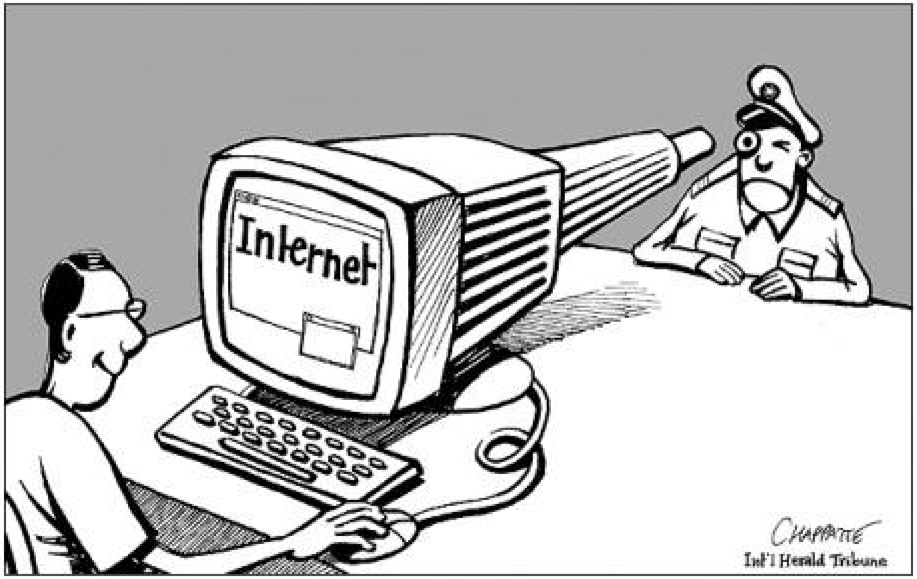
Preserving Privacy in a Connected World



Hugo Jonker
University of Luxembourg

uni.lu
UNIVERSITÉ DU
LUXEMBOURG

Security and Trust of Software Systems

Background

- Former IPA student (TU/e)
- PhD thesis on Fair Sharing and Vote Privacy
- Interests:
  - vote privacy
  - healthcare privacy, e-health
  - auction verifiability & privacy
  - privacy
  - …
  - practical security

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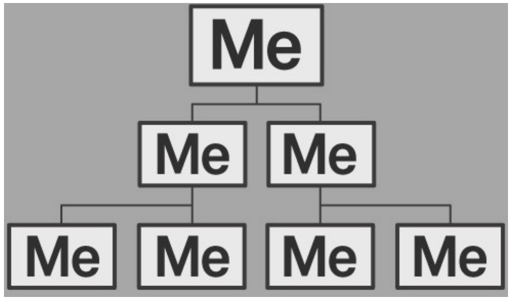

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We suck at privacy

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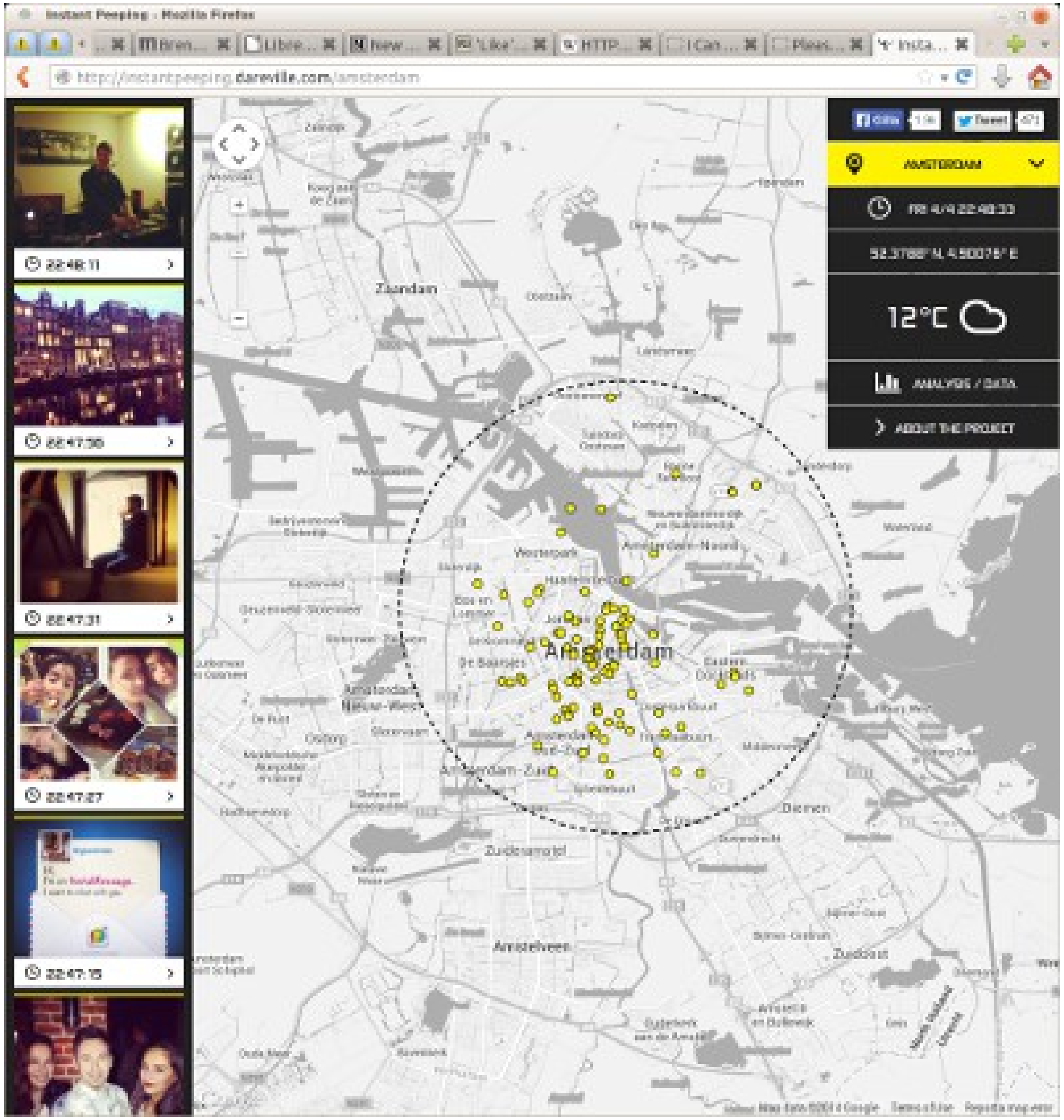

