FP-Block

usable web privacy

by controlling browser fingerprinting

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

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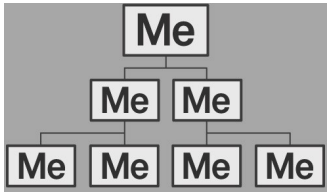
OUtline

- Part 1:
  introduction

- Part 2:
  thwarting 3rd party fingerprint-based web-tracking

Introducing myself



- PhD thesis on Fair Sharing and Vote Privacy (UL & TU/e)
- Voting @ University of Surrey
- Privacy in mobile/web @ University of Luxembourg
- Hybrid mixnet @ TU Darmstadt
- Interests:
  - vote privacy
  - healthcare privacy, e-health
  - auction verifiability & privacy
  - formalising privacy
  - practical security

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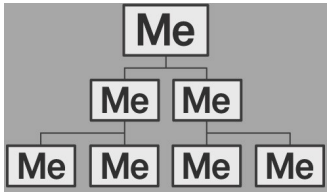
Introducing myself



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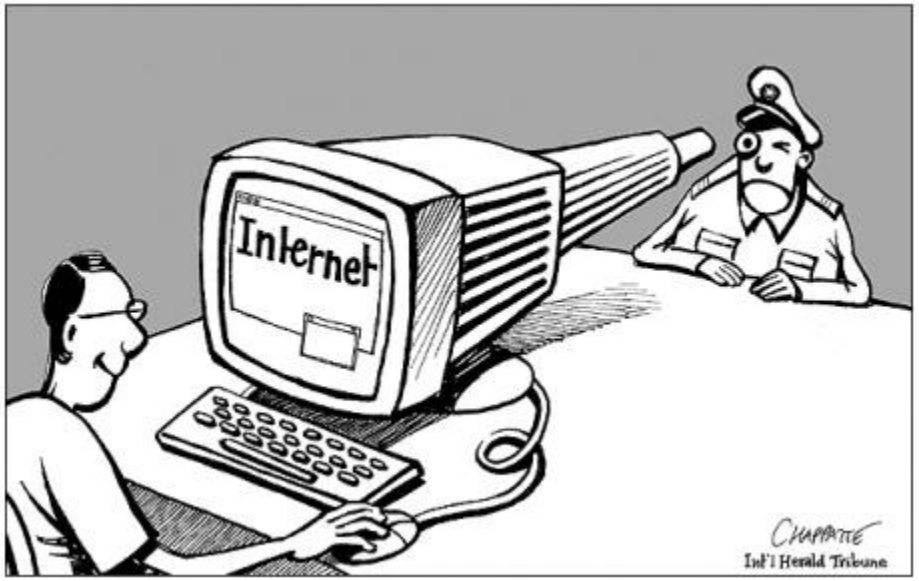

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We are terrible at privacy

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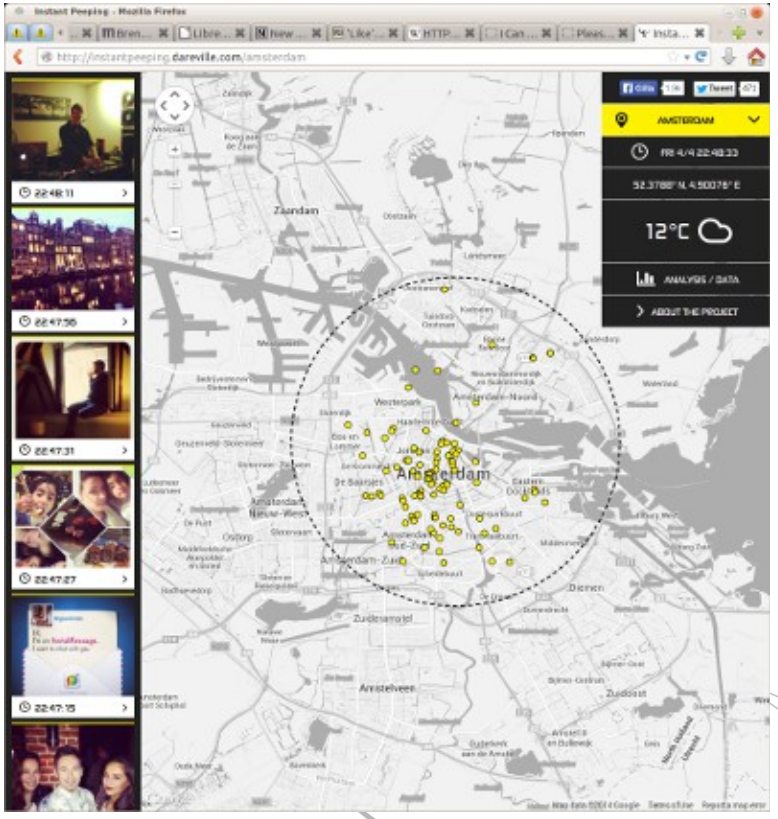

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We really don't get privacy

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Note: account number can suffice for withdrawal

In our defence: privacy is hard...

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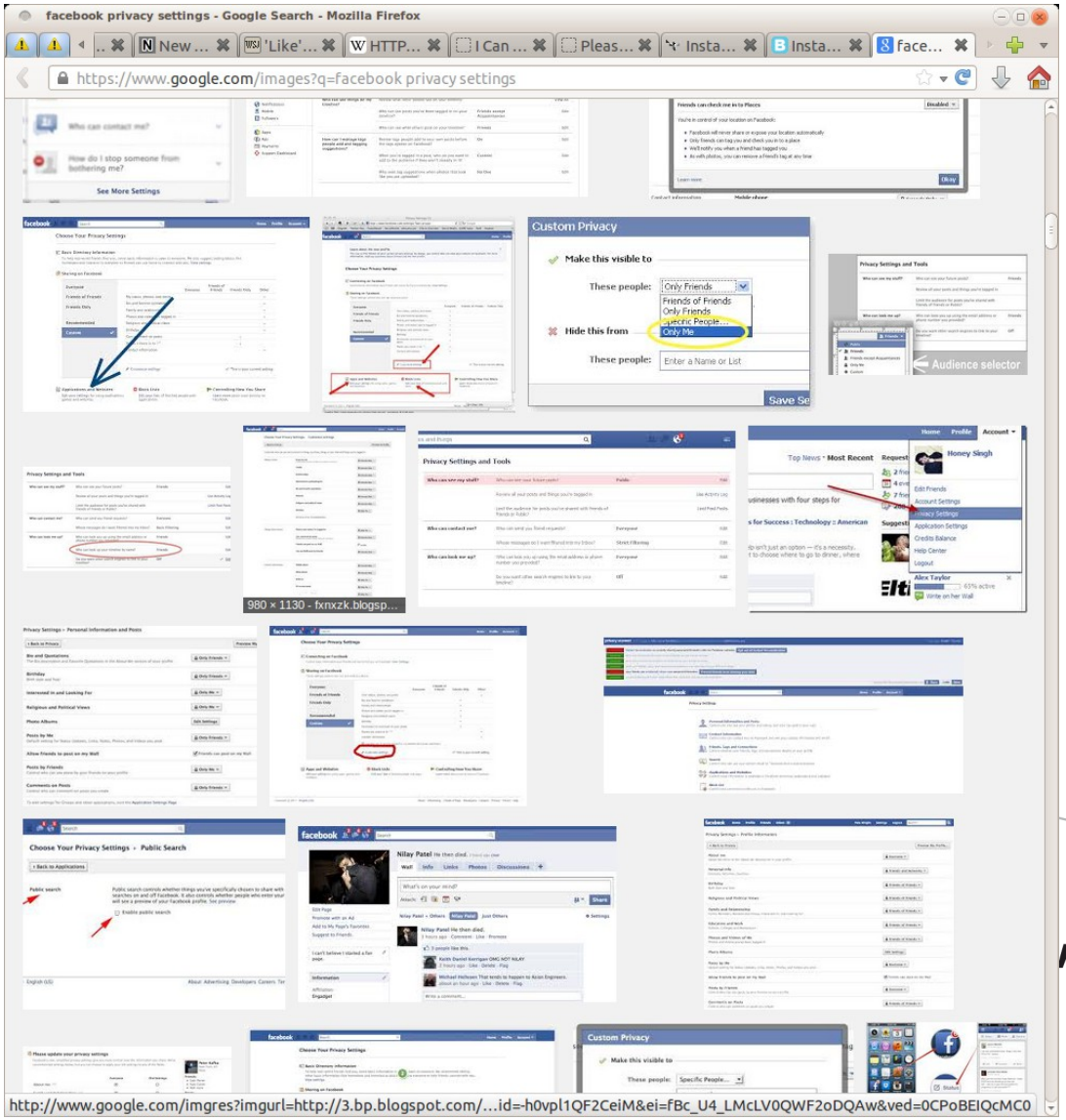
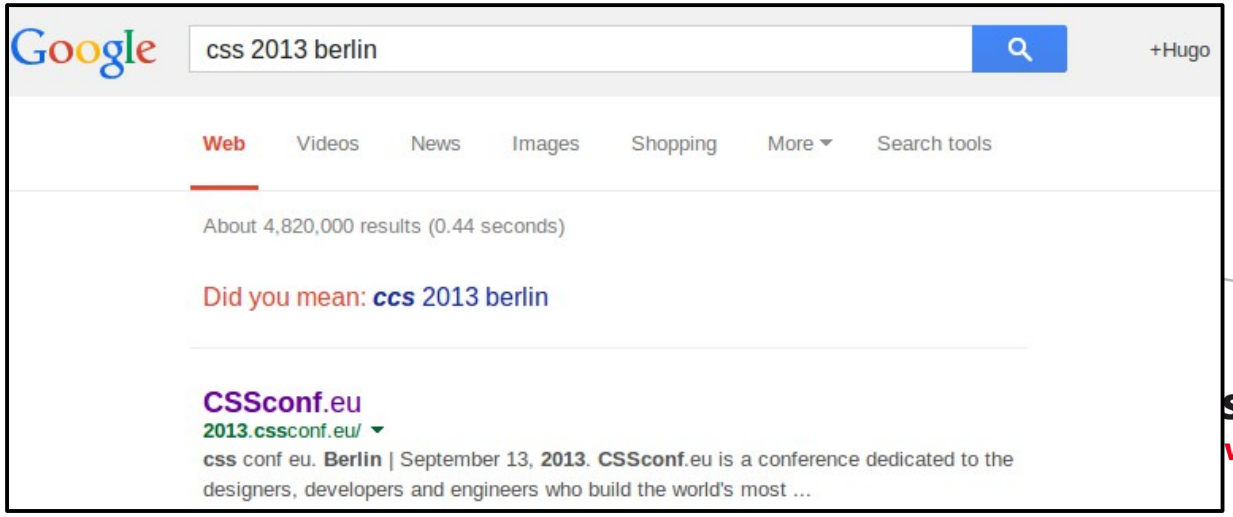


… really hard...

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

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



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… really, 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***  *.”*

– anonymous UL Bachelor student / coauthor

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Reasoning about privacy

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- Privacy is wrt. someone

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Reasoning about privacy

- Privacy is wrt. someone
- Two sides:
  - (in)distinguishability

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Reasoning about privacy

- Privacy is wrt. someone
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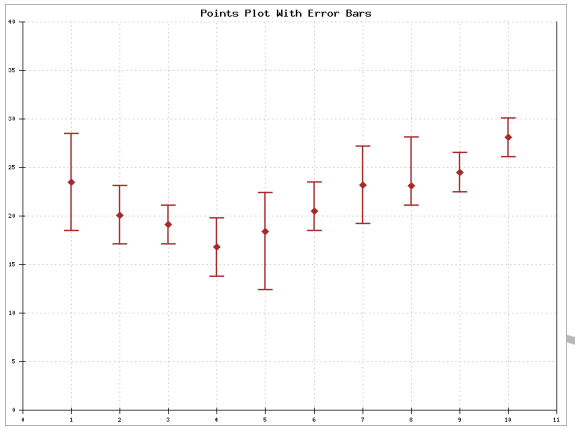
  - (in)distinguishability
  - (un)certainty



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Did privacy become harder?

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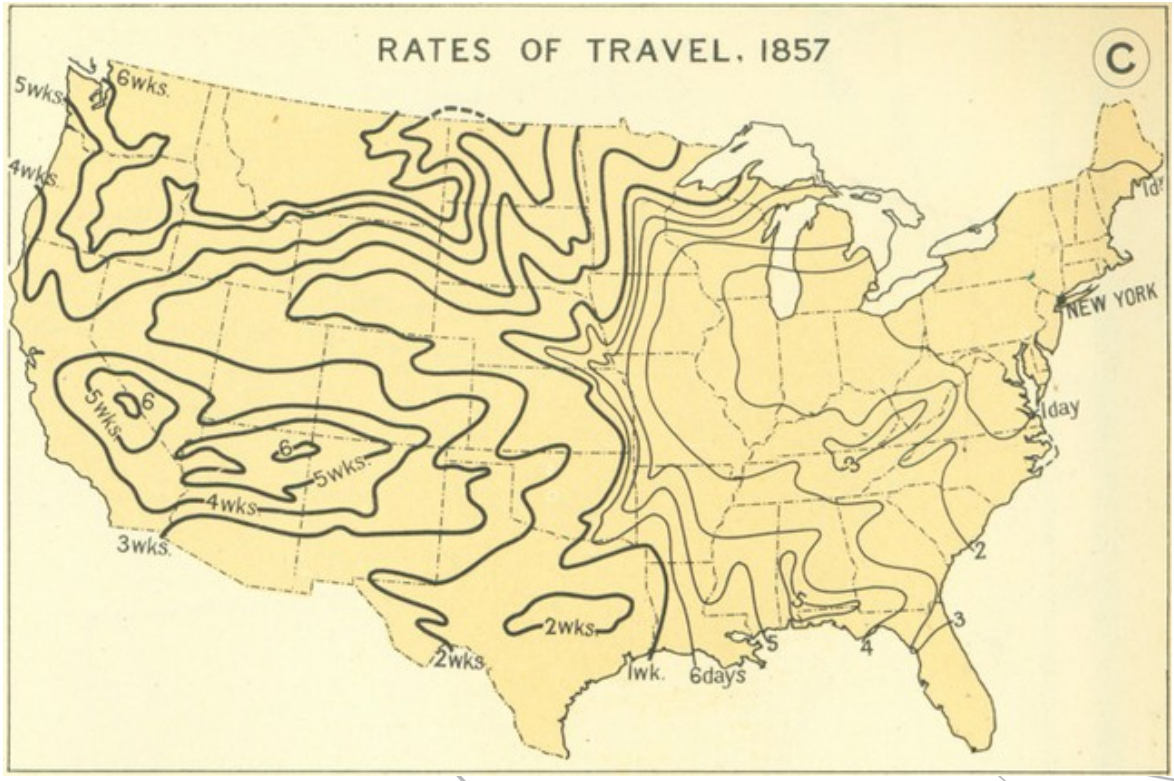

