FP-Block

Usable web privacy via fingerprint

Hugo Jonker
@hugojonker

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
Introducing myself

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• First big student project: no SQL injection! ...at login screen...
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  – I promise I'll try not to break it!
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We're not really good at privacy
We're not really good at privacy
We're not really good at privacy
We're not really good at privacy
We're really not good at privacy
We're really **not** good at privacy

*Note: account number can suffice for withdrawal*
Privacy is hard
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 website to test my implementation. Today Facebook suggested me on my phone the group of .”

– Bachelor student
Privacy is really really hard

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

Google search for "css 2013 berlin"
Actually, what is privacy?
Actually, what is privacy?

• Privacy is secrecy wrt. someone
Actually, what is privacy?

- Privacy is secrecy wrt. someone
- Two aspects:
  - (in)distinguishability
Actually, what is privacy?

• Privacy is secrecy wrt. someone
• Two aspects:
  – (in)distinguishability
  – (un)certainty
Did privacy become harder?
Did privacy become harder?
Did privacy become harder?
Did privacy become harder?
In a nutshell
In a nutshell
In a nutshell
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...
However...
However...
Embedded content

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

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8. .....

<table>
<thead>
<tr>
<th></th>
<th>Top 10k</th>
<th>Top 1mil</th>
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<tbody>
<tr>
<td>1. Akamai</td>
<td>17%</td>
<td>11%</td>
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<tr>
<td>2. Doubleclick</td>
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<td>20%</td>
</tr>
<tr>
<td>3. Google Analytics</td>
<td>19%</td>
<td>44%</td>
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<tr>
<td>4. YouTube</td>
<td>26%</td>
<td>47%</td>
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<tr>
<td>5. Facebook Like*</td>
<td>20%</td>
<td>16%</td>
</tr>
<tr>
<td>6. PayPal button</td>
<td>33%</td>
<td>44%</td>
</tr>
<tr>
<td>7. JQuery</td>
<td>18%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Data from September 2015.
* aggregated numbers from builtwith.com. numbers by similartech.com are higher.
Tracking via embedded content
Tracking via embedded content
Tracking via embedded content
Tracking via embedded content

ID visited A

Website A

Facebook

A,ID

Browser ID
Tracking via embedded content

Website A

ID visited A

Facebook

Website C

Browser ID

A,ID

C,ID

A,ID
Tracking via embedded content
Tracking via embedded content

ID visited A

Website A

Facebook

Website C

Browser ID

A,ID

C,ID

A,ID

C,ID
Tracking via embedded content

- ID visited A
- ID visited A, then C

- Website A
- Facebook
- Website C

- Browser ID
- A,ID
- C,ID
- C,ID

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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.
  - Active: gather info from client side on-the-fly.
Why fingerprinting?

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- Effective?
  - [PETS10]: 90% desktop browsers is unique.

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

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- Effective?
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  - [S&P13, CCS13]: some, but not much... yet.
  - Firefox 42 Beta added “tracking protection”
Effectiveness of fingerprinting [PETS10]

- Research by one academic associated with EFF
Effectiveness of fingerprinting [PETS10]

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- 90% of desktop browsers unique
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- Fingerprints change...
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- ...predecessor found in 65% (99.1% correct)
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• Revealing: order of fonts, order of plugins
Effectiveness of fingerprinting [PETS10]

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- Fingerprints change...
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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.
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
Separate web identities
Separate web identities
Separate web identities

Website A

A, IDₐ

Browser
ID

ID
Separate web identities
Separate web identities
Separate web identities
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Separate web identities
Separate web identities
Separate web identities
“Fingerprint surface”

Non-profit:
• Panopticlick - academic study
• FingerPrintJS - open source

Commercial:
• AddThis - social media buttons
• BlueCava - advertisements
• Iovation - fraud prevention
• ThreatMetrix - fraud prevention
“Fingerprint surface”

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

static
IE specific
using DLL
Fingerprint vectors [S&P13]

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static
IE specific
using DLL
### Fingerprint vectors

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

<table>
<thead>
<tr>
<th>Attribute</th>
<th>PA</th>
<th>PP</th>
<th>IO</th>
<th>TM</th>
<th>Add</th>
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<td>HTML Body Behavior</td>
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</tbody>
</table>

Hugo Jonker – FP-Block
Generating believable & distinguishable identities

<table>
<thead>
<tr>
<th></th>
<th>Win</th>
<th>Mac</th>
<th>Linux</th>
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<tbody>
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<td>.06</td>
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<td>.96</td>
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<td>iexplorer</td>
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<table>
<thead>
<tr>
<th>Platform</th>
<th>Processor string probability</th>
</tr>
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<tbody>
<tr>
<td>Linux</td>
<td>‘i686’: .5</td>
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<tr>
<td></td>
<td>‘x86_64’: .5</td>
</tr>
<tr>
<td>Mac</td>
<td>‘Intel’: .48</td>
</tr>
<tr>
<td></td>
<td>‘PPC’: .01</td>
</tr>
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<td></td>
<td>‘U; Intel’: .48</td>
</tr>
<tr>
<td></td>
<td>‘U; PPC’: .01</td>
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<tr>
<td>Windows</td>
<td>‘’: .3</td>
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<td>‘WOW64’: .3</td>
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<tr>
<td></td>
<td>‘Win64; x64’: .3</td>
</tr>
</tbody>
</table>

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

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<thead>
<tr>
<th>Attribute</th>
<th>FP</th>
<th>TR</th>
<th>PV</th>
<th>RAS</th>
<th>FPB</th>
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FP-Block's fingerprint coverage

Original canvas

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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
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 Sleegers (BSc): Firesheep 7 years later
- Lucas Vos, Bas Doorn (BSc): Private Tweeeeteeting
- Clayton Drazner, Nikola Đuza: Block Assessor
Thank you for your attention!

Hugo.jonker@ou.nl
@hugojonker
Www.open.ou.nl/hjo/supervision.htm
References (1)


References (2)

[Roos12] Arnold Roosendaal. We are all connected to facebook ... by facebook! In European Data Protection: In Good Health, pages 3–19. Springer, 2012.