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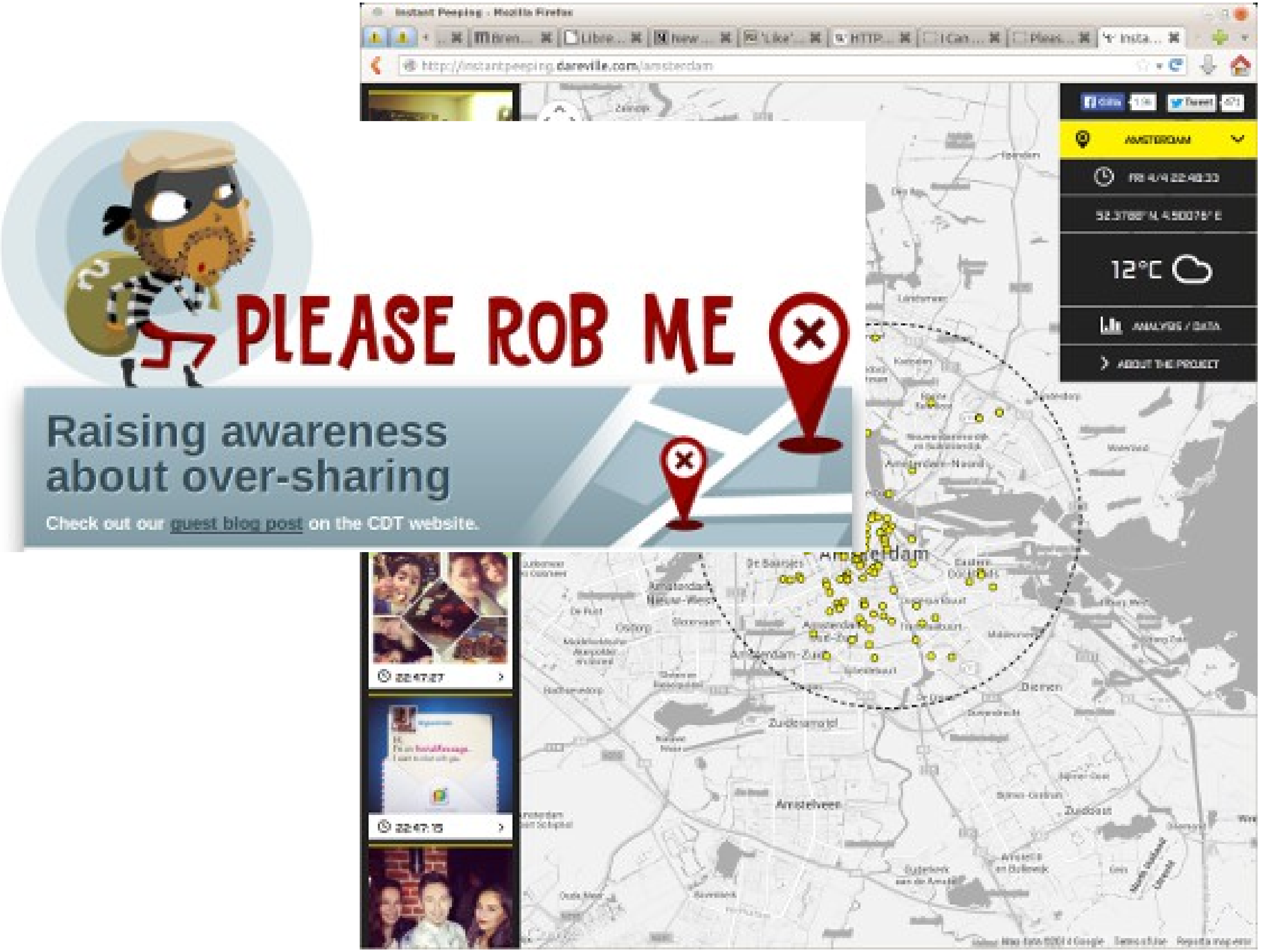
PLEASE ROB ME
Raising awareness about over-sharing
Check out our guest blog post on the CDT website.
Instant Peeping - Mozilla Firefox
http://instantpeeping.dareville.com/amsterdam
AMSTERDAM
FRI 4/4 22:48:33
52.3788° N, 4.90078° E
12°C
ANALYSIS / DATA
ABOUT THE PROJECT
22:47:27
22:47:15
Amsterdam
Amstelveen
Diemen
Zuidoost

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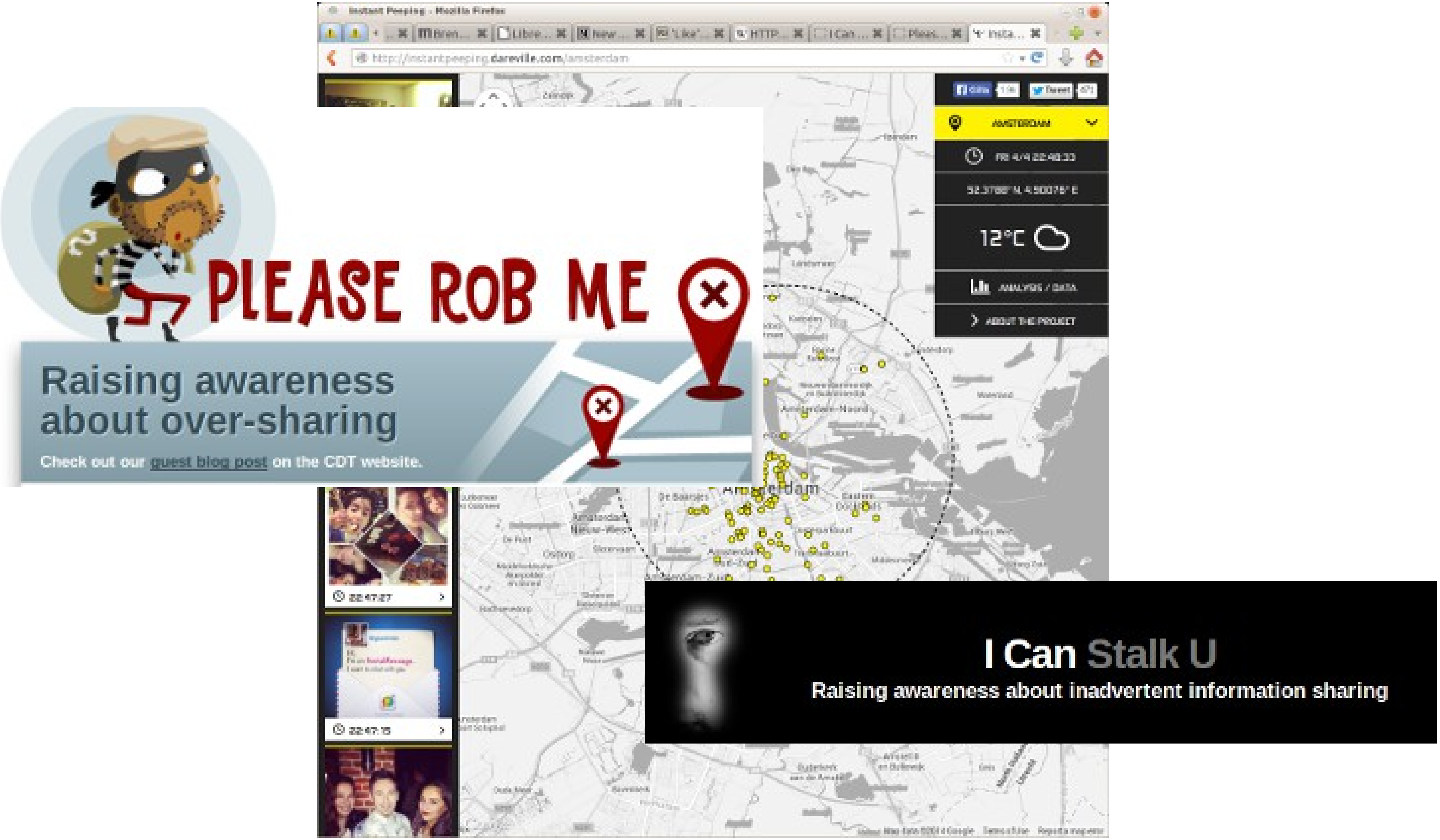