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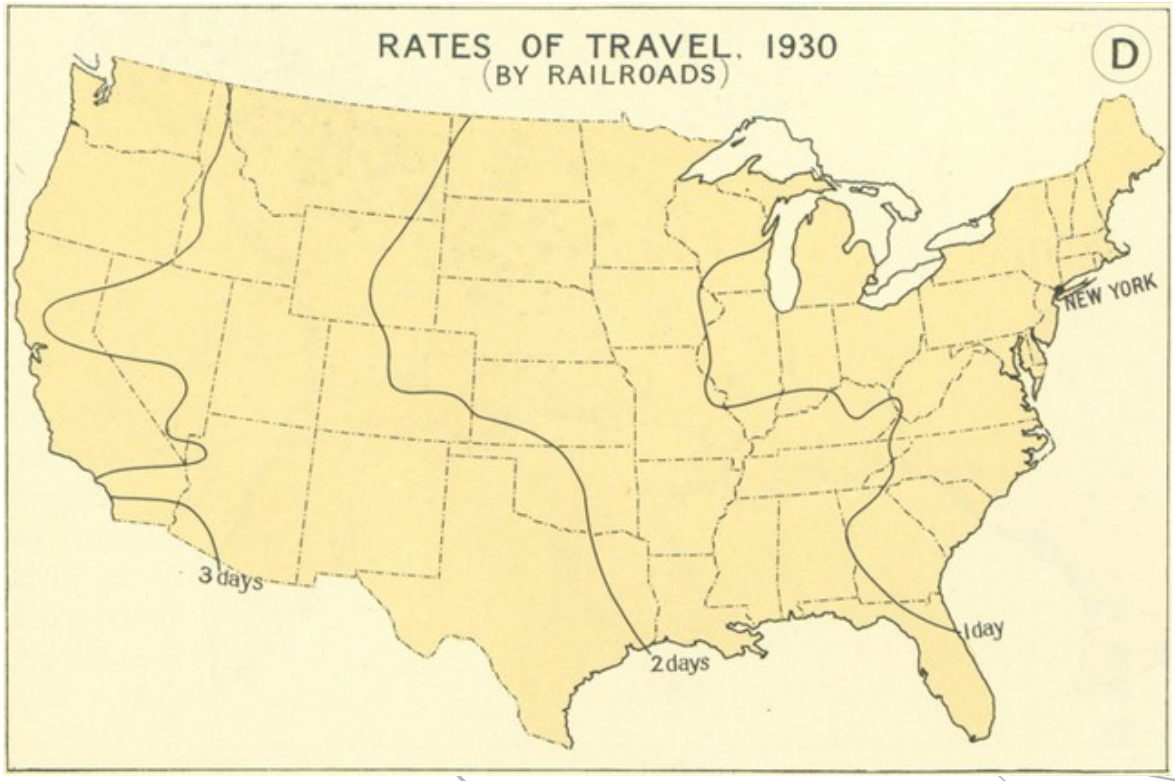

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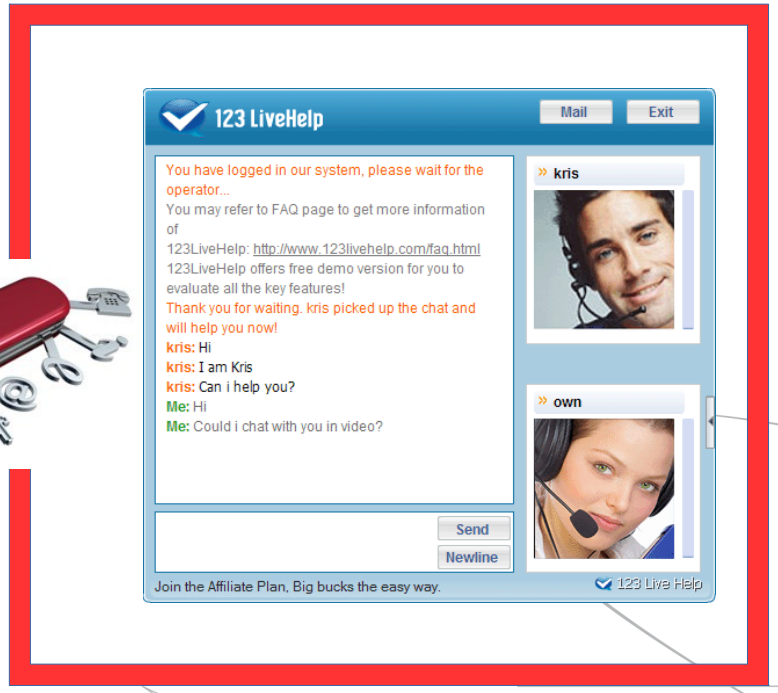

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OUtline

- What is tracking
- What is FP-based tracking
- Literature + countermeasures
- Web identities
- Fingerprint surface / Fingerprint vectors
- FP-Block

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Reasons to track

- Find site errors / problems
- Count visitors, not pageviews
- Detect suspicious logins
- Targeted advertising

- Goal: track **a user**

Web tracking

Tracking is good!

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

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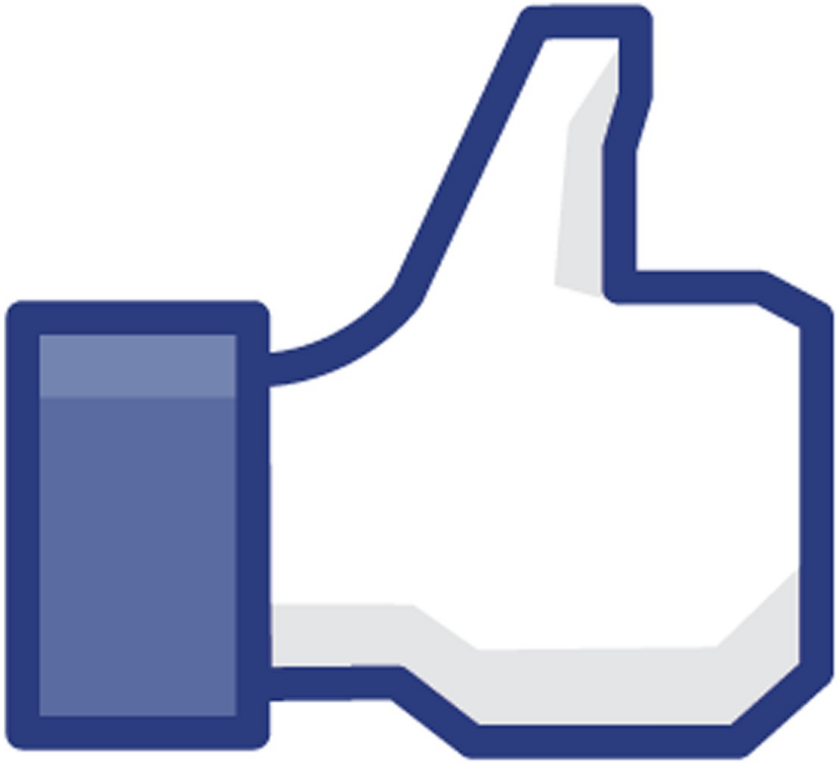
Embedded tracking, however...



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Embedded tracking, however...

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Embedded tracking, however...

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  - Response can set / update cookie

- Facebook can track people not on FB [Roos11]
- Google is worse (AdSense, Analytics)

Embedded content

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

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	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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7. JQuery	18%	20%

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

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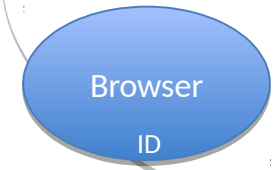
Tracking via embedded content



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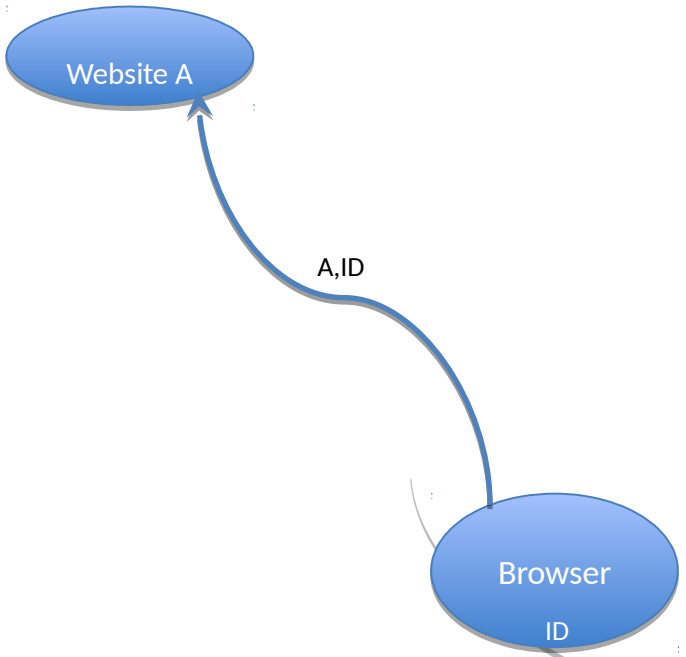
Tracking via embedded content



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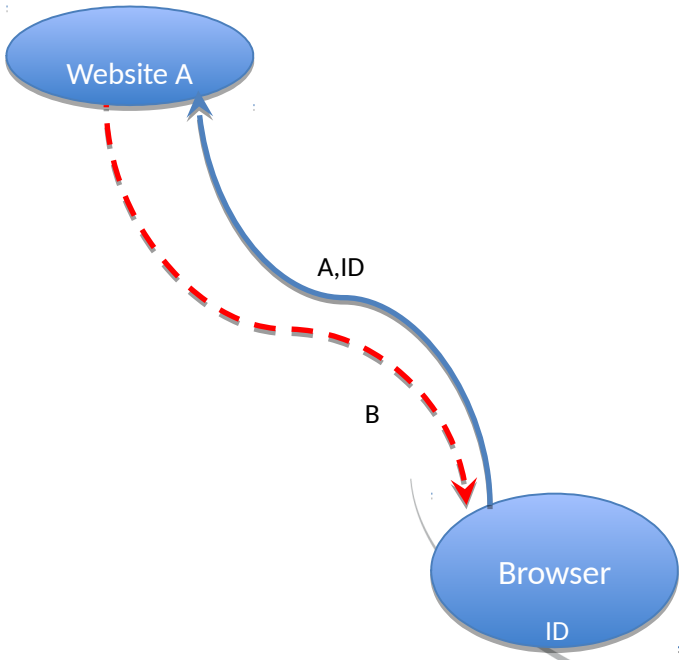

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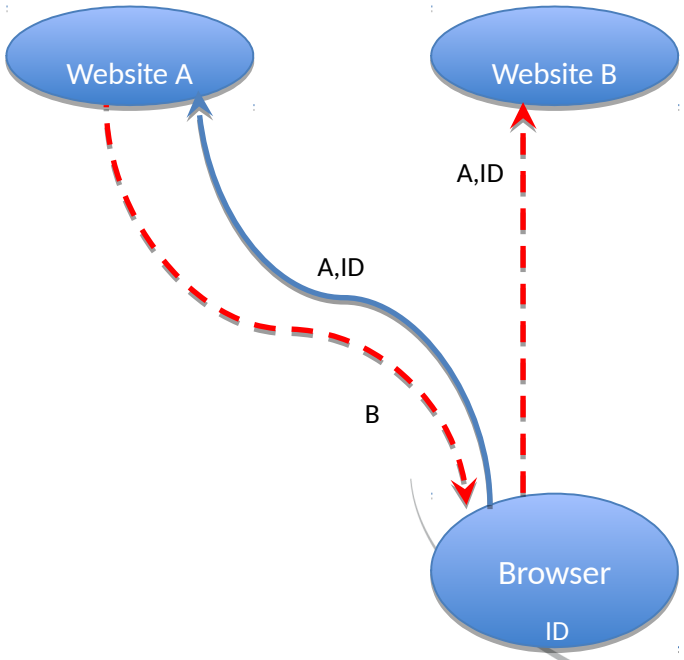

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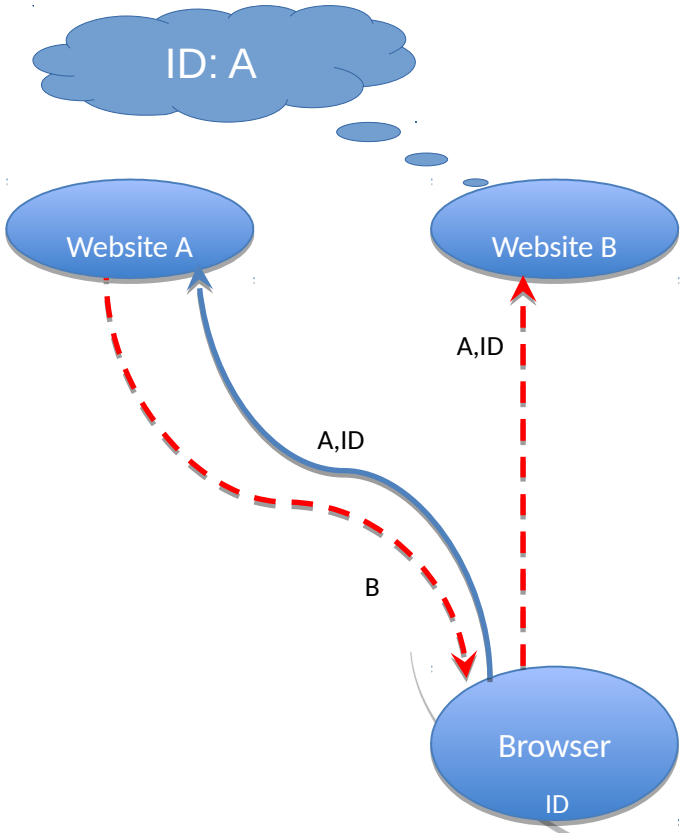

