FP-Block

Usable web privacy via fingerprint

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

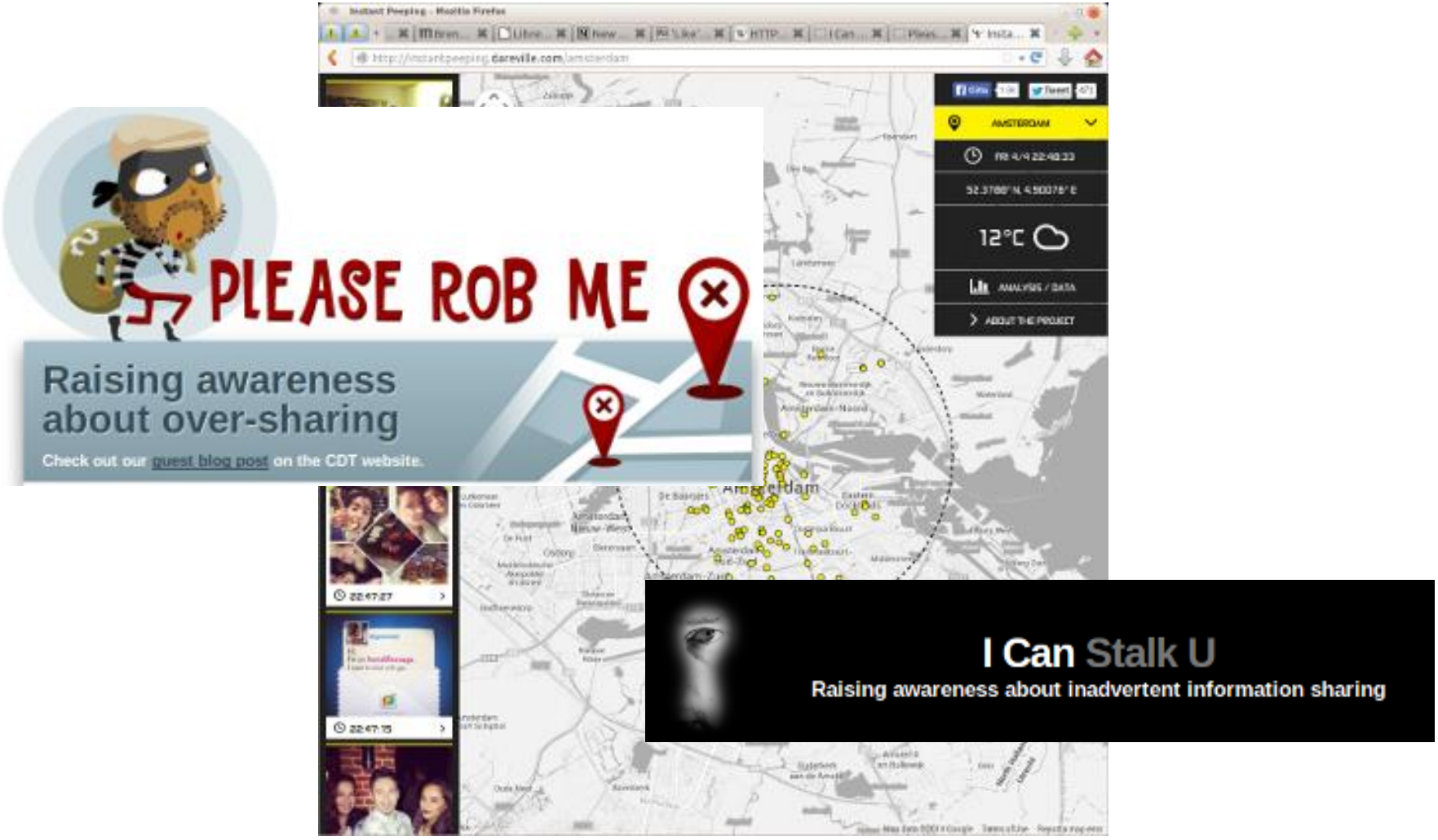
First

Privacy does not need to be motivated.