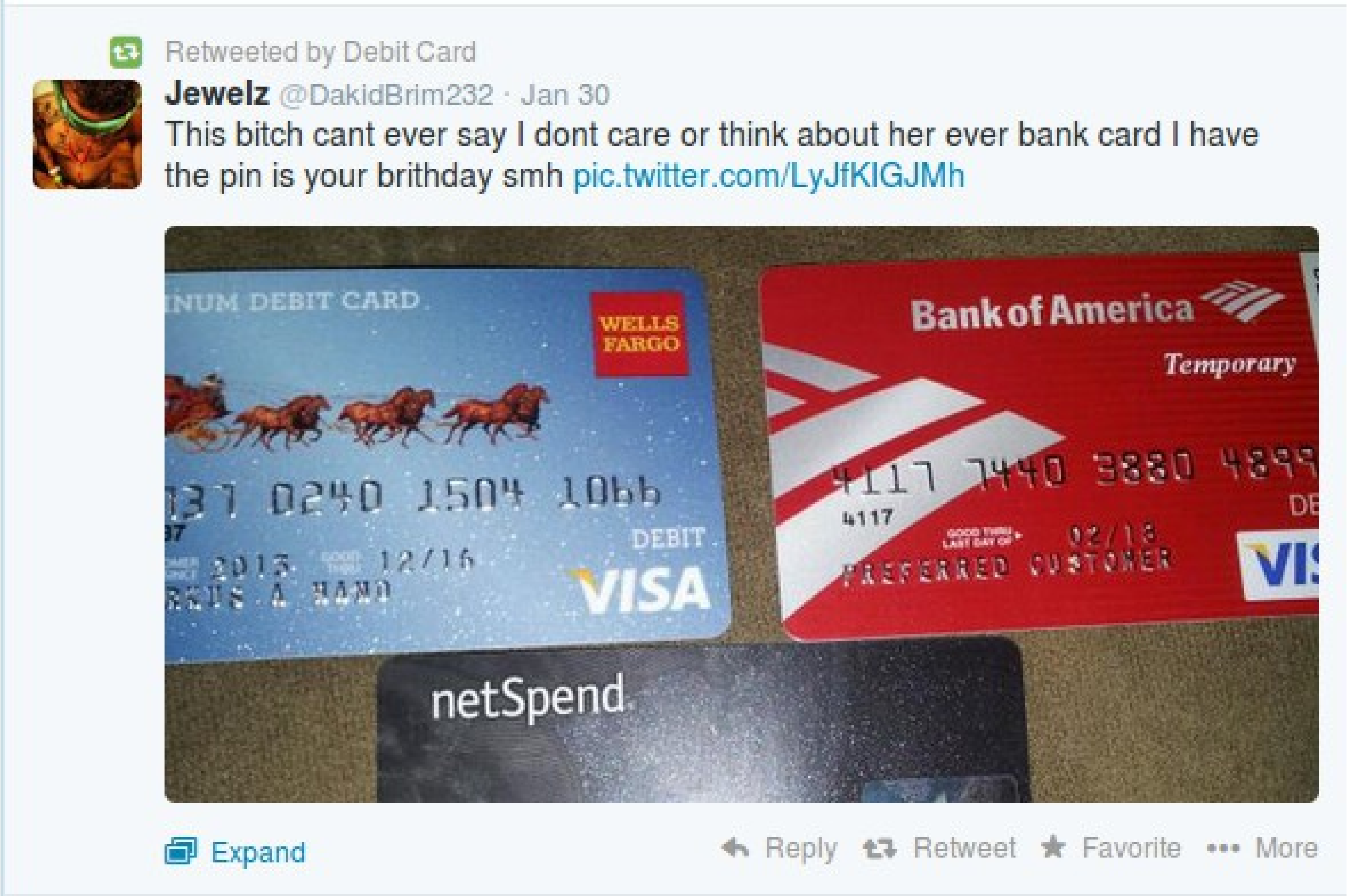
Raising awareness about over-sharing

Check out our guest blog post on the CDT website.

I Can Stalk U

Raising awareness about inadvertent information sharing

We **really** suck 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 smh pic.twitter.com/LyJfKIGJMh