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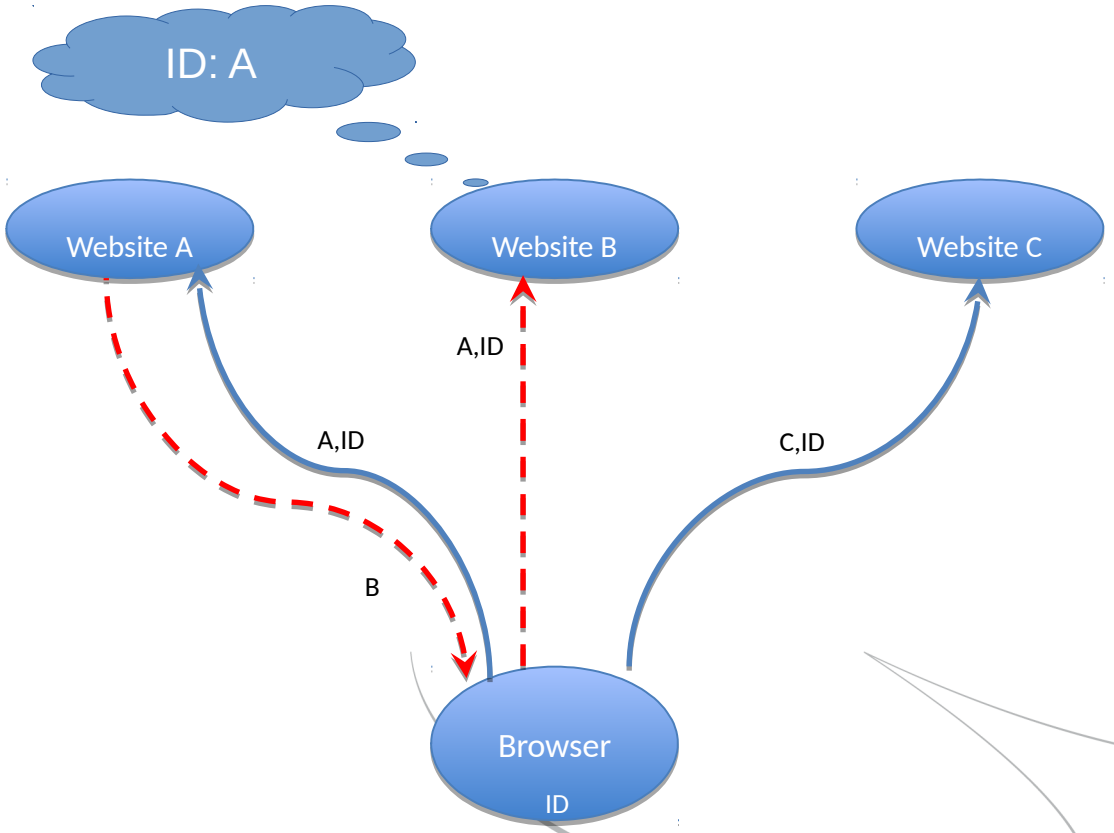

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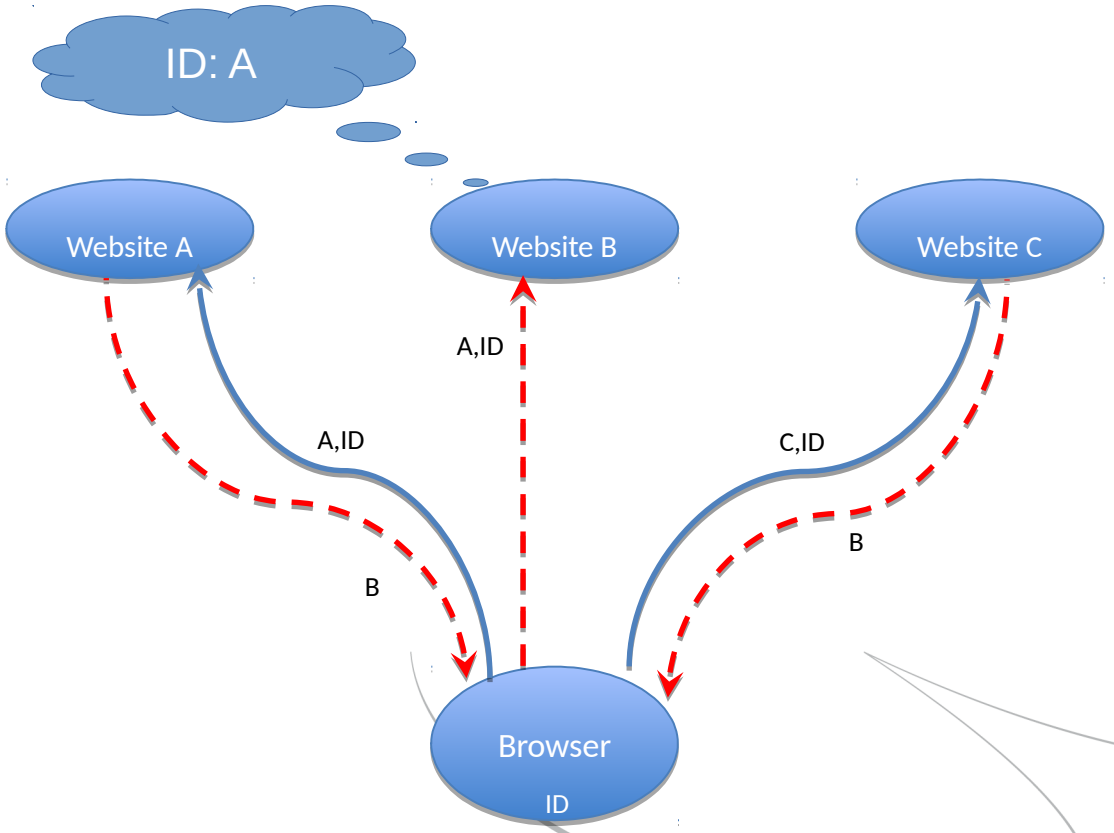

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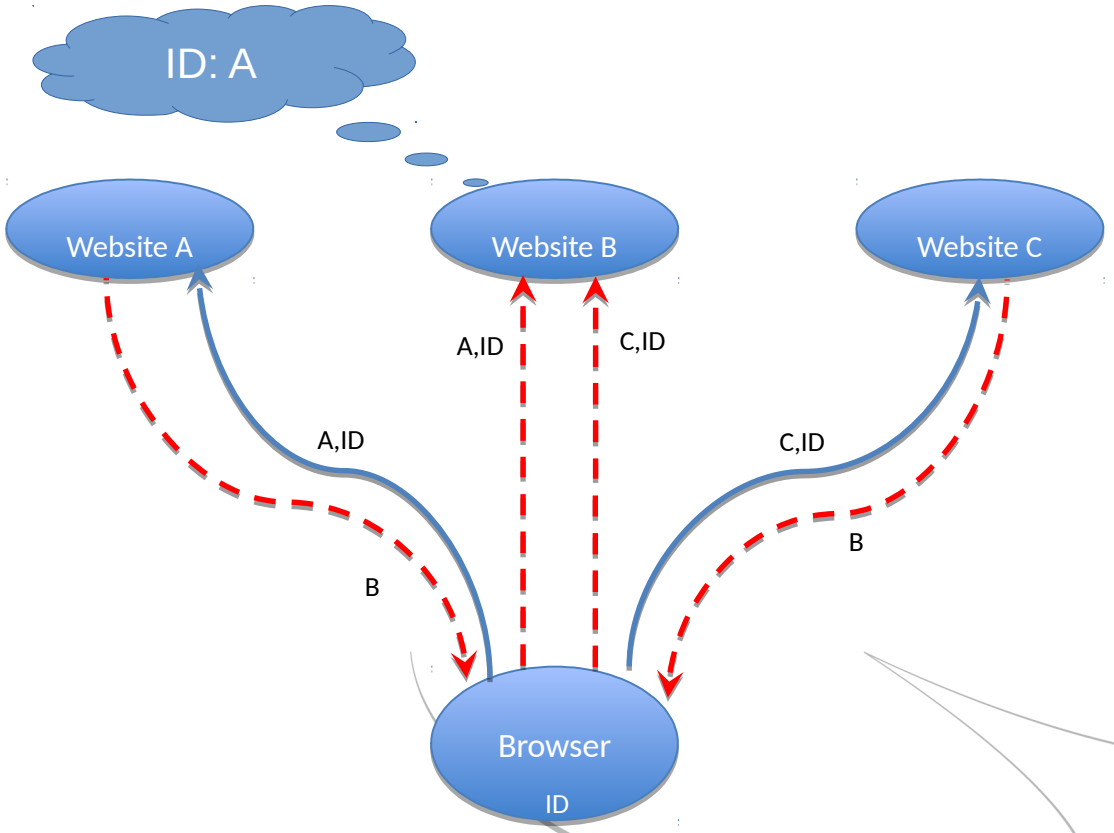

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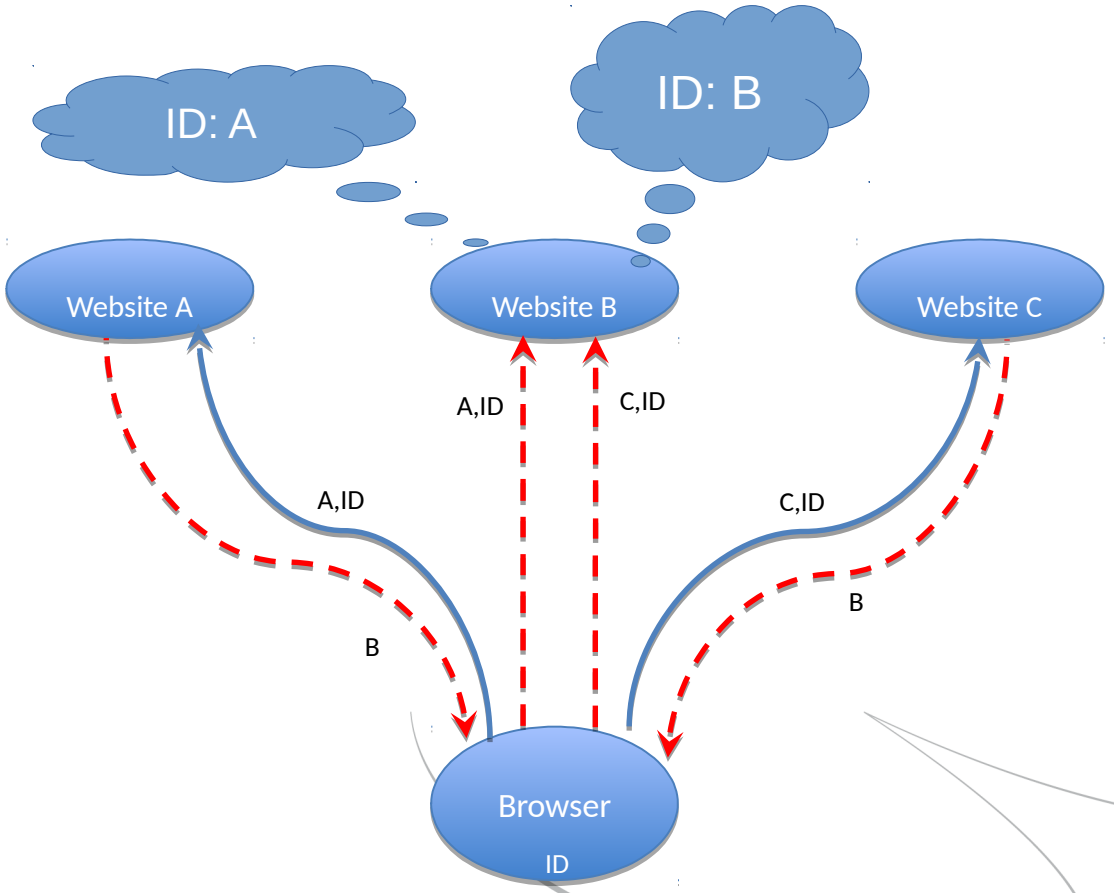

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How to track

- Client-side
  - Cookies / evercookies / zombiecookies / ...
  - History exploit / CSS tricks / ...
  - Active fingerprinting
- Server-side only
  - Web bugs
  - Passive fingerprinting

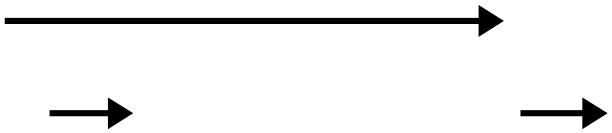
Why fingerprinting?

- Cookies: client-side storage.
- Fingerprinting:
  - Passive: infer info from server side.
  - Active: gather info from client side on-the-fly.

- Actually in use?
  - [S&P13, CCS13]: some, but not much... yet.

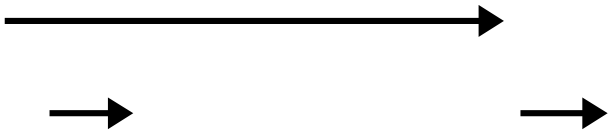
Related work

Panopticlick [PETS10]



Panopticlick [PETS10]

- Effectiveness of fingerprinting



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Panopticlick [PETS10]

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- Defensive paradox

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Panopticlick (2)

Test	Entropy (bits)
user-agent header	10.00
plugins	15.40
fontlist	13.90
screen resolution	4.83
supercookie test	2.12
http accept headers	6.09
timezone	3.04
cookies enabled?	0.35

Panopticlick (2)

Test	Entropy (bits)	
user-agent header	10.00	←
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Mozilla/5.0 (Windows; U; Windows NT 5.1; en-US; rv:1.9.1.3) Gecko/20090824 Firefox/3.5.3 (.NET CLR 3.5.30729)

More ways to fingerprint

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[W2SP11] – fingerprinting JavaScript implementations
Hooray for the speedwars!

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“Foutje, bedankt.”

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Clock skew can be passively detected, proxies don't help.

Fighting fingerprinting

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- Do Not Track header? [NSDI12]: **X**

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- Do Not Track header? [NSDI12]: **X**
- Blacklisting fingerprinters? [W2SP11]: **X**

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- Tor Browser? [CCS13]: **X**

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- Again: defensive paradox.