Violation of privacy needs to be motivated.

see also *Je hebt wél iets te verbergen - Maurits Martijn & Dimitri Tokmetzis*
https://kiosk.decorrespondent.nl/products/je-hebt-wel-iets-te-verbergen-boek

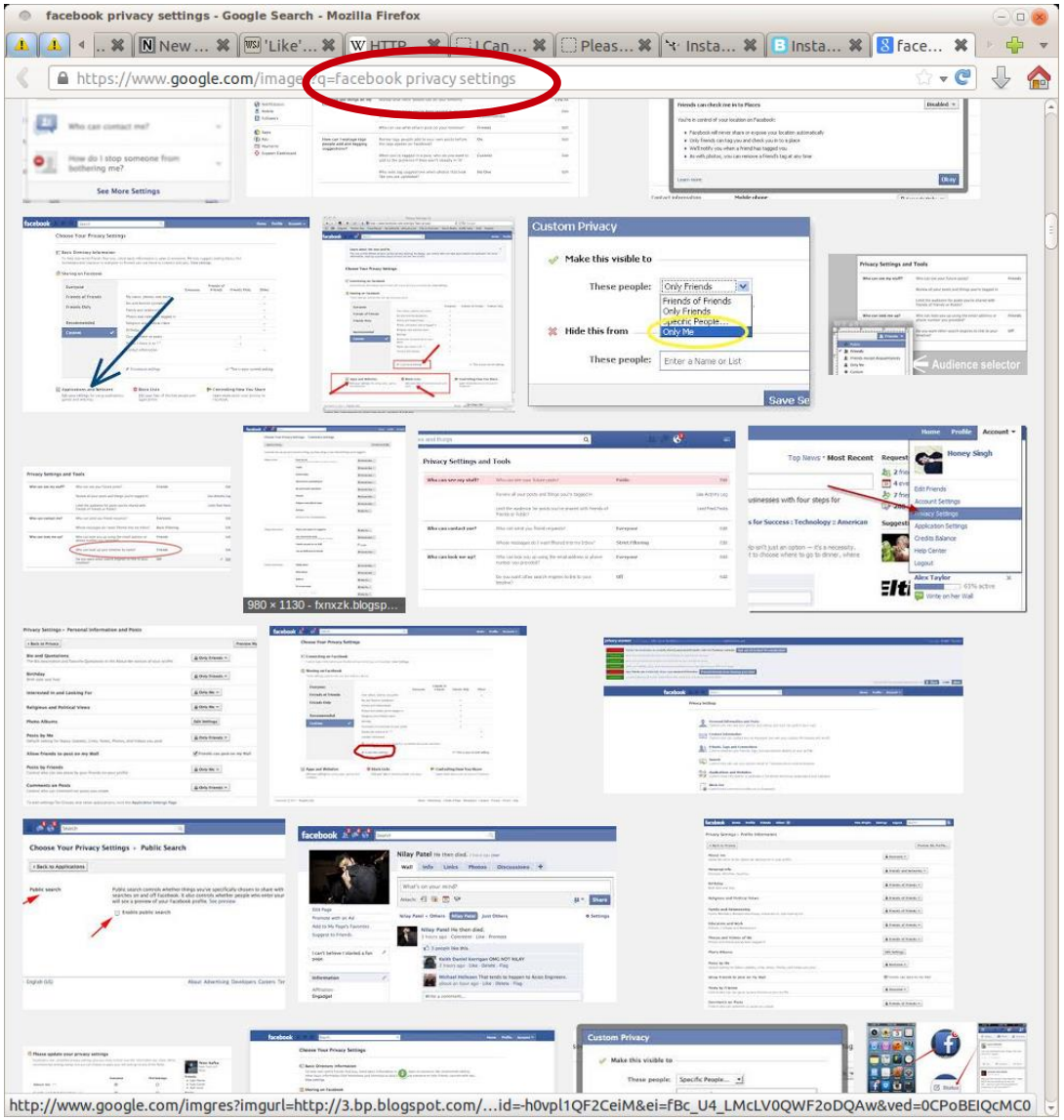
We're not really good at privacy



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

Note: account number can suffice for withdrawal

Privacy is hard



Privacy is **really** hard

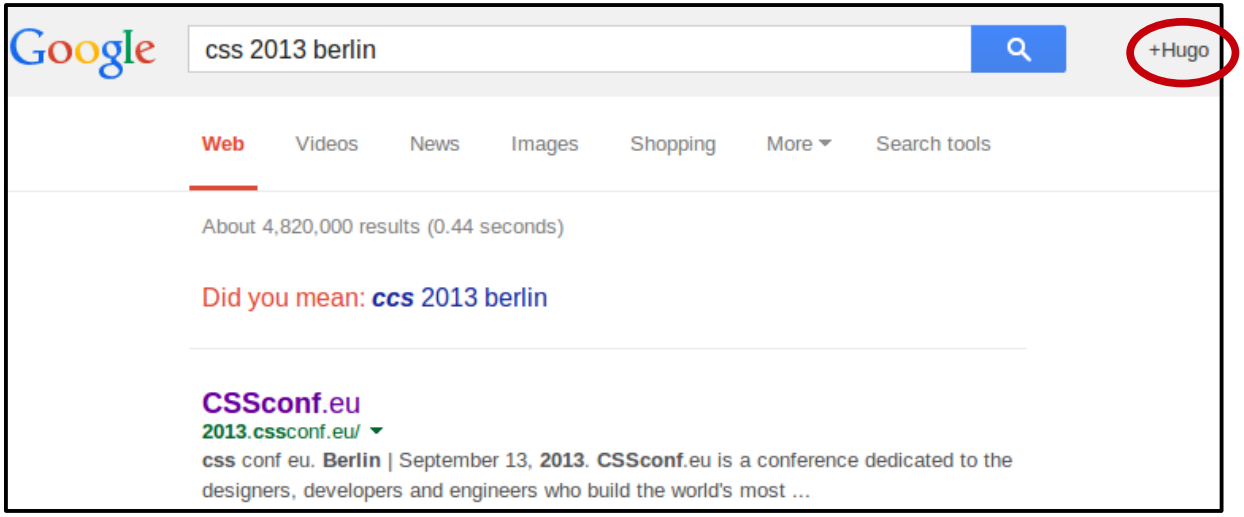