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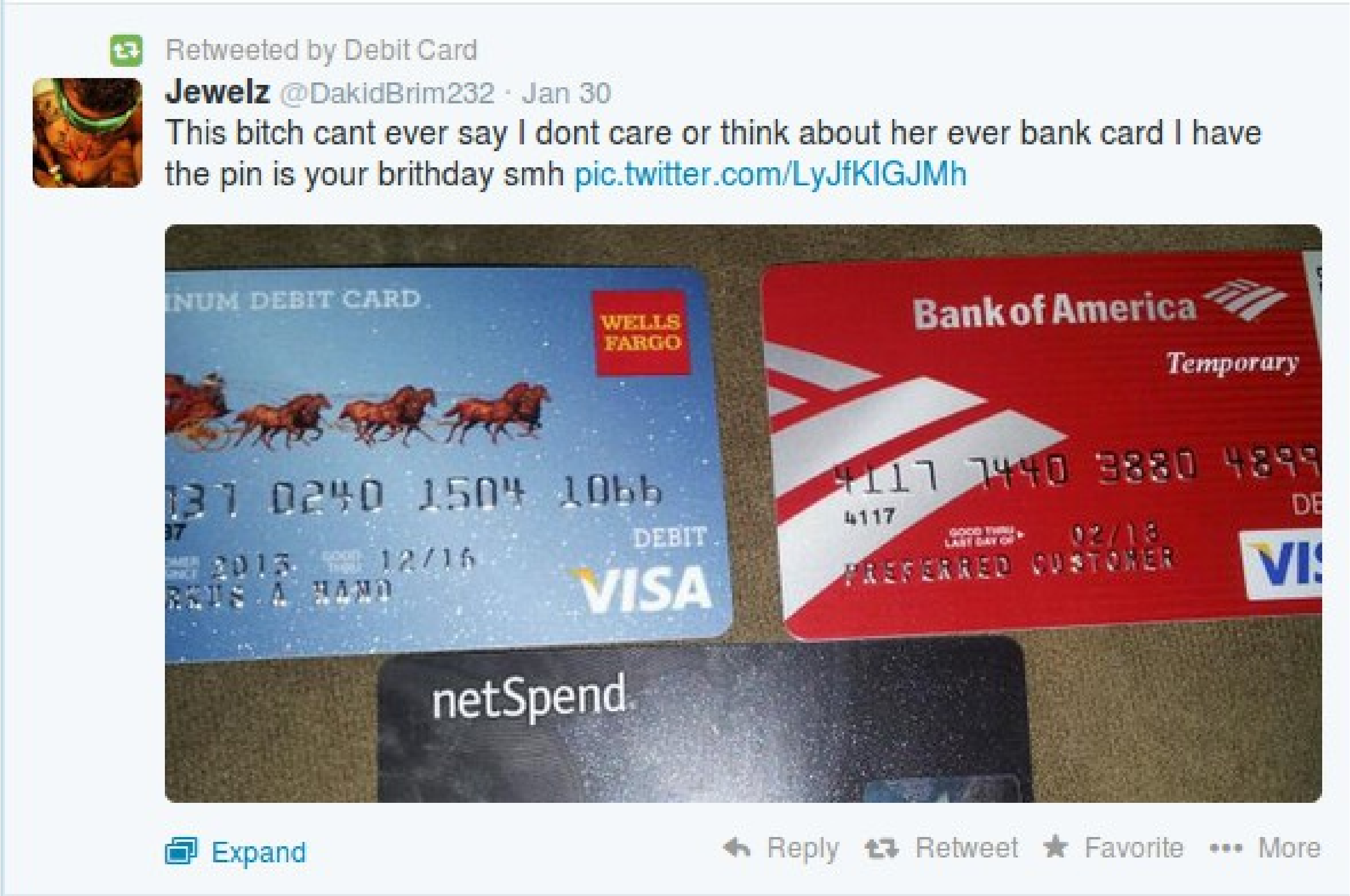

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Note: account number can suffice for withdrawal

Privacy is hard

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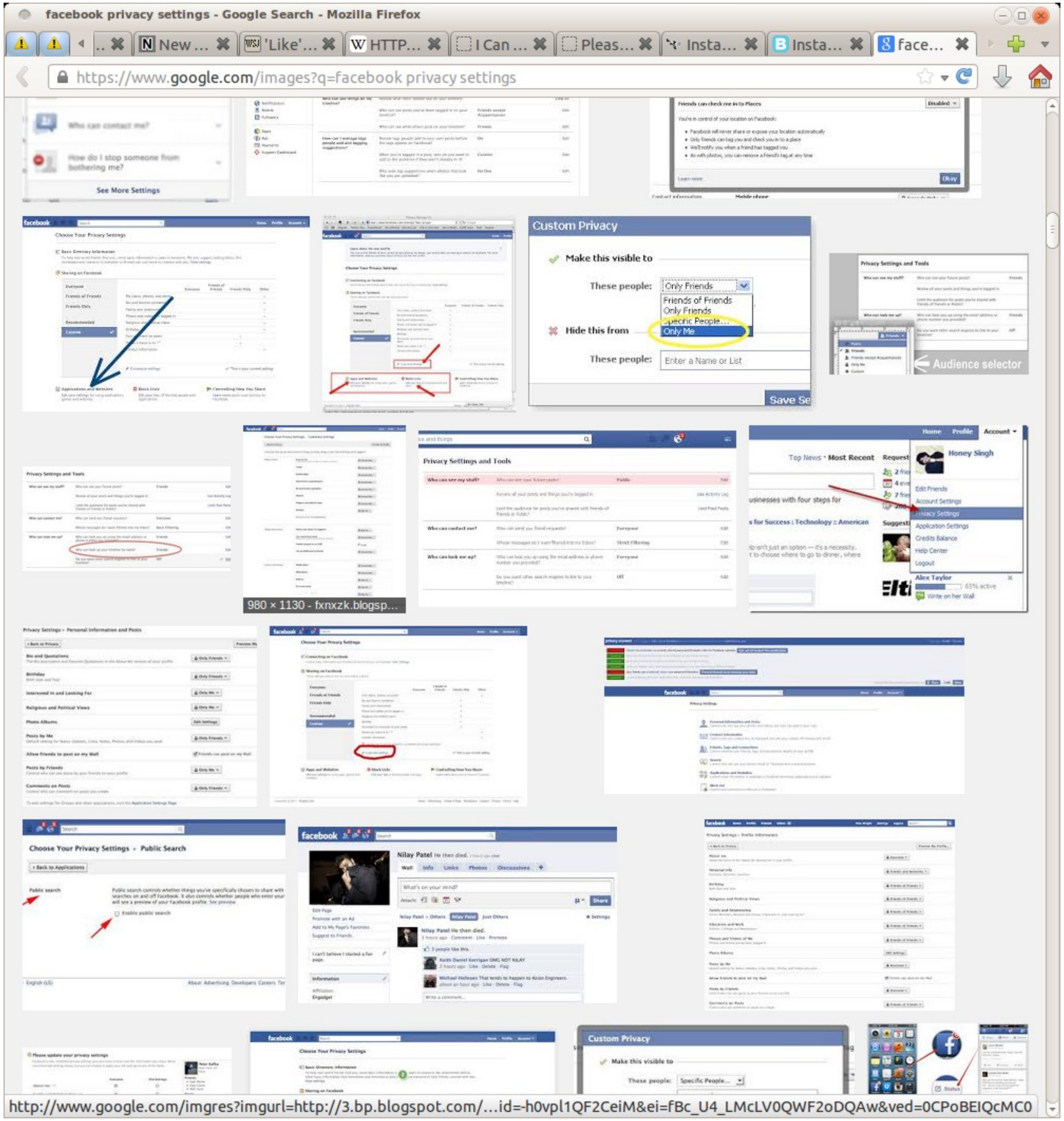
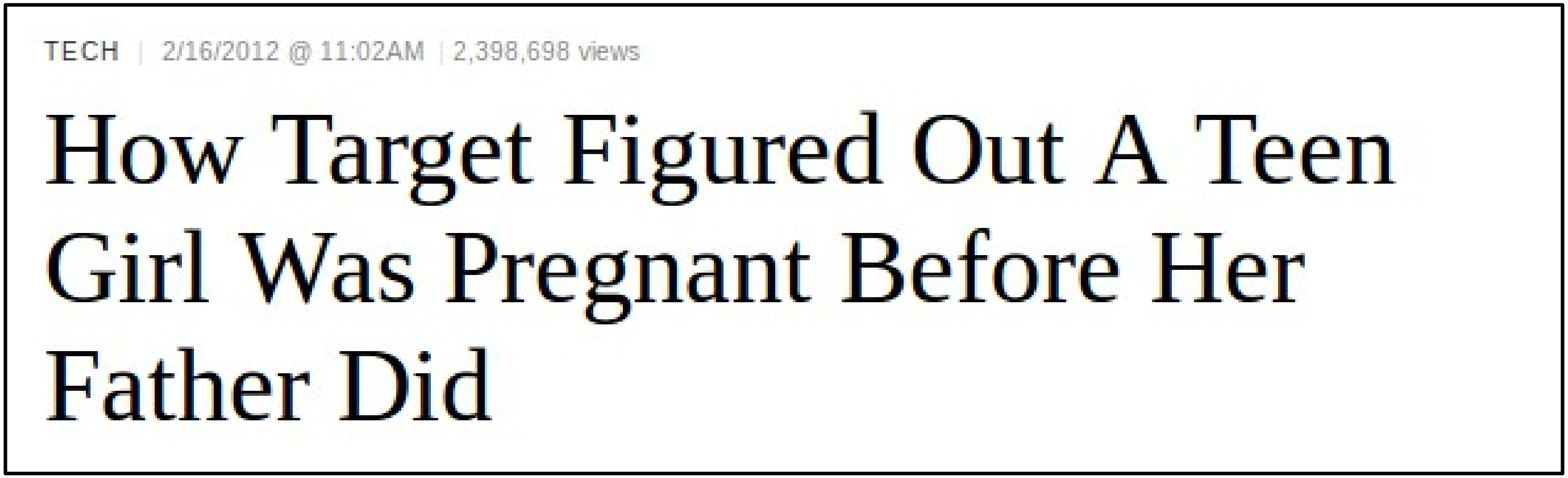