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Privacy plugins

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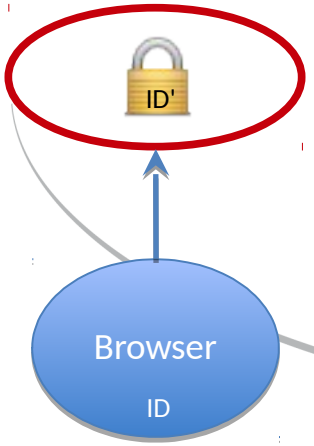
Typical countermeasures



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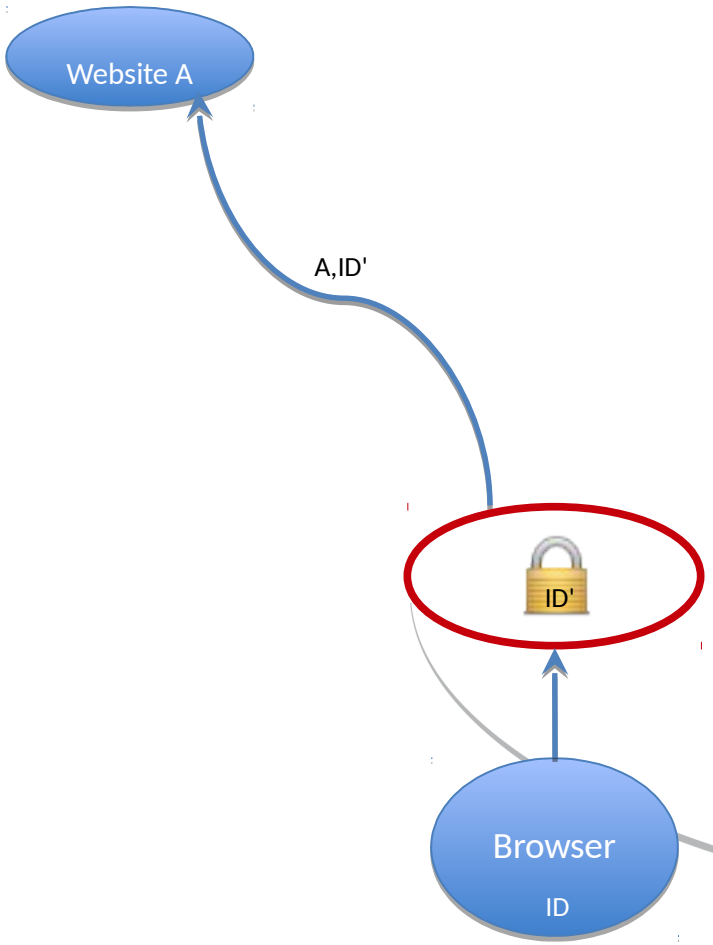

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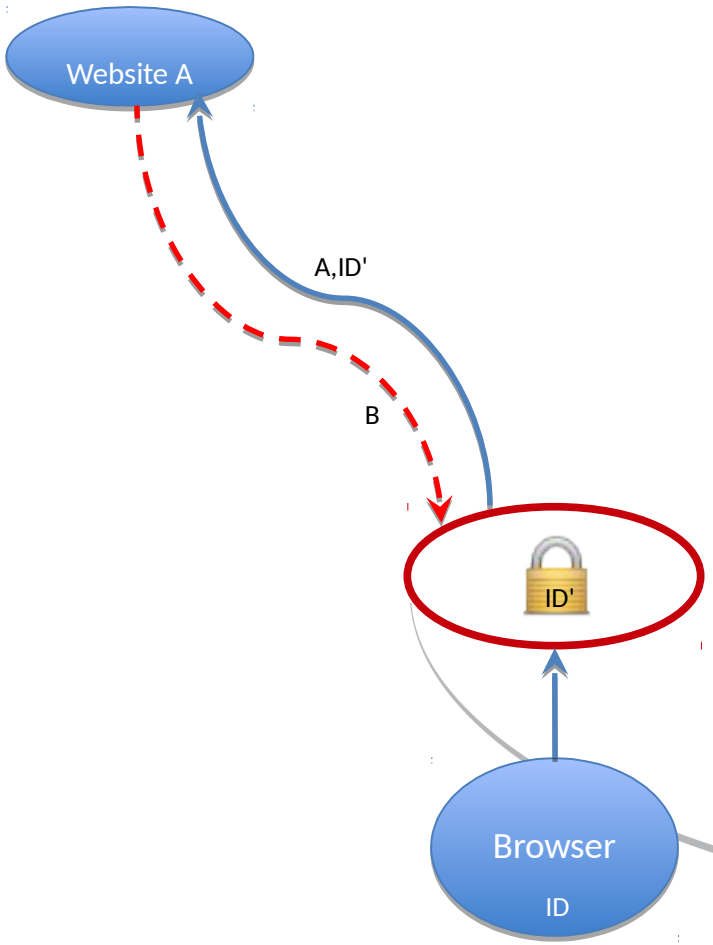

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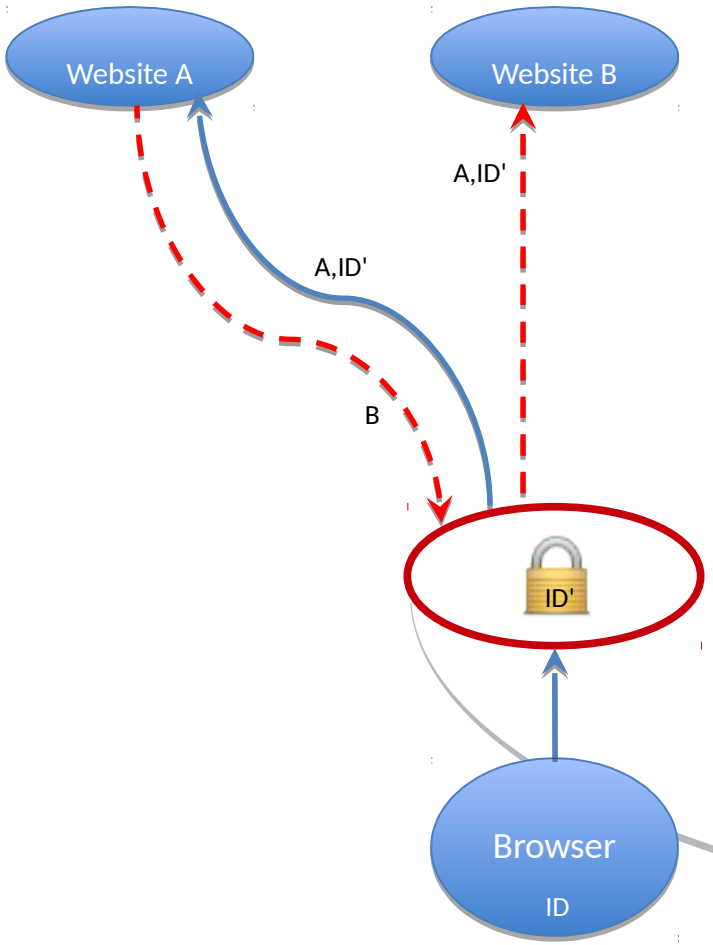

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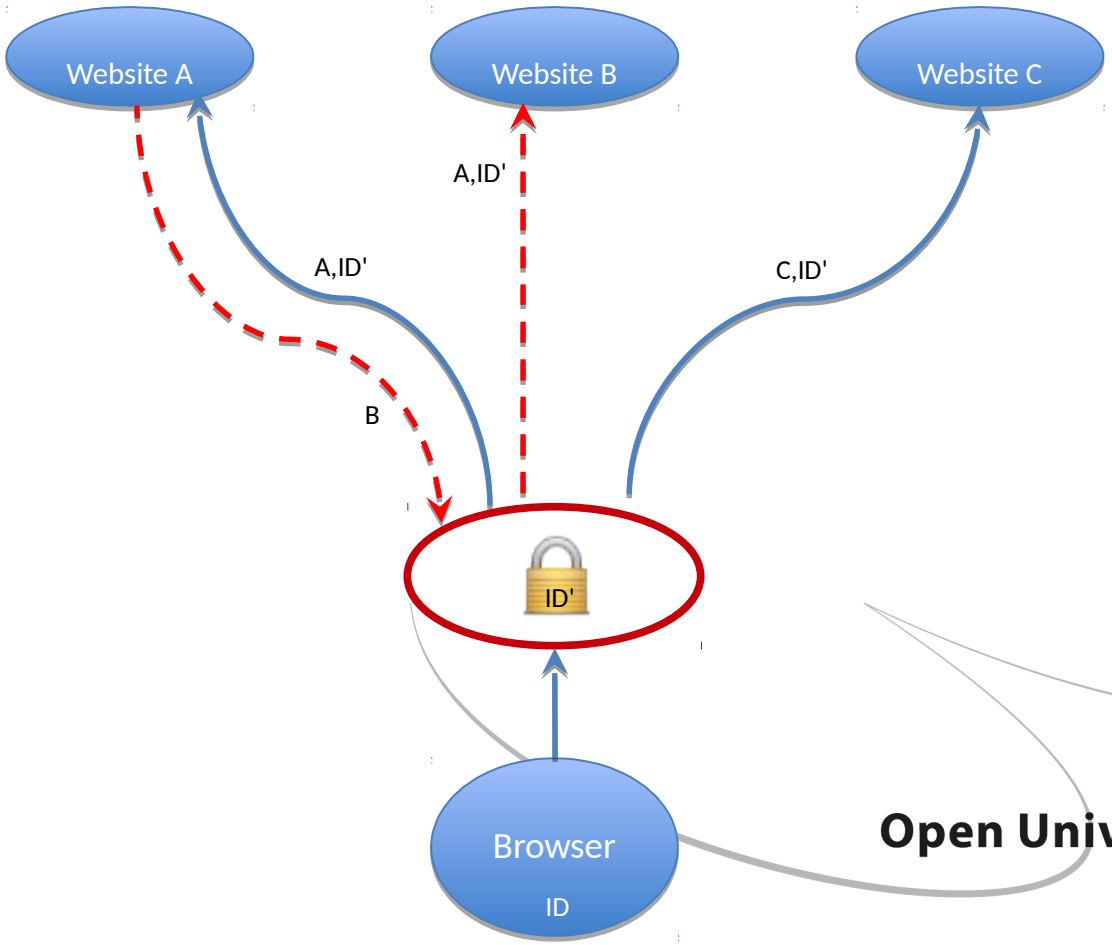

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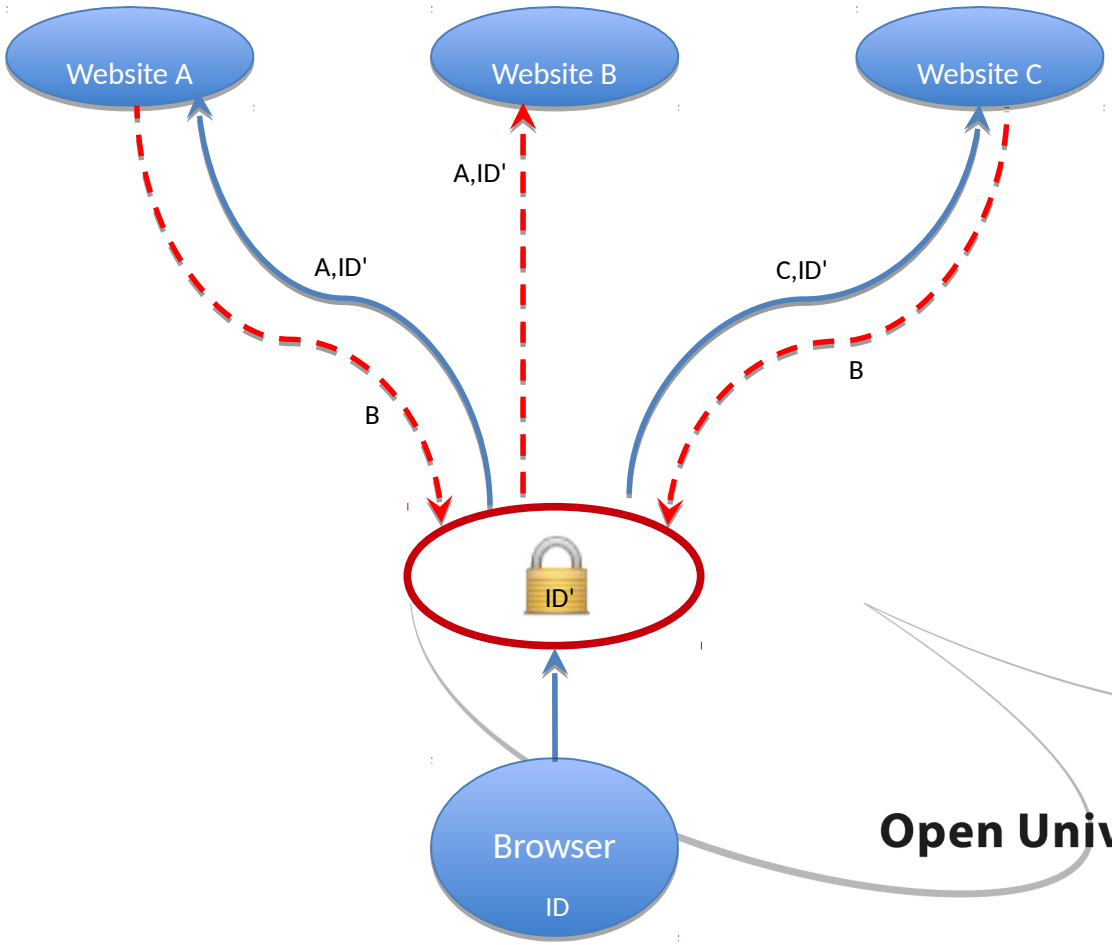

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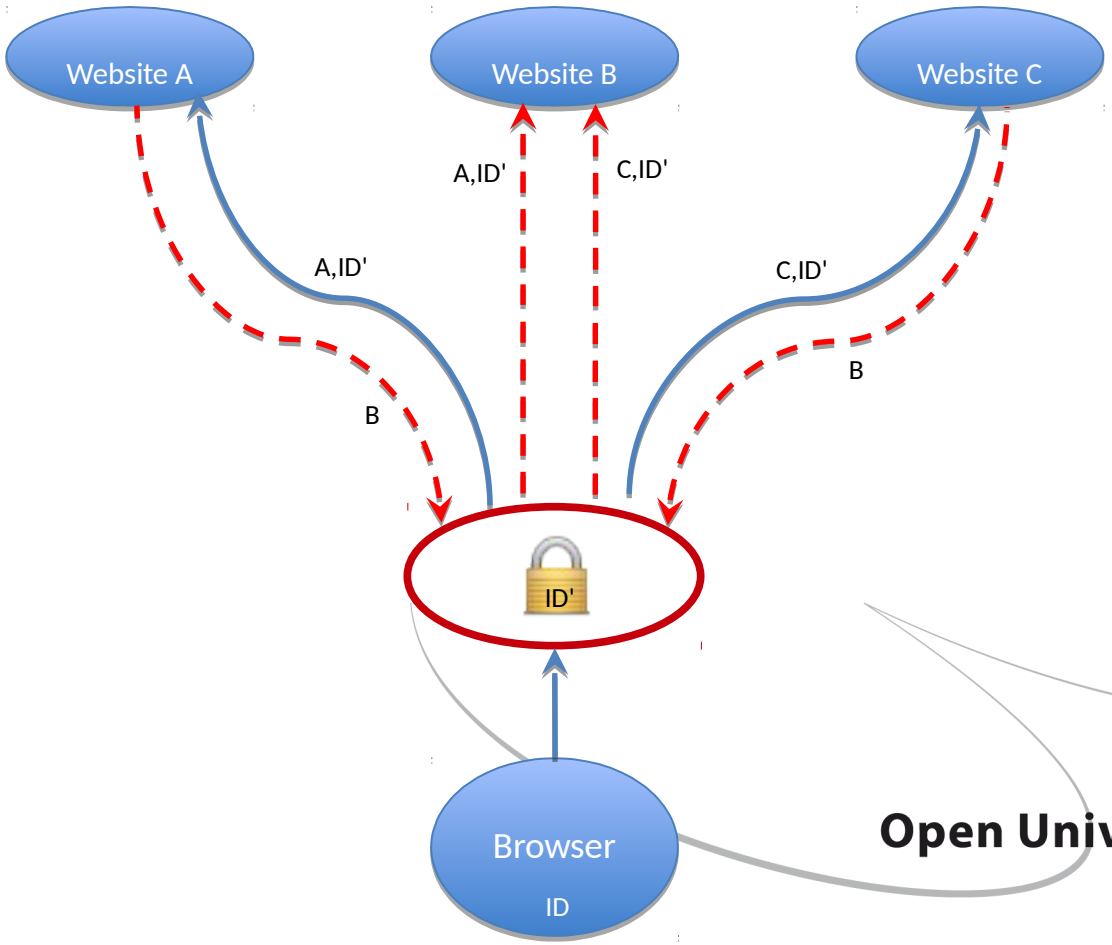

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Overcoming the defensive paradox

The defense can be detected …

... which makes you more unique.