*"Another thing which is just an observation, when I was working on the **blocking of the social plugins**, I always used the [redacted] website to test my implementation. Today **Facebook suggested** me on my phone the **group of** [redacted]."*

– Bachelor student

Privacy is **really really** hard

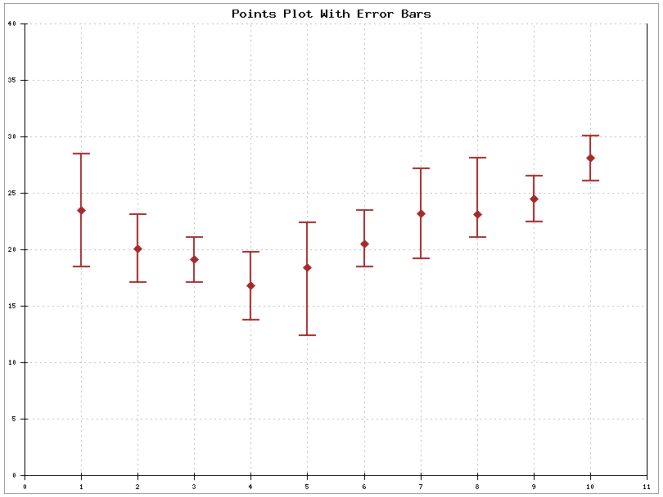
TECH | 2/16/2012 @ 11:02AM | 2,398,698 views

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



Actually, what is privacy?

