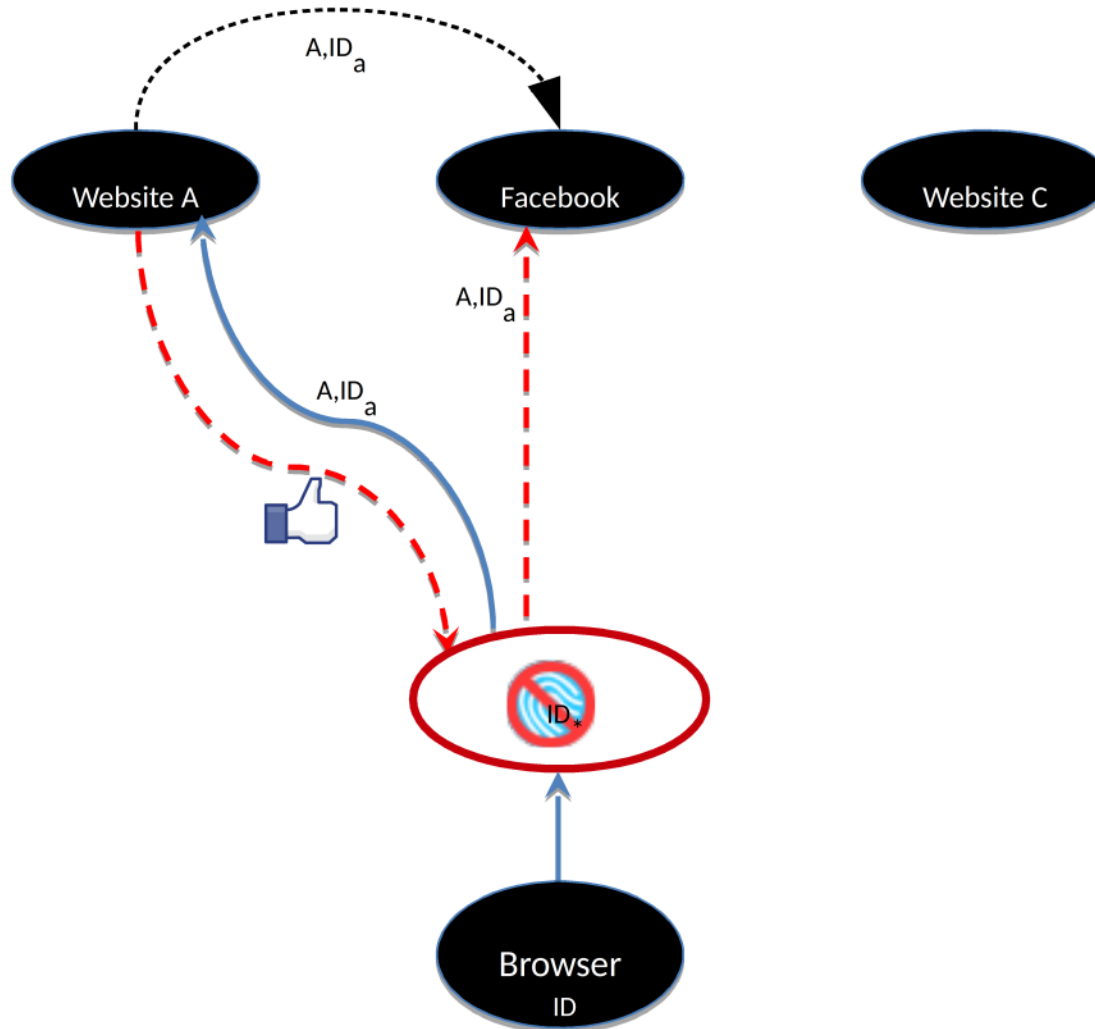


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# “Fingerprint surface”

## Non-profit:

- Panopticlick - academic study
- FingerPrintJS - open source

## Commercial:

- AddThis - social media buttons
- BlueCava - advertisements
- Iovation - fraud prevention
- ThreatMetrix - fraud prevention

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# Fingerprint vectors [S&P13]