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Overcoming the defensive paradox

The defense can be detected …

... which makes you more unique.

How to overcome?

- Leverage this uniqueness;
- Allow local tracking.

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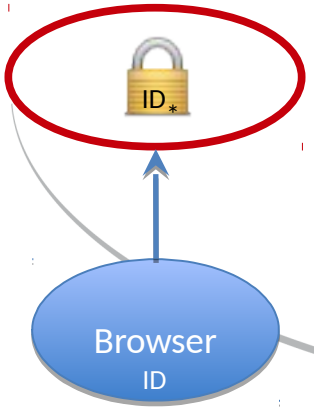
Option 1: constant fingerprint / site



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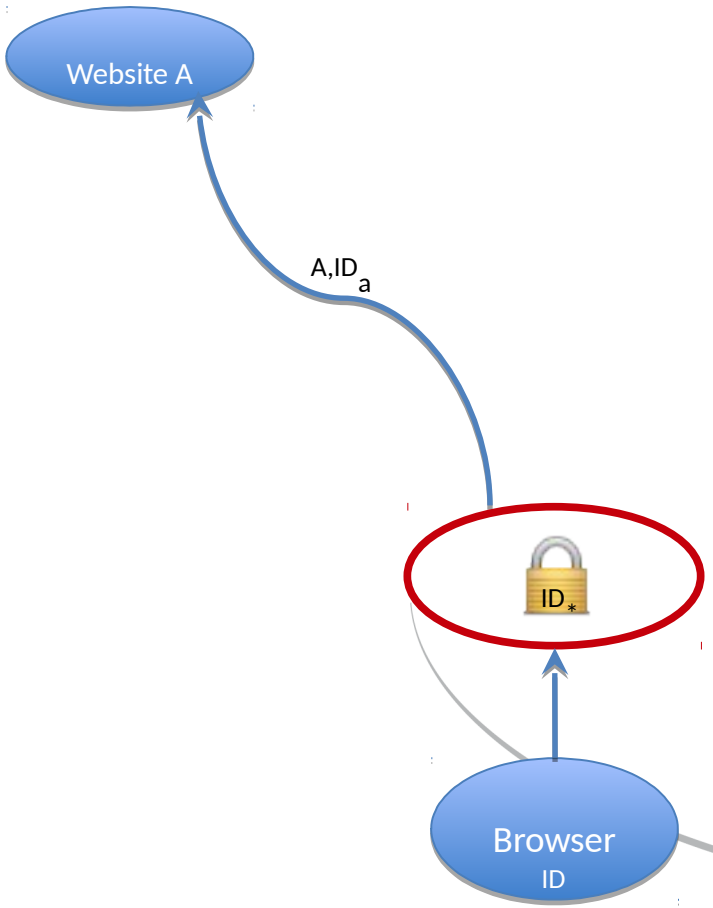

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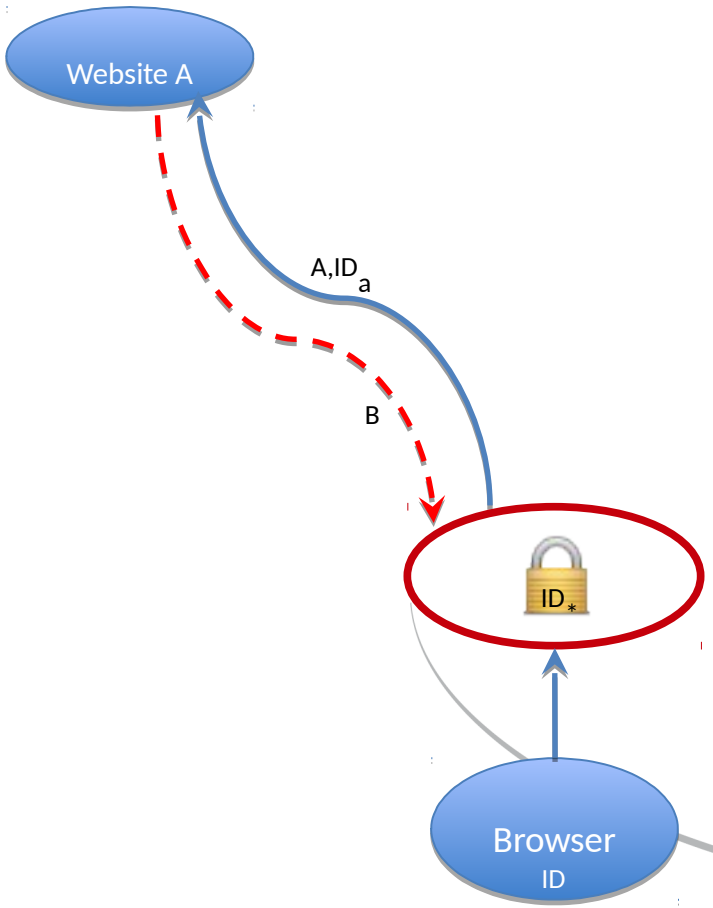

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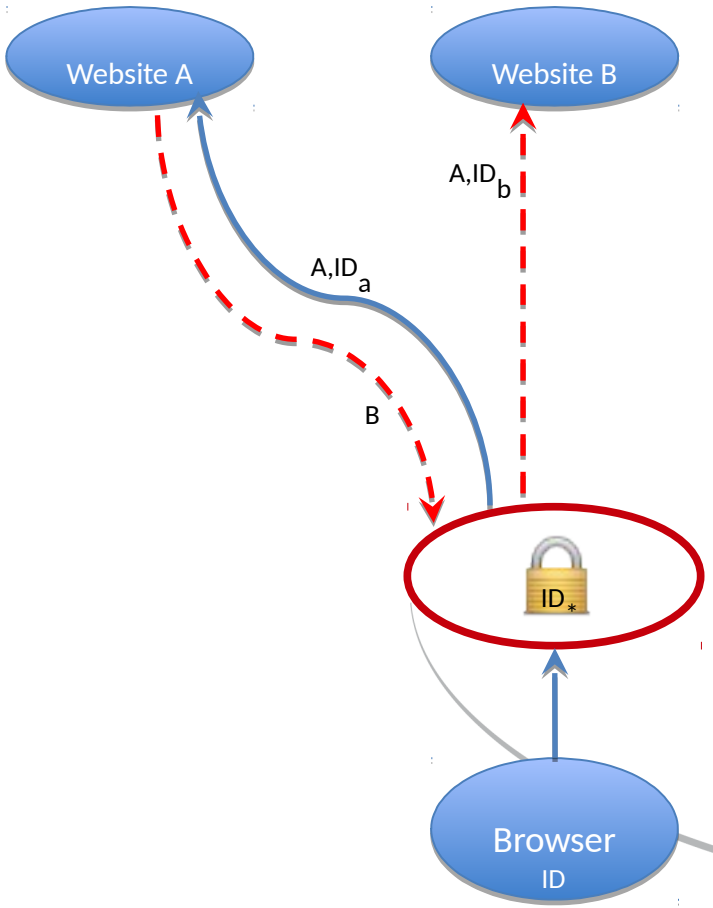

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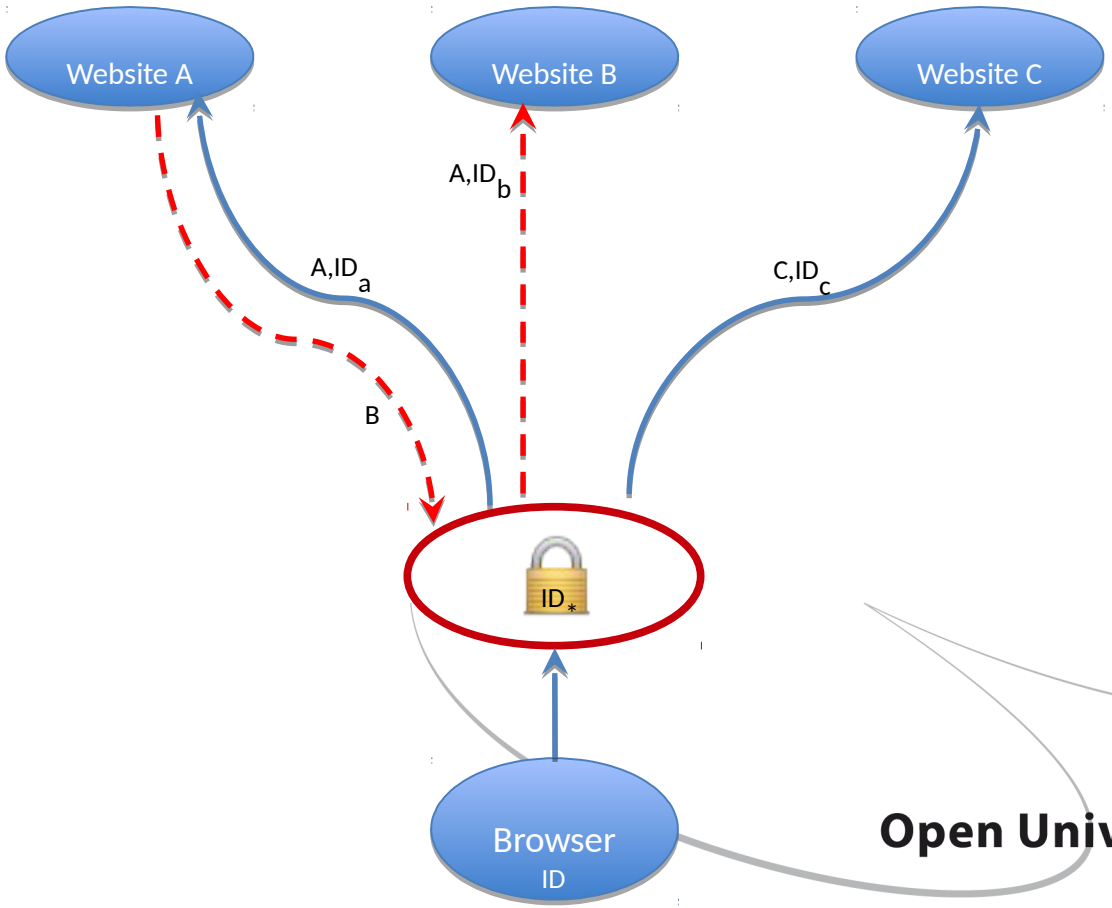
Option 1: constant fingerprint / site



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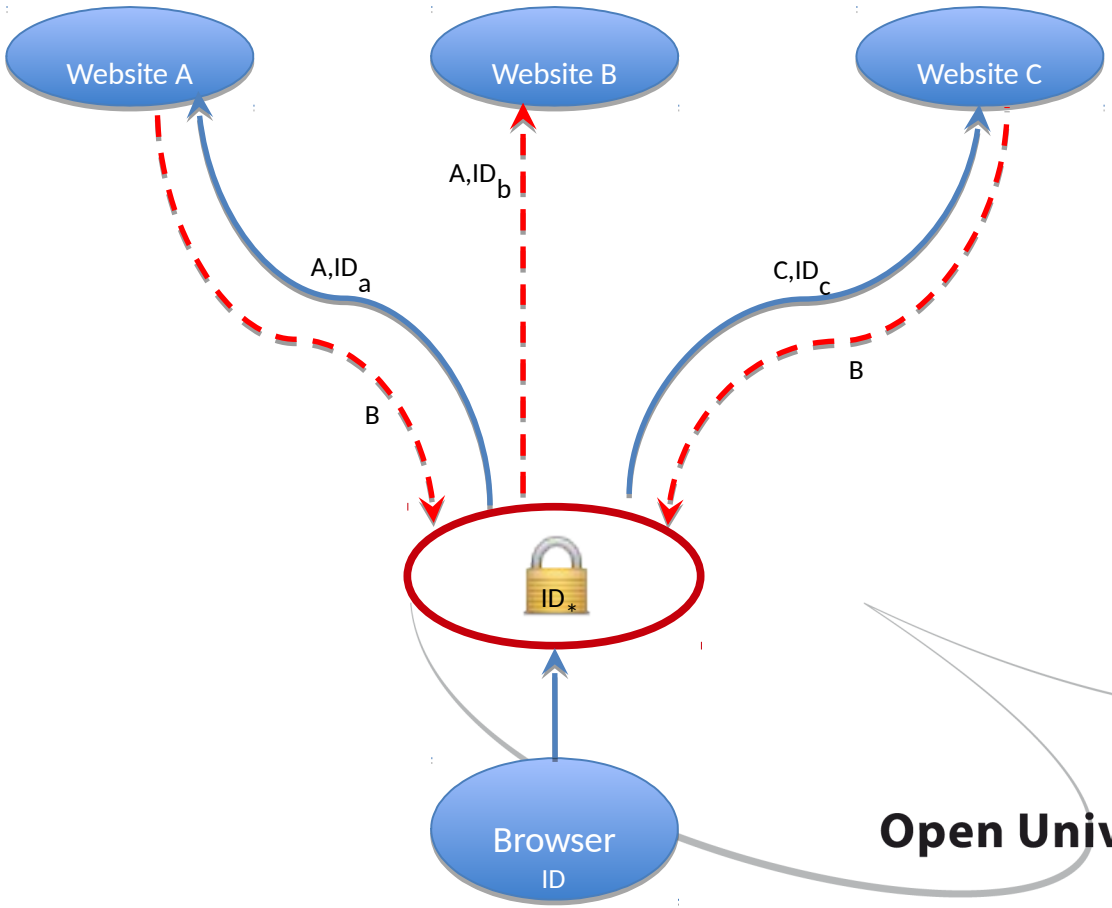
Option 1: constant fingerprint / site