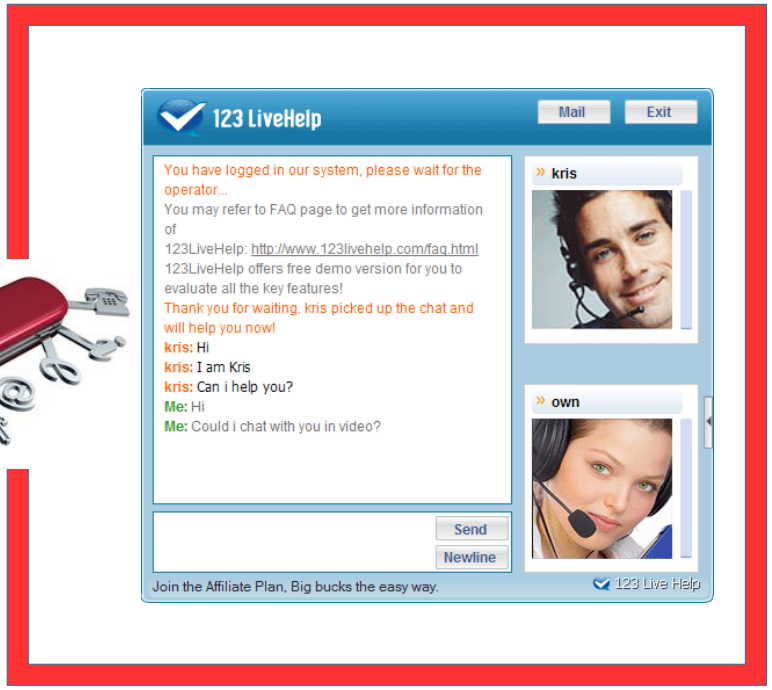
- Privacy is secrecy wrt. someone
- Two aspects:
  - (in)distinguishability
  - (un)certainty



Did privacy become harder?

In a nutshell

≈



Contributions

- New paradigm for online privacy
- Distinguish between local and cross-domain tracking
- Fingerprint privacy via separating web identities
- Determined common fingerprint vectors

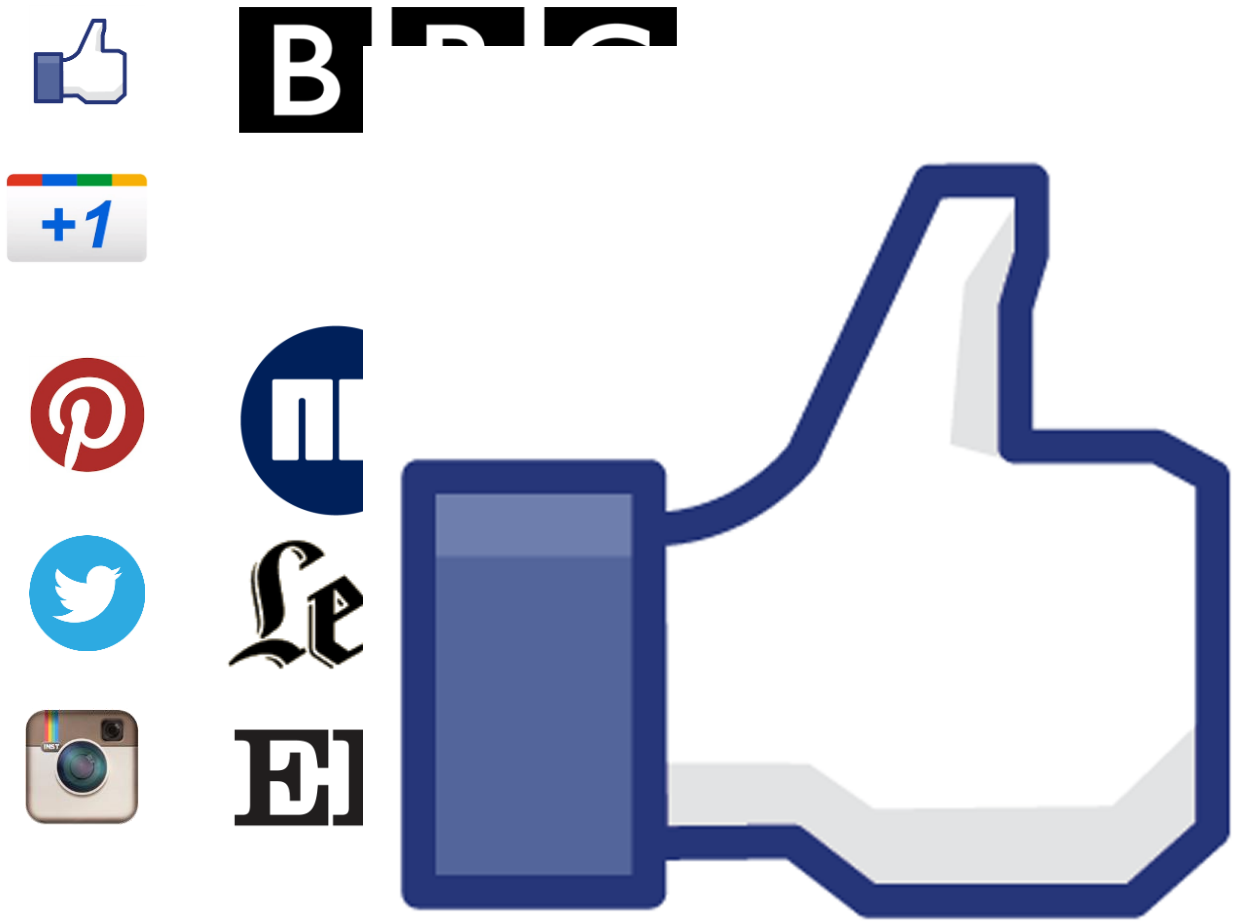
- Proof-of-concept implementation
  - https://github.com/ChristofTorres/FP-Block
  - effective against commercial fingerprinters