- Plugin Enumeration
- Font Detection
- User-Agent
- HTTP Header Accept
- HTTP Header Accept-Charset
- HTTP Header Accept-Encoding
- HTTP Header Accept-Language
- HTTP Accept Headers Order
- Screen Resolution
- Timezone
- Browser Language
- OS & Kernel Version
- DOM Storage
- IE userData
- Java Enabled
- DNT User Choice
- Cookies Enabled
- Flash Enabled
- ActiveX + CLSIDs
- Date & Time
- CPU
- System/User Language
- OpenDatabase
- Canvas Fingerprinting
- Mime-type Enumeration
- HTTP Proxy Detection
- IndexedDB
- Math Constants
- Windows Registry
- TCP/IP Parameters
- Google Gears Detection
- Flash Manufacturer
- MSIE Security Policy
- AJAX Implementation
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IE specific

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# Fingerprint vectors

- ✓: this work
- √: [S&P13]
- -: [S&P13], but dropped

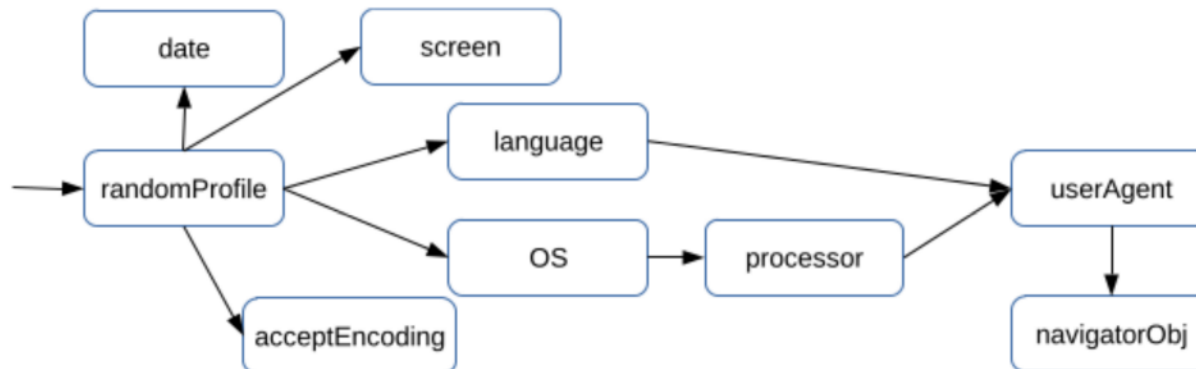
Attribute	Pan	BC	IO	TM	Add	FP's
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Font Detection	✓	✓		✓		
User-Agent	✓	✓	✓	✓	✓	✓
HTTP Header Accept	✓					
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HTTP Header Accept-Language	✓					
Screen Resolution	✓	✓	✓	✓	✓	✓
Timezone	✓	✓	✓	✓	✓	✓
Browser Language		✓	✓	-	✓	✓
OS & Kernel Version		✓	✓	✓	✓	✓
DOM Storage	✓	✓	✓	✓	✓	✓
IE userData	✓	✓				
Java Enabled	✓				✓	
DNT User Choice		-			✓	✓
Cookies Enabled	✓		✓			
JS detect: Flash Enabled	✓	✓	✓	✓	✓	✓
ActiveX + CLSIDs	✓	✓		✓	✓	✓
Date & Time		✓	✓	✓	✓	
CPU		✓	✓		✓	✓
System/User Language		✓	✓		✓	
OpenDatabase			✓		✓	✓
Canvas Fingerprinting					✓	✓
Mime-type Enumeration	✓			✓		
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TCP/IP Parameters		✓	✓			
Google Gears Detection		✓				
Flash Manufacturer				✓		
MSIE Security Policy		✓				
AJAX Implementation		✓				
MSIE Product key			✓			
Device Enumeration		✓				
Device Identifiers			✓			
IP address		✓				
HTML Body Behavior						✓
Battery					✓	
WebGLRenderingContext					✓	



# Generating believable & distinguishable identities

	Win	Mac	Linux	Platform	Processor string	probability
chrome	.89	.09	.02	Linux	'i686':	.5
firefox	.83	.16	.01		'x86_64':	.5
opera	.91	.03	.06	Mac	'Intel':	.48
safari	.04	.96			'PPC':	.01
iexplorer	1.00				'U; Intel':	.48
					'U; PPC':	.01
				Windows	':	. $\bar{3}$
					'WOW64':	. $\bar{3}$
					'Win64; x64':	. $\bar{3}$