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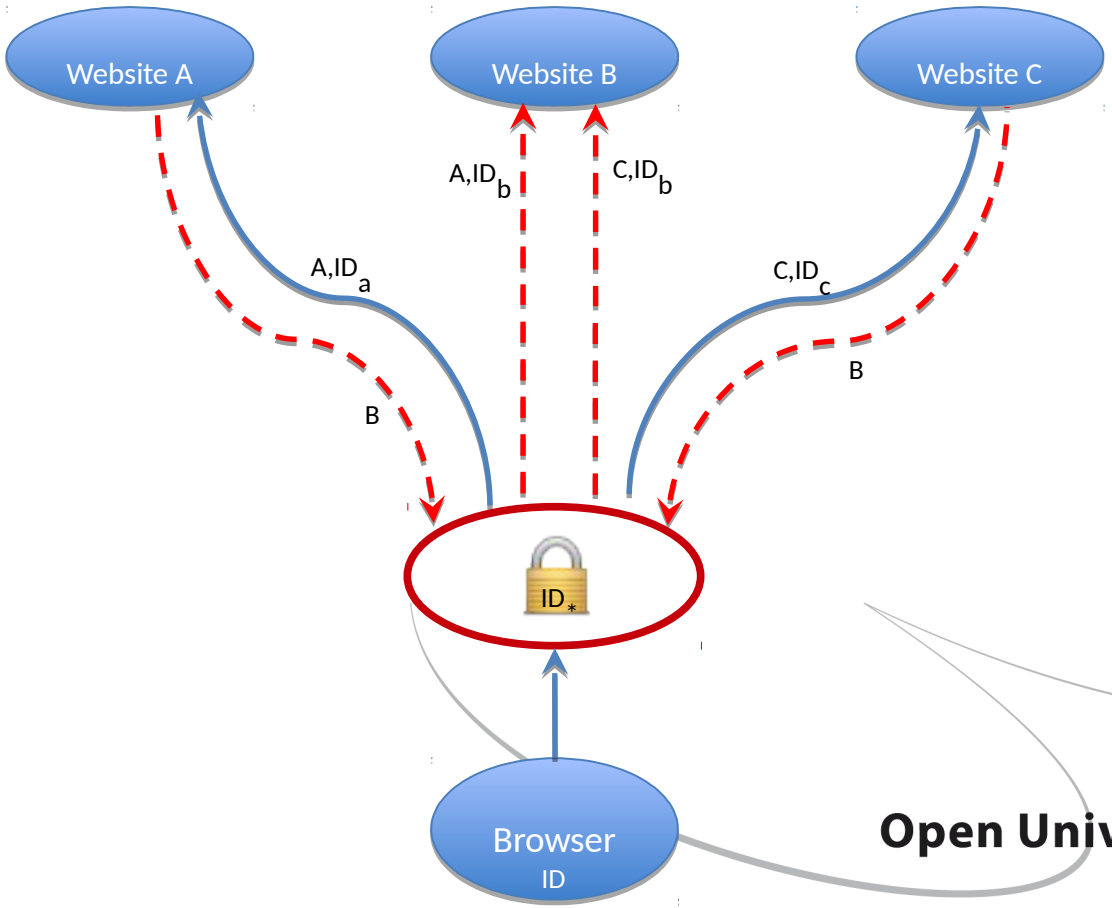
Option 1: constant fingerprint / site



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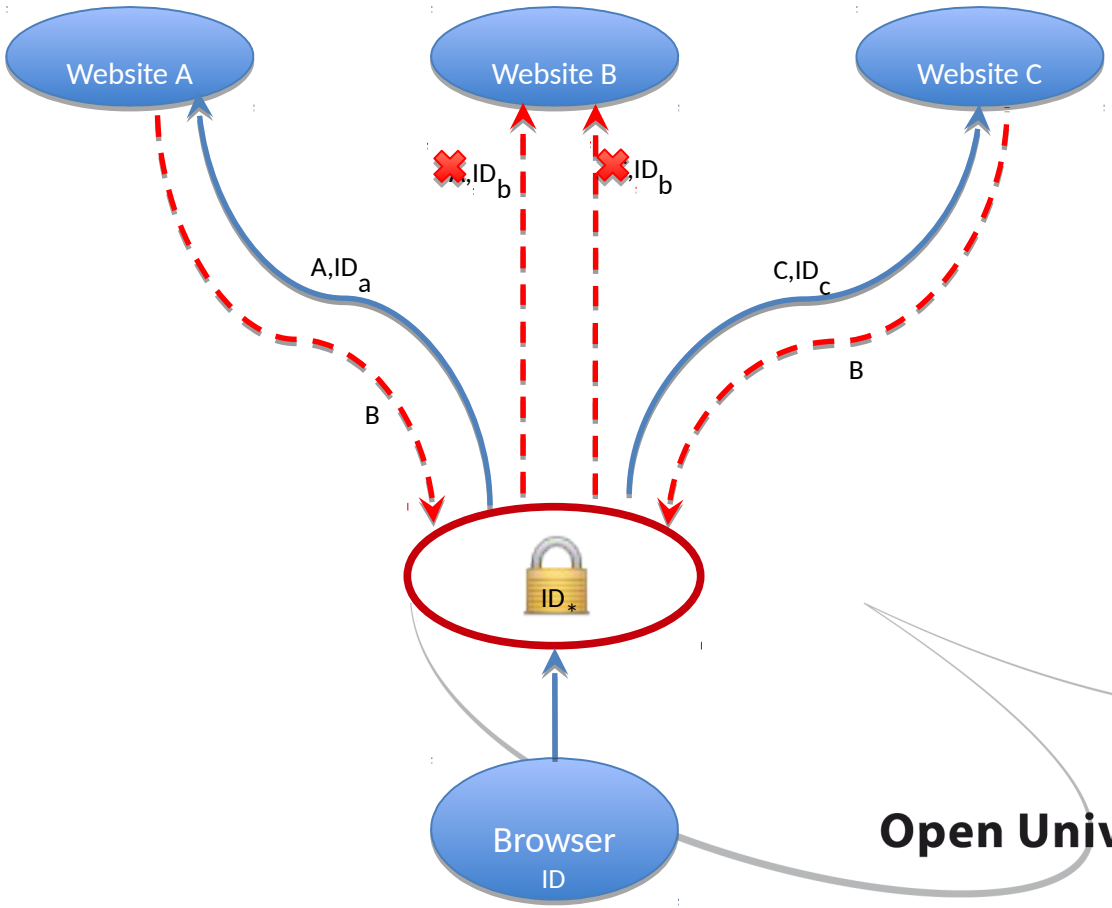
Option 1: constant fingerprint / site



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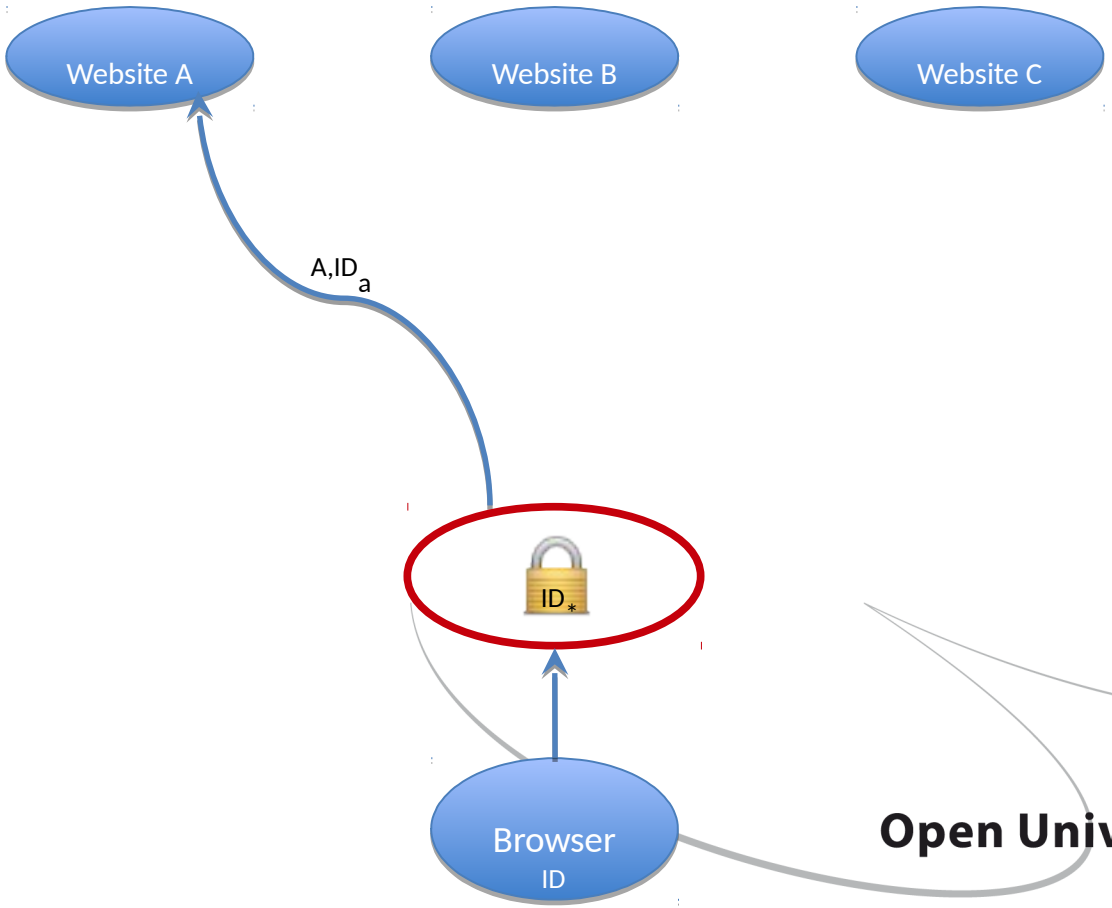
Option 1: constant fingerprint / site



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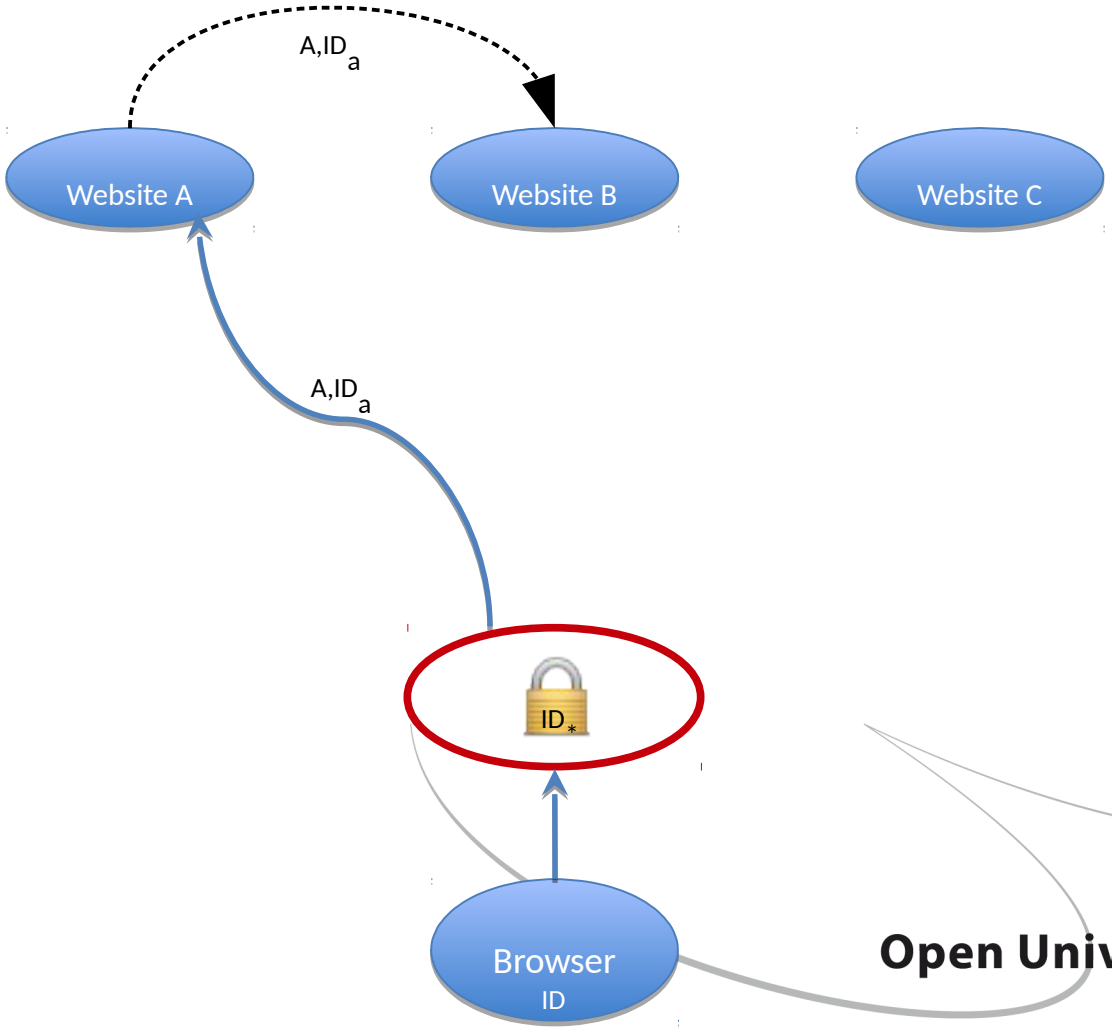
Option 1: constant fingerprint / site



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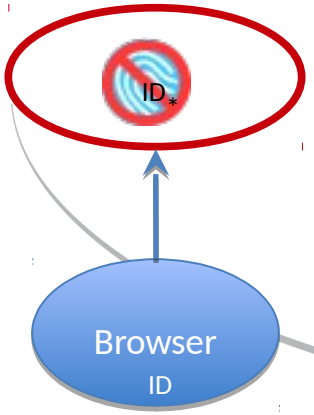
Option 2: separate web identities



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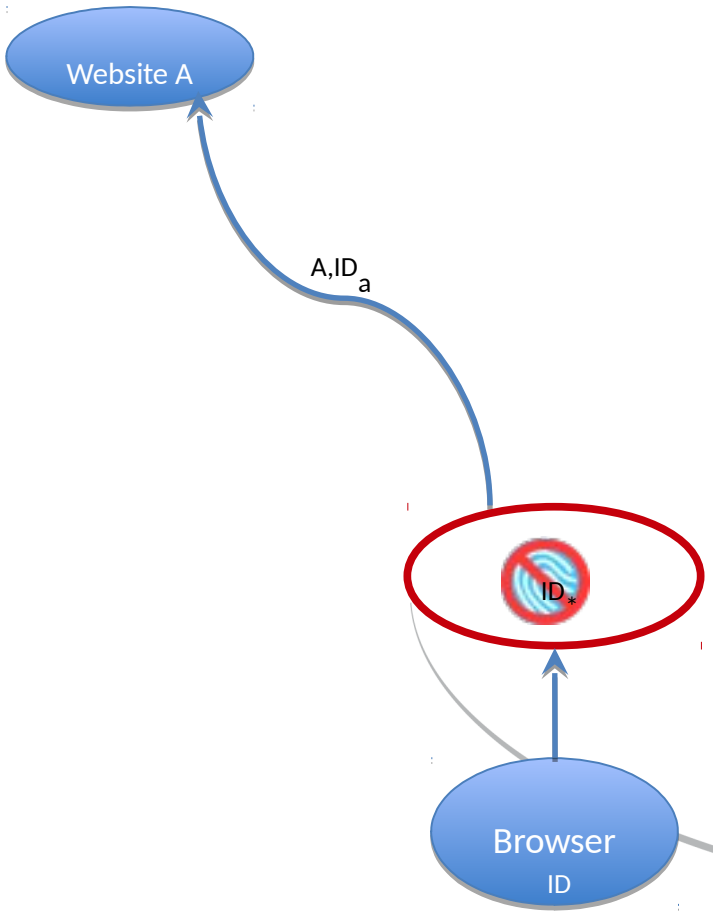
Option 2: separate web identities