Web tracking

Tracking is good!

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

However...



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
1.Akamai		17%
2.Doubleclick		10%
3.Google Analytics	19%	
4.YouTube		26%
5.Facebook Like*	20%	
6.PayPal button		33%
7.JQuery		18%

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

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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.

- Effective?
  - [PETS10]: 90% desktop browsers is unique.
- Actually in use?
  - [S&P13, CCS13]: some, but not much... yet.
  - **Firefox 42 Beta added “tracking protection”**

Effectiveness of fingerprinting [PETS10]

- 90% of desktop browsers unique
- No JS ⟶ better results
- Mobile ⟶ less plugins ⟶ better results

- Fingerprints change...
- ...predecessor found in 65% (99.1% correct)

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

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.

Idea:

- local tracking okay,
- 3rd party tracking not

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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
- ...

“Fingerprint surface”

Non-profit:

- Panopticlick - academic study
- FingerPrintJS - open source

Commercial:

- AddThis - social media buttons
- BlueCava - advertisements [S&P13]
- Iovation - fraud prevention [S&P13]
- ThreatMetrix - fraud prevention [S&P13]

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

- 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
- MSIE Product key
- Device Enumeration
- Device Identifiers
- IP address
- HTML Body Behavior
- Battery
- WebGLRenderingContext

static

IE specific

using DLL

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 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

Original canvas

+

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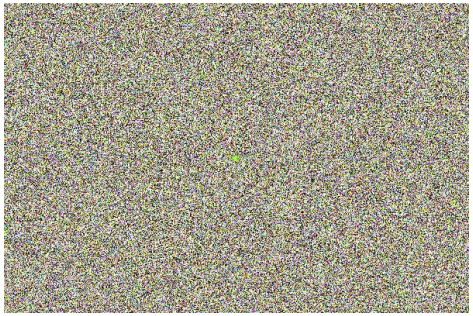


Attribute	FG	Tor	PV	RAS	FPB
Plugin Enumeration	✔	✔	✔		✔
Font Detection	✔	✔	✔	✔	✔
User-Agent	✔	✔		✔	✔
HTTP Header Accept					
HTTP Header Accept-Charset		✔			
HTTP Header Accept-Encoding				✔	✔
HTTP Header Accept-Language		✔		✔	✔
Screen Resolution	✔	✔		✔	✔
Timezone	✔	✔		✔	✔
Browser Language	✔				✔
OS & 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, Panopticlick, AddThis

- Actual test: BlueCava ID request

Monitoring evolution of fingerprinters

Sep 2014 – Sep 2015:

- Panopticlick –
- **BlueCava** *** (2 updates)**
- **AddThis** *** (many updates)**
- **Iovation** **35.7kb, 36.8kb, 35.7kb, 36.8kb, 36.7kb, 37.1kb**
- FingerPrintJS added screen orientation, *****
- **ThreatMetrix** **major changes since 27 oct '14**

Conclusions

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

Results:

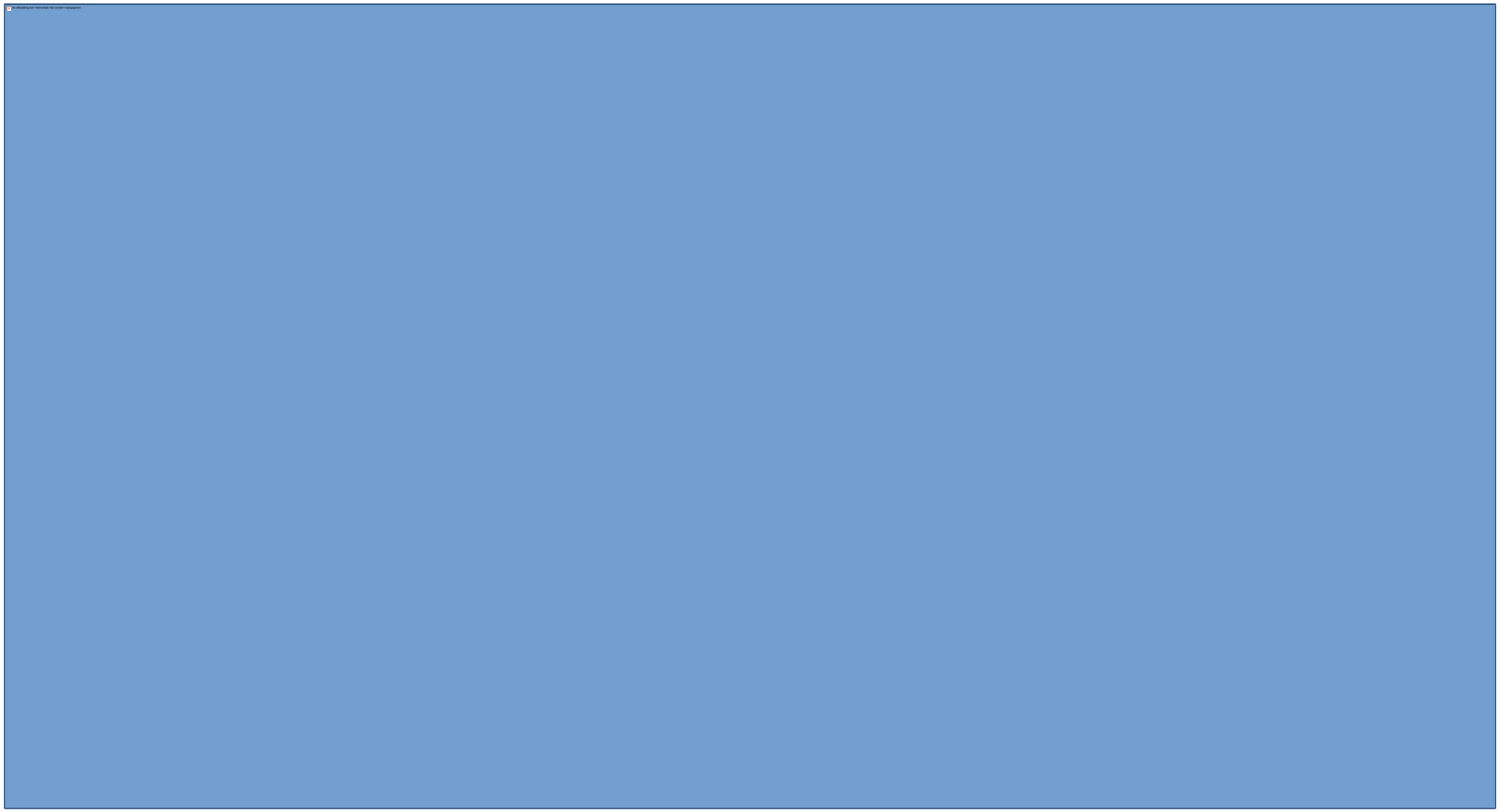
- Propose separation of web identities
- Determine fingerprint vectors
- Proof-of-concept implementation
- Validation against commercial fingerprinters

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 Sleegers (BSc): **Firesheep 7 years later**
- Lucas Vos, Bas Doorn (BSc): **Private Tweeeting**
- Clayton Drazner, Nikola Đuza: **Block Assessor**
- Interested? Hugo.jonker@ou.nl
  Www.open.ou.nl/hjo/supervision.htm

Thank you for your attention!

References (1)



References (2)