**Table 3.** Example attribute distributions, due to J. Mealo



# Proof-of-concept: FP-Block plugin

<http://www.open.ou.nl/hjo/software/fp-block.htm>

- Generates **consistent** fingerprint
- One fingerprint per primary domain
- 23 attributes (Tor: 14, FireGloves: 8)
- Covers
  - HTTP (passive fingerprinting)
  - JavaScript (active fingerprinting)
- Additional coverage to ensure functionality
- Canvas fingerprint
  - detection [CCS14]
  - prevention (new)



# FP-Block's fingerprint coverage



Attribute	FG	Tor	PV	RAS	FPB
Plugin Enumeration	✓	✓	✓		✓
Font Detection	✓	✓	✓	✓	✓
User-Agent	✓	✓		✓	✓
HTTP Header Accept					
HTTP Header Accept-Charset		✓			
HTTP Header Accept-Encoding				✓	✓
HTTP Header Accept-Language		✓		✓	✓
Screen Resolution	✓	✓		✓	✓
Timezone	✓	✓		✓	✓
Browser Language	✓				✓
OS & Kernel Version	✓	✓		✓	✓
DOM Storage				✓	✓
IE userData					
Java Enabled					✓
DNT User Choice				✓	✓
Cookies Enabled					✓
JS detect: Flash Enabled					✓
ActiveX + CLSIDs					
Date & Time					
CPU				✓	✓
System/User Language					✓
OpenDatabase					✓
Canvas Fingerprinting		✓		✓	✓
Mime-type Enumeration	✓	✓	✓		✓
HTTP Proxy Detection					
IndexedDB					✓
Math Constants					
Windows Registry					
TCP/IP Parameters		✓			
Google Gears Detection					
Flash Manufacturer					
MSIE Security Policy					
AJAX Implementation					
MSIE Product key					
Device Enumeration					
Device Identifiers					
IP address		✓			
HTML Body Behavior					
Battery		✓			✓
WebGLRenderingContext		✓		✓	✓

# FP-Block's fingerprint coverage

Original canvas

+



+



Attribute	FG	Tor	PV	RAS	FPB
Plugin Enumeration	✓	✓	✓		✓
Font Detection	✓	✓	✓	✓	✓
User-Agent	✓	✓		✓	✓
HTTP Header Accept					
HTTP Header Accept-Charset		✓			
HTTP Header Accept-Encoding				✓	✓
HTTP Header Accept-Language		✓		✓	✓
Screen Resolution	✓	✓		✓	✓
Timezone	✓	✓		✓	✓
Browser Language	✓				✓
OS & Kernel Version	✓	✓		✓	✓
DOM Storage				✓	✓
IE userData					
Java Enabled					✓
DNT User Choice				✓	✓
Cookies Enabled					✓
JS detect: Flash Enabled					✓
ActiveX + CLSIDs					
Date & Time					
CPU				✓	✓
System/User Language					✓
OpenDatabase					✓
Canvas Fingerprinting		✓		✓	✓
Mime-type Enumeration	✓	✓	✓		✓
HTTP Proxy Detection					
IndexedDB					✓
Math Constants					
Windows Registry					
TCP/IP Parameters		✓			
Google Gears Detection					
Flash Manufacturer					
MSIE Security Policy					
AJAX Implementation					
MSIE Product key					
Device Enumeration					
Device Identifiers					
IP address		✓			
HTML Body Behavior					
Battery		✓			✓
WebGLRenderingContext		✓		✓	✓

# Validation

- Verify setup
  - Generate fingerprint with fingerprintJS
  - 2 sites, embedding each other
  - Test without and with FP-Block
- Run validation
  - BC, IO, TM, fingerprintJS, Panoptick, AddThis
- Actual test: BlueCava ID request

# Conclusions

- Ubiquitous tracking is a reality
- Countermeasures fall short
- Local tracking is acceptable

## Results:

- Propose separation of web identities
- Determine fingerprint vectors
- Method to generate distinctive, believable identities
- Proof-of-concept implementation
- Validation against commercial fingerprinters

## Current / future work (interested?)

- Boris Arkenaar (Msc): **webscraping + fingerprinting**
- Gabry Vlot (Msc): **“every webscraper is equal... but are some more equal than others?”**
- Benni Krumnow (PhD): **Tracking online data**
- Marc Slegers (BSc): **Firesheep 7 years later**
- Lucas Vos, Bas Doorn (BSc): **Private Tweeeeeting**
- Clayton Drazner, Nikola Đuza: **Block Assessor**

**Thank you for your attention!**



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[www.open.ou.nl/hjo/supervision.htm](http://www.open.ou.nl/hjo/supervision.htm)



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