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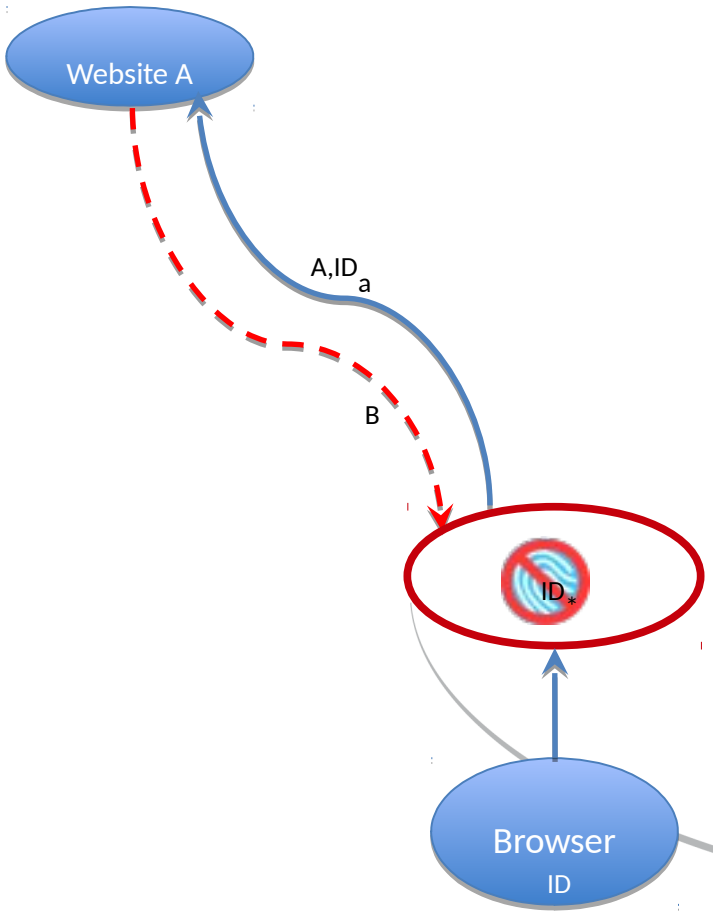
Option 2: separate web identities



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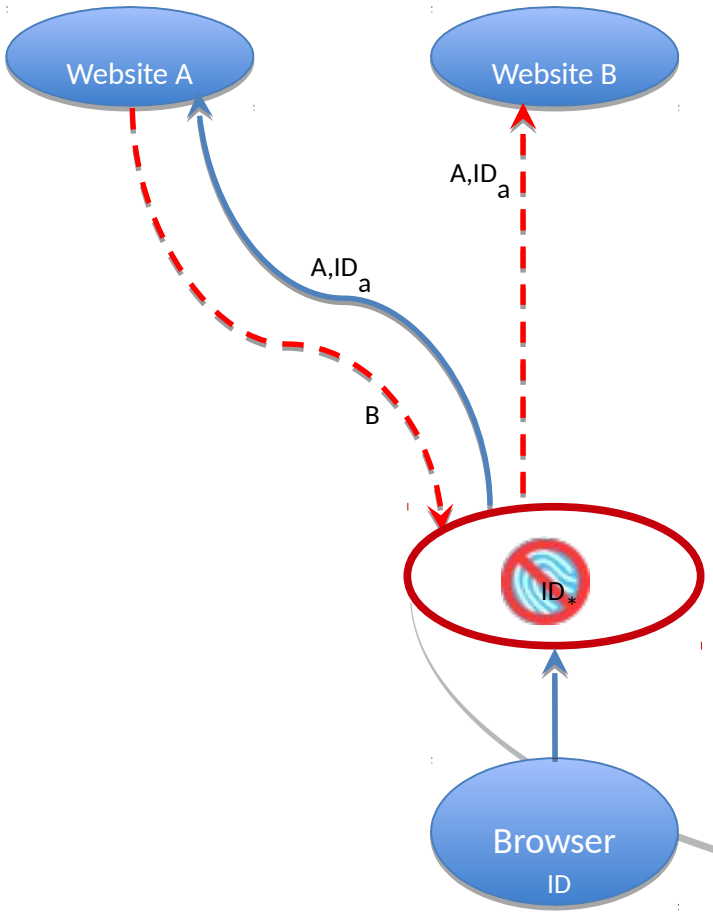
Option 2: separate web identities



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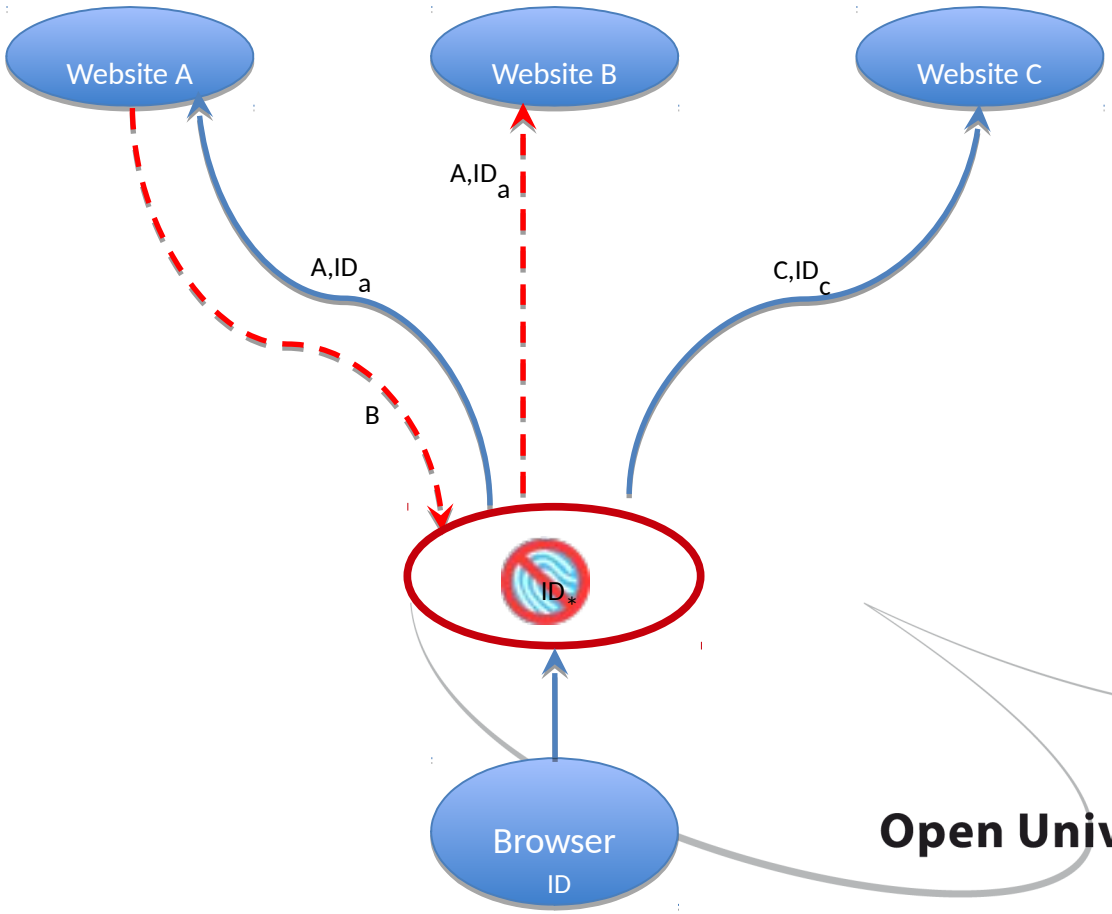
Option 2: separate web identities



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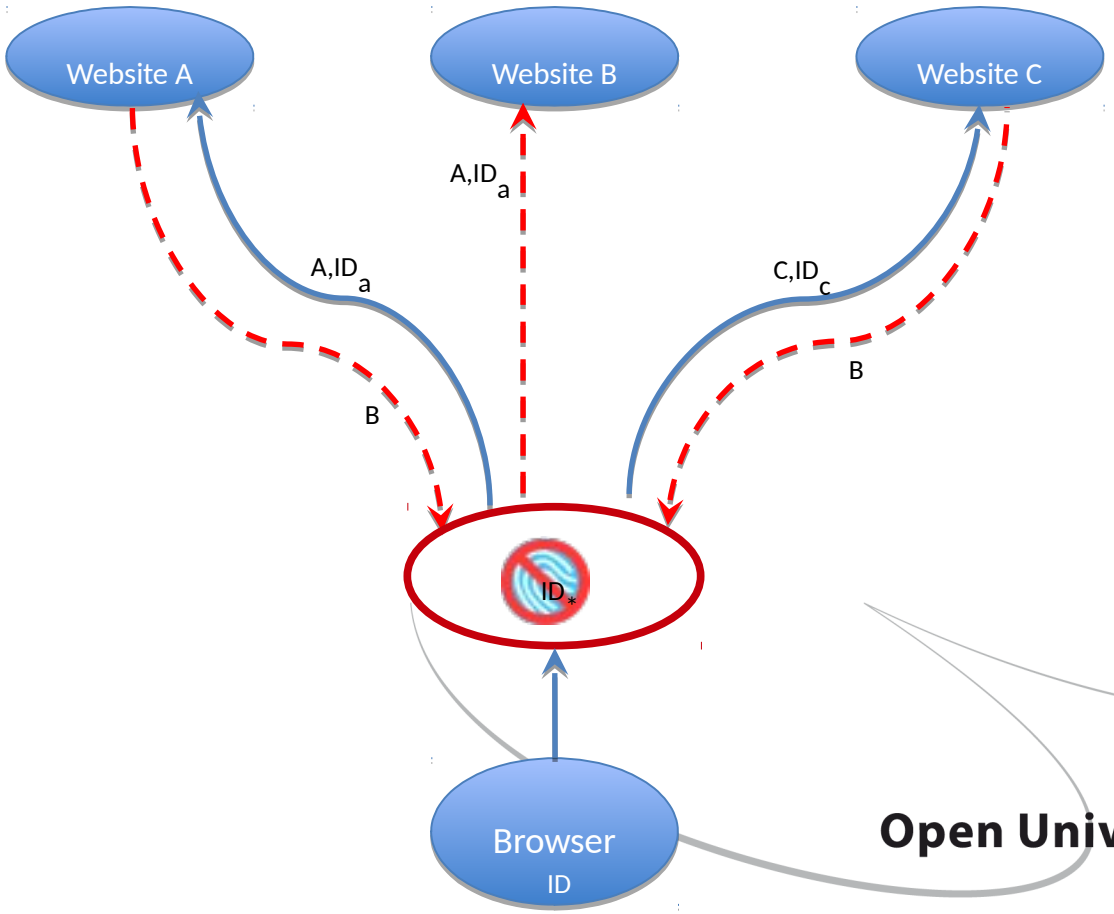

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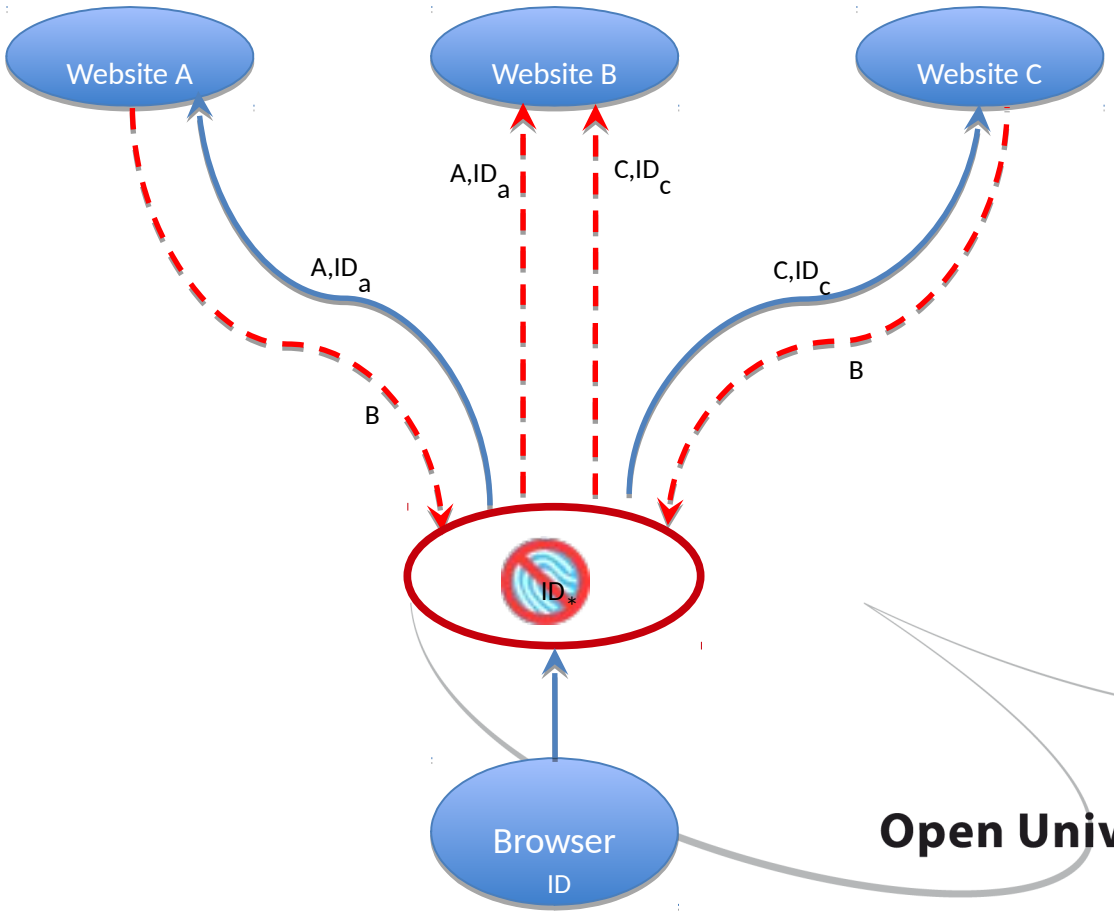
Option 2: separate web identities