facebook privacy settings - Google Search - Mozilla Firefox
New ...
'Like'...
HTTP...
I Can ...
Pleas...
Insta...
Insta...
face...
https://www.google.com/images?q=facebook privacy settings
Custom Privacy
Make this visible to
These people: Only Friends
Friends of Friends
Only Friends
Specific People...
Only Me
Hide this from
These people: Enter a Name or List
Save Se
Audience selector
980 × 1130 - fxnxzk.blogsp...
Privacy Settings and Tools
Choose Your Privacy Settings › Public Search
See More Settings
http://www.google.com/imgres?imgurl=http://3.bp.blogspot.com/...id=-h0vpl1QF2CeiM&ei=fBc_U4_LMcLV0QWF2oDQAw&ved=0CPoBEIQcMC0

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*** *👣.”*

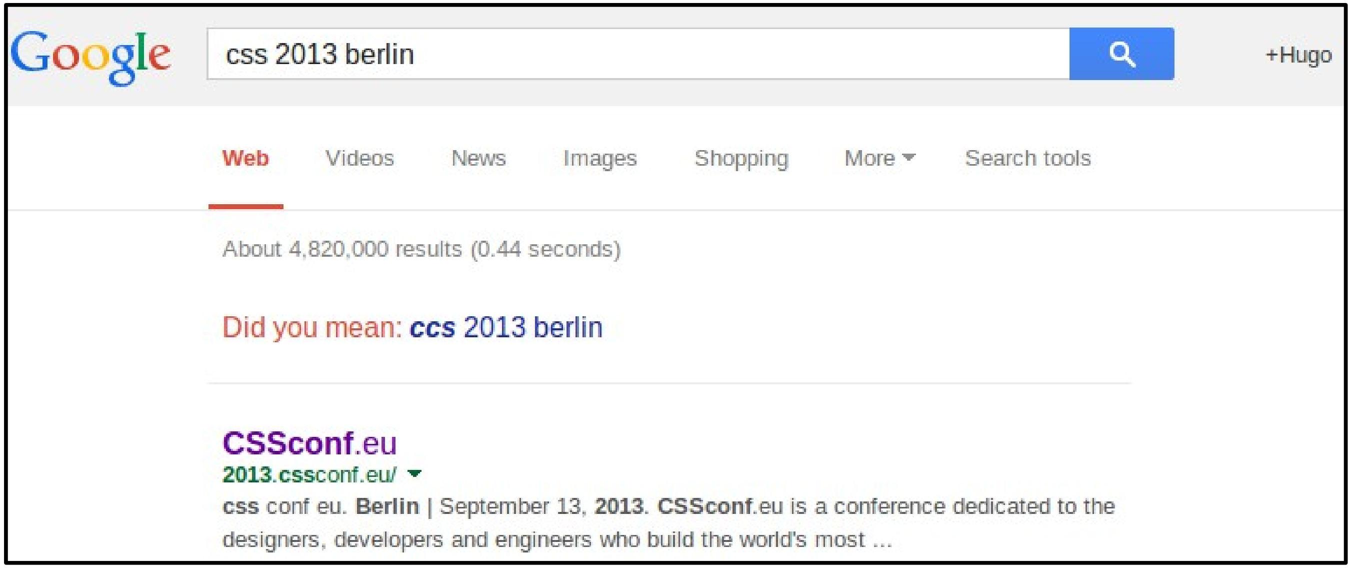
– an anonymous UL Bachelor student

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



css 2013 berlin

About 4,820,000 results (0.44 seconds)

Did you mean: ***ccs*** 2013 berlin

CSSconf.eu
2013.cssconf.eu/

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 ...

?

Wait, what **is** privacy?

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Good question!

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- Privacy is wrt. someone

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- Two sides:
  - (in)distinguishability

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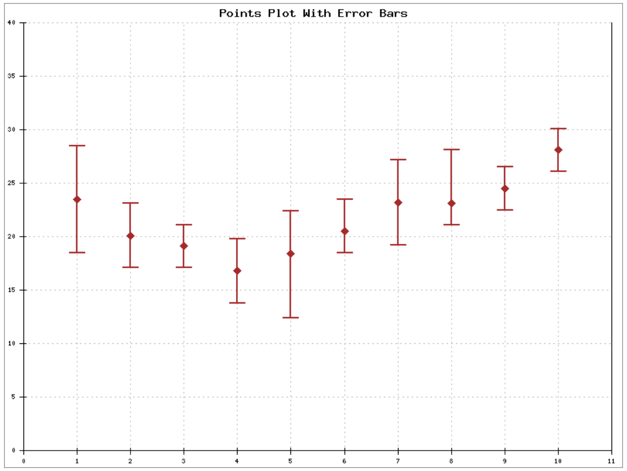
Good question!

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



Did privacy become harder?

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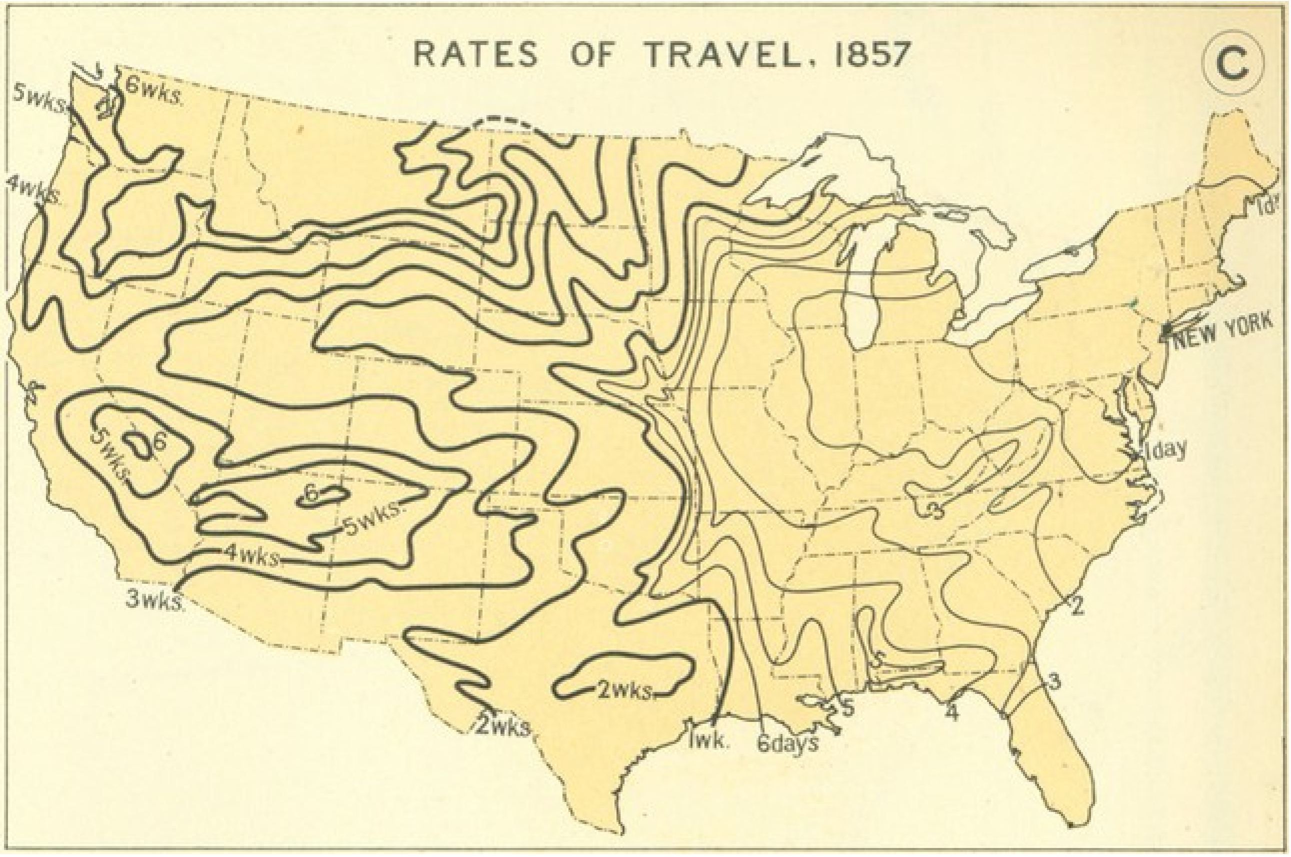

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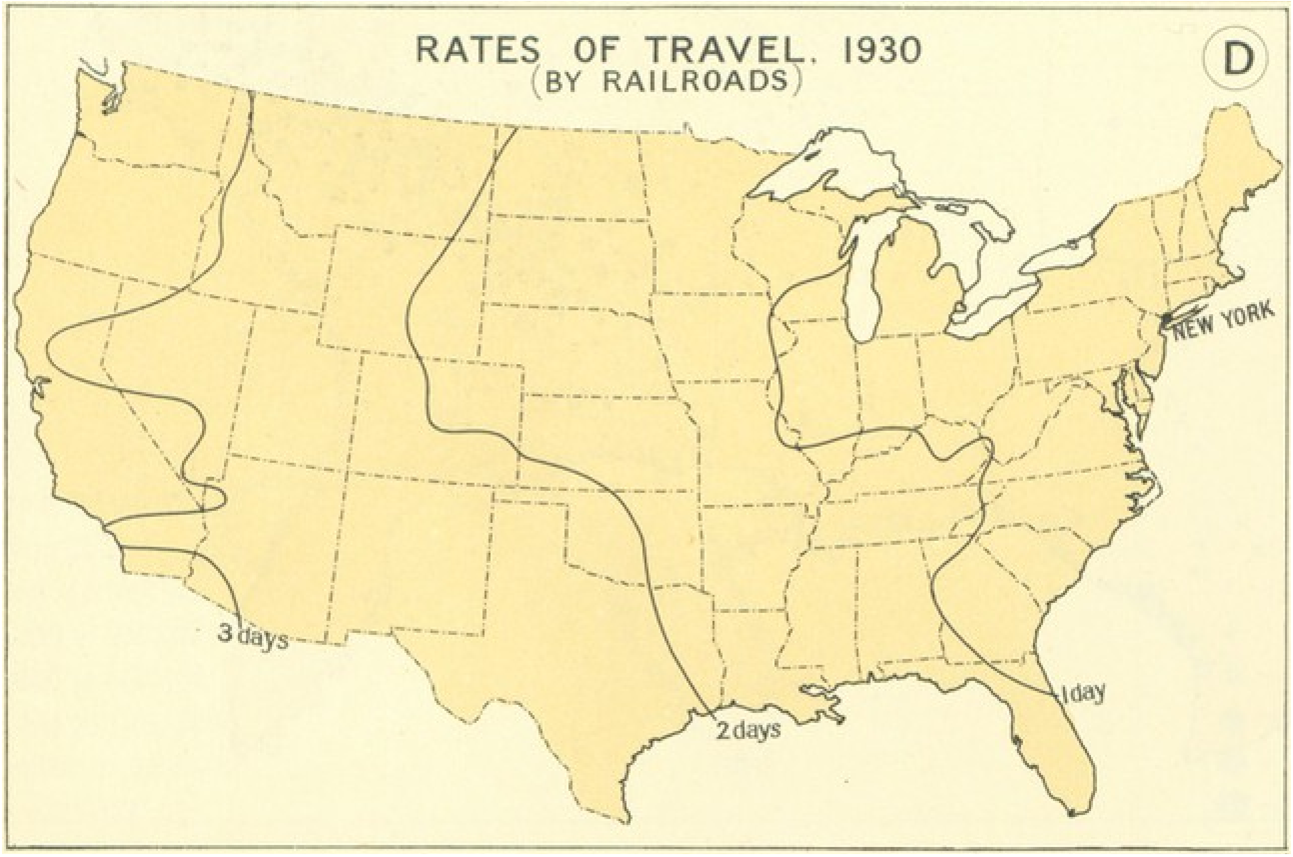

Did privacy become harder?