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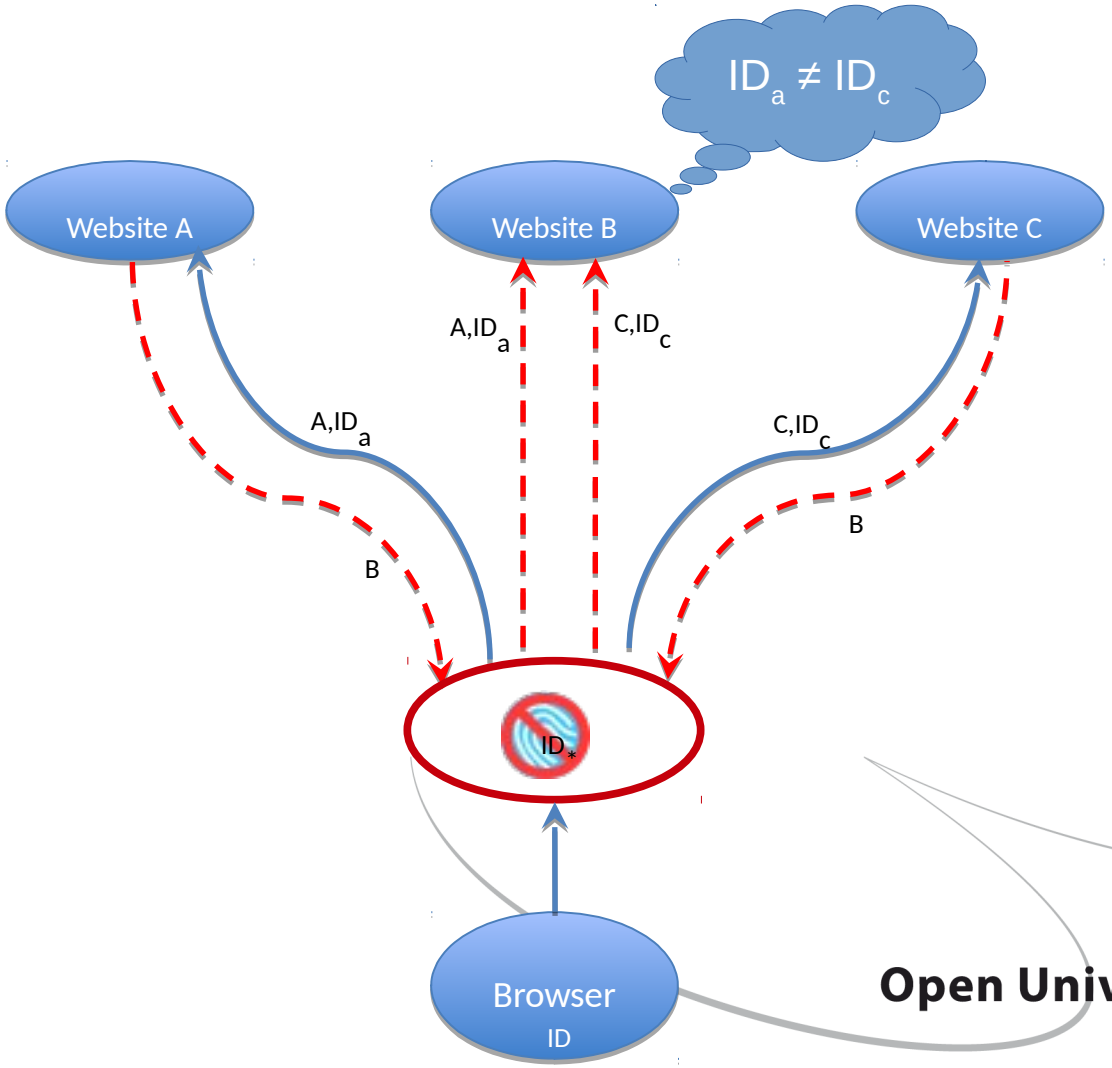
Option 2: separate web identities



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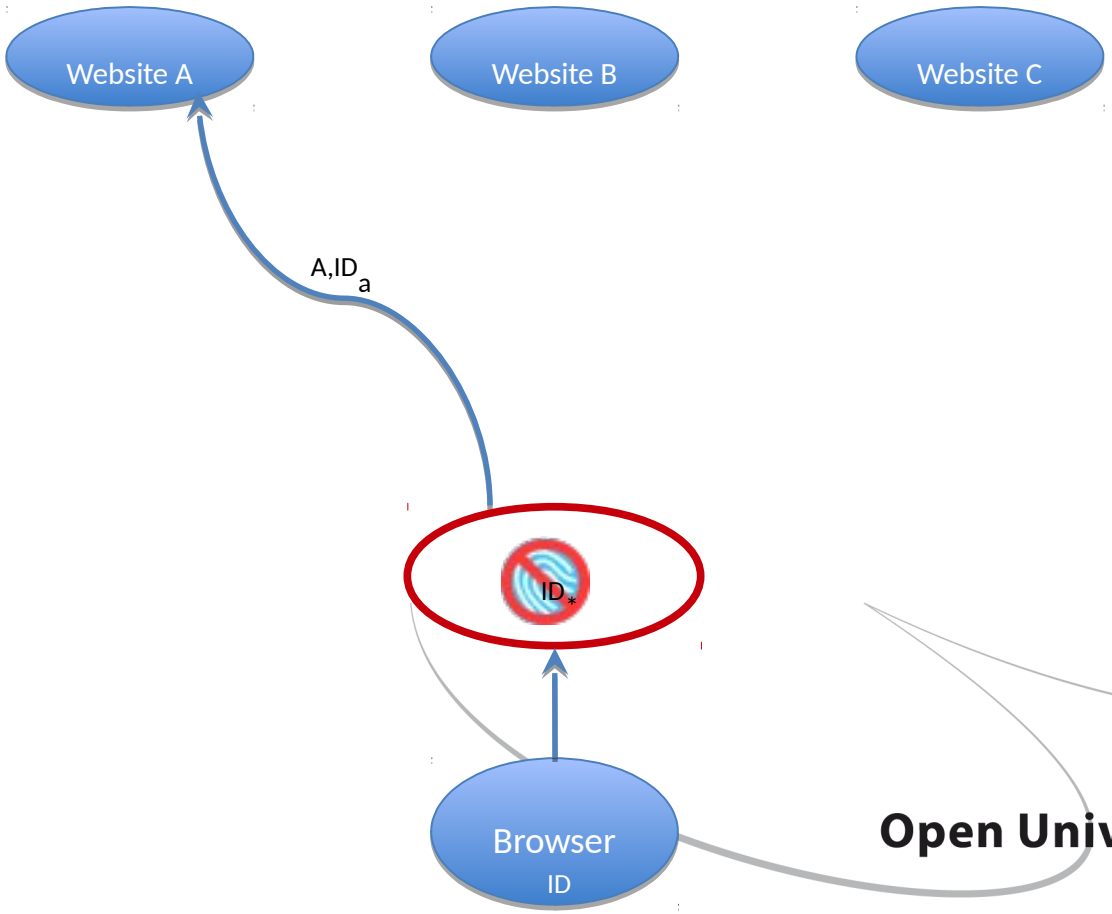

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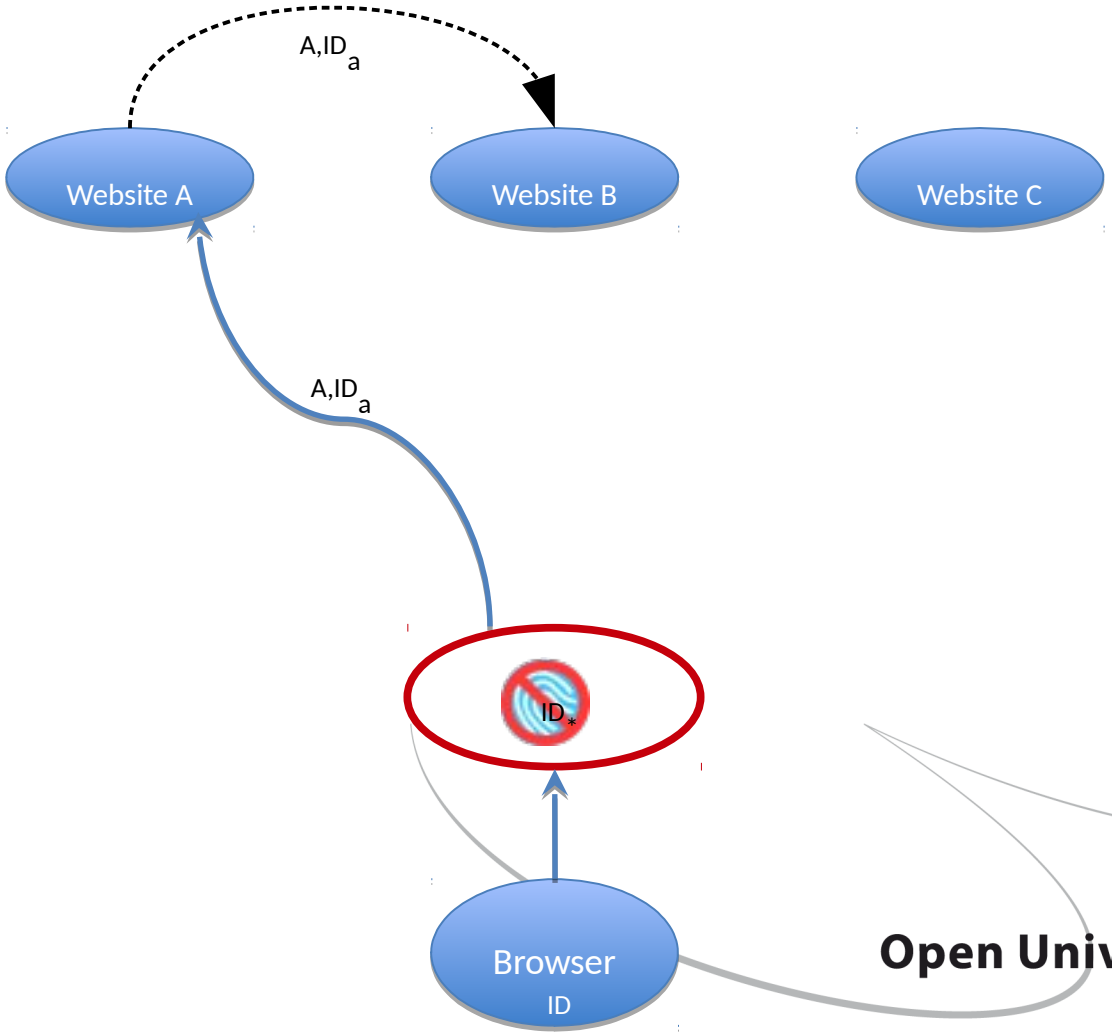

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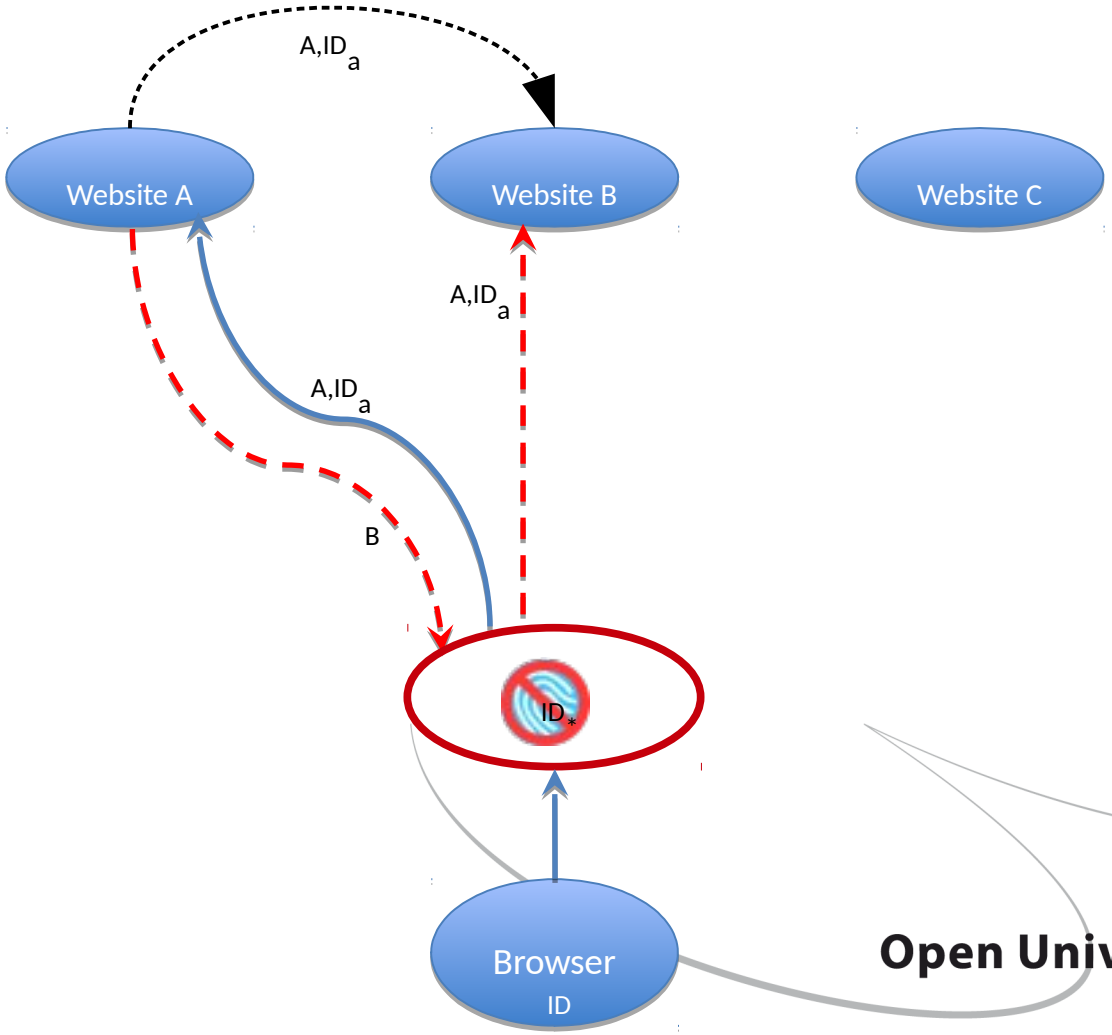

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Determining the fingerprint surface

Theoretical argument:

If there is one computer used directly by everyone at the same time, then fingerprints might be indistinguishable.

Practice

- Different physical locations
- Different hardware
- Different software

complete coverage infeasible → determine fingerprint vectors

Fingerprinters

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

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

Attribute	Pan	BC	IO	TM	Add	FPjs
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					✓	

Proof-of-concept: FP-Block plugin

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

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Fingerprint coverage

Footnotes:

- Property can be checked passively, i.e., no client-side technology required.
- Property specific to Internet Explorer.
- Property is determined using a Windows DLL created by the fingerprinting company.
- Out of scope – FP-Block only targets HTTP and Javascript layers.
- Blocking or spoofing this attribute would break or limit important functionality.

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

- Controlled test setup
  - 2 domains
  - On each: page embedding file from other domain
  - Generate fingerprint with fingerprintJS

- Real-life test setup
  - BC, IO, TM, fingerprintJS, Panopticlick, AddThis

- Additional test: BlueCava ID request

Monitoring evolution of fingerprinters

Updates since September 2014:

- Panopticlick –
- **BlueCava** –
- **AddThis** –
- **Iovation** **complex**
- FingerPrintJS added screen orientation
- **ThreatMetrix** **major changes since 27 oct '14**

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Conclusions

- Ubiquitous tracking is a reality
- Countermeasures fall short
- Local tracking is acceptable
  → overcomes defensive paradox

Results:

- Propose separation of web identities
- Determine fingerprint vectors
- Proof-of-concept implementation
- Validation against commercial fingerprinters

Thank you for your attention!

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