© Facebook

In a nutshell

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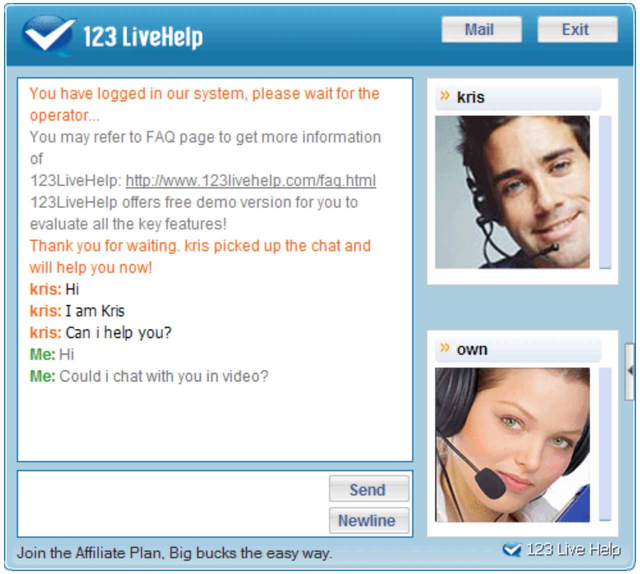
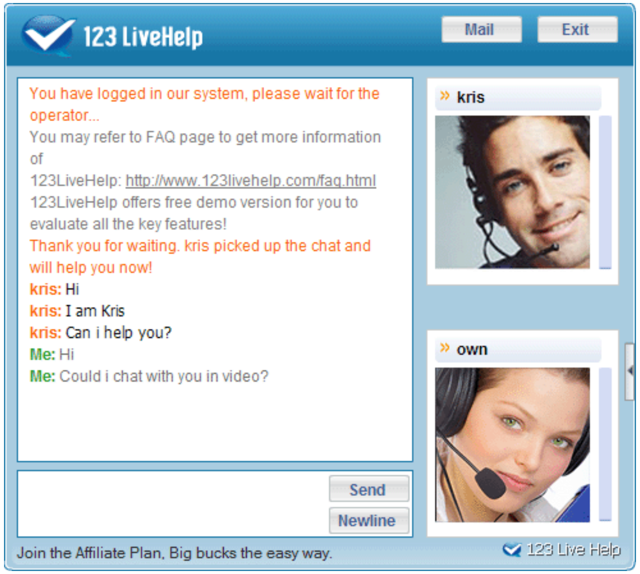


You have logged in our system, please wait for the operator...
You may refer to FAQ page to get more information of 123LiveHelp: http://www.123livehelp.com/faq.html
123LiveHelp offers free demo version for you to evaluate all the key features!
Thank you for waiting. kris picked up the chat and will help you now!
kris: Hi
kris: I am Kris
kris: Can i help you?
Me: Hi
Me: Could i chat with you in video?

In a nutshell



You have logged in our system, please wait for the operator...
You may refer to FAQ page to get more information of 123LiveHelp: http://www.123livehelp.com/faq.html
123LiveHelp offers free demo version for you to evaluate all the key features!
Thank you for waiting. kris picked up the chat and will help you now!
kris: Hi
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Me: Hi
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Join the Affiliate Plan, Big bucks the easy way.

≈

Online privacy challenges

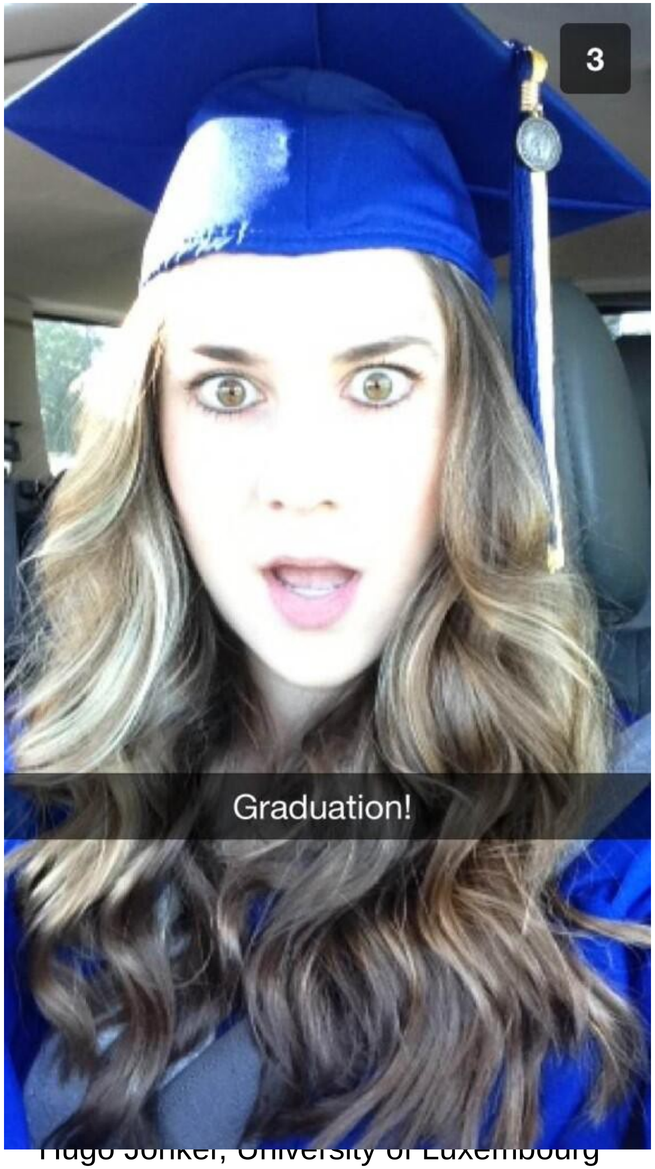
1. How to share with limits,

2. How to limit web tracking.

Sharing with limits

a case study of SnapChat

SnapChat



Graduation!

Failures of SnapChat (in 2012)

- Photos renamed, not fully removed
  a version still accessible via USB

- Photos not encrypted
  i.e. **always** accessible via USB

- ...

Beyond SnapChat

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Obvious fixes:

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Example applications:

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How to control access?

Beyond SnapChat

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How to control access?

- context → privacy

Context implies privacy?

“In the office”

- Office wifi / AP
- Augmented location
  - Cell phone network
  - GPS

“work context”

- Shared: not accessible outside office
- Pic-taking device: only after passwd/unlock

Limit web tracking

Outline

- How the web works
- Tracking/fingerprinting outline
- Related work
- Thwarting ubiquitous tracking

How the web works (abstractly)

- Client-server communication:
  Server needs to know client address

- Layered structure
  - TCP/IP stack (OSI 1-6)
  - HTTP (OSI 7)
  - Browser + plugins: HTML + CSS / Java / Flash / …
  - JavaScript

HTTP

```
$ telnet facebook.com 80
HEAD /unsupportedbrowser HTTP/1.1
Host: www.facebook.com

HTTP/1.1 301 Moved Permanently
Cache-Control: private, no-cache, no-store, must-revalidate
Content-Type: text/html; charset=utf-8
Date: Fri, 04 Apr 2014 22:37:48 GMT
Expires: Sat, 01 Jan 2000 00:00:00 GMT
Location: https://www.facebook.com/unsupportedbrowser
P3P: CP="Facebook does not have a P3P policy. Learn why here: http://fb.me/p3p"
Pragma: no-cache
Set-Cookie: datr=PDQ_UxyV3GBjiWmyk27HthOf; expires=Sun, 03-Apr-2016 22:37:48 GMT; path=/; domain=.facebook.com; httponly
X-Content-Type-Options: nosniff
X-Frame-Options: DENY
X-XSS-Protection: 0
X-FB-Debug: bJwsyEWZ2vw1AOhRFNOe9jSRe8+DrsC8ZMXbC6jwmpc=
Connection: keep-alive
Content-Length: 0
```

HTTP headers

Server		**Client**
• Set-cookie	↔	• Cookie
• E-tag	↔	• If-non-match
		• Referer
		• User-agent
		• Accept, Accept-*
		• DNT
		• ...

Cookies

- **Hack to add state**
- Last received cookie sent back to server

- validity:
  - Time: set by server (session, 1 yr, …)
  - Paths: set by server (path=/, path=/~user/, ...)
- can be “secure” and/or “httponly”

Why tracking?

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

- Goal: track **a user**

How to track

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

Zombiecookies

- Standard HTTP cookies
- Storing cookies in and reading out web history
- Storing cookies in HTTP ETags
- Internet Explorer (<9) userData storage
- HTML5 Session Storage
- HTML5 Local Storage
- HTML5 Global Storage
- HTML5 Database Storage via SQLite
- Storing cookies in RGB values of auto-generated, force-cached PNGs using HTML5 Canvas tag to read pixels (cookies) back out
- Local Shared Objects (Flash cookies)
- Silverlight Isolated Storage
- Cookie syncing scripts that function as a cache cookie and respawn the MUID cookie
- Caching in HTTP authentication
- …

Why fingerprinting?

- Cookies/zombiecookies/...: 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

Privacy plugins

ABP
No
cript

...

Share this buttons [Roos11]

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- Buttons everywhere

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- JS code loaded from social network
  - Request will send cookie
  - Response can set / update cookie

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

Panopticlick [PETS10]

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  - 90% of desktop browsers **unique**
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- Defensive paradox

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

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

Fighting fingerprinting

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- Again: defensive paradox.

Defensive paradox [S&P13]

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  … consistent with plugins?

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… check popular websites' JS

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The defense can be detected … which makes you more unique.

Abstract view on tracking

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i_u = (OSI_1, OSI_2, …, OSI_7, Java, flash, JS,...)

Decomposition functions

- cookie(i_u) = get-cookie(i_u.OSI$_7$)
- username(i_u) = $\begin{cases} \text{user(session(}i_u\text{))} & \text{if is\_logged\_in(}i_u\text{)} \\ \textit{empty} & \text{otherwise} \end{cases}$
- ipaddr(i_u) = get-remote-addr(i_u.OSI7)
- etc.

Linking interactions

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Consider interactions i_{u1} , i_{u2}

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- How is $\approx_x$ defined, for any x?

Linking interactions

Consider interactions i_{u1} , i_{u2}

- Same for FaceBook iff $i_{u1} \approx_{fb} i_{u2}$
- Same for Google iff $i_{u1} \approx_{goog} i_{u2}$

- How is $\approx_x$ defined, for any x?
- How can we ensure $\not\approx_x$?

$i_{u1} \approx_x i_{u2}$?

- $\text{username}_x(i_{u1}) = \text{username}_x(i_{u2})$ $\lor$
- $\text{cookie}_x(i_{u1}) = \text{cookie}_x(i_{u2})$ $\lor$
- … $\lor$
- $\text{fingerprint}(i_{u1}) = \text{fingerprint}(i_{u2})$ $\lor$
- $\text{match}(\text{fingerprint}(i_{u1}), \text{fingerprint}(i_{u2})) > 85\%$ $\lor$
- $i_{u1} \in \text{clickhistory}(i_{u2})$ (e.g., logging in)

$i_{u1} \not\approx_{x} i_{u2}$?

- $\text{username}_x(i_{u1}) \neq \text{username}_x(i_{u2})$, $\wedge$
- $\text{cookie}_x(i_{u1}) \neq \text{cookie}_x(i_{u2})$ $\wedge$
- … $\wedge$

- $\text{match}(\text{fingerprint}(i_{u1}), \text{fingerprint}(i_{u2})) < 12\%$

$i_{u1} \not\approx_{x} i_{u2}$?

- $\text{username}_x(i_{u1}) \neq \text{username}_x(i_{u2})$, $\wedge$
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- … $\wedge$

- $\text{match}(\text{fingerprint}(i_{u1}), \text{fingerprint}(i_{u2})) < 12\%$

Preventing matching ≠ ensuring non-matching!

Solution approach

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- Each website gets unique interaction

Solution approach

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Concept:

- Each website gets unique interaction
- Thwart identification for 3rd party sites

Take-home message

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- Online privacy is hard...

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- Online privacy is hard...
- ...and therefore an interesting research area

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- IPA-days can be more than fun [FSEN07,FI08]
- Good targets for your security papers:
  CCS, CSF, S&P, NDSS, ESORICS,Usenix Security.
- Security papers need a security analysis.

Thank you for your attention!

References (1)

[PETS10] P. Eckersley. **How unique is your web browser?** In *Proc. 10Th Privacy Enhancing Technologies Symposium (PETS'10)*, LNCS 6205, pp. 1-18. Springer, 2010.

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