PRINCETON UNIVERSITY

CENTER FOR INFORMATION TECHNOLOGY POLICY
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I never signed up for this!

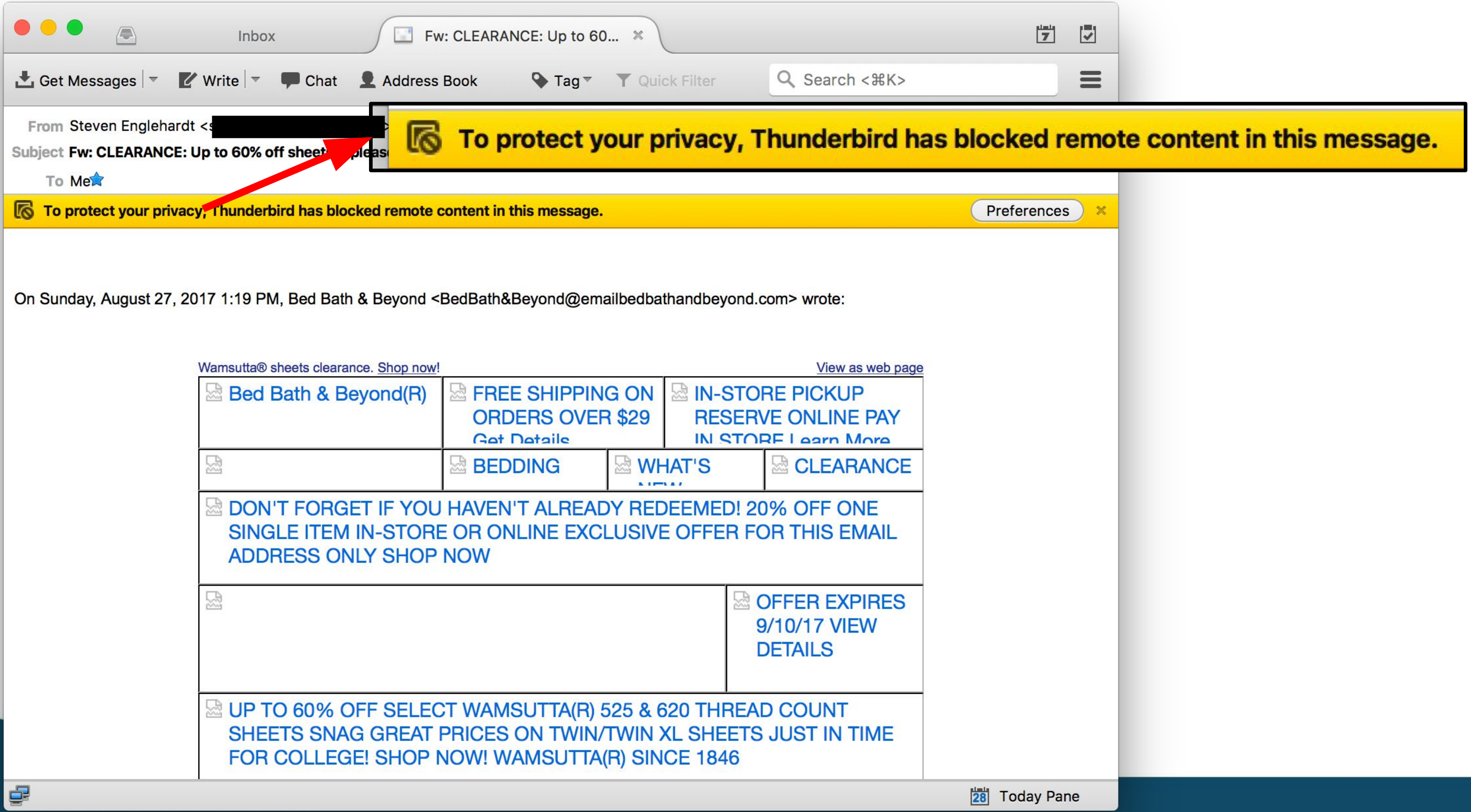
Privacy implications of email tracking

Steven Englehardt
@s_englehardt
senglehardt.com

Joint work with:
Jeffrey Han and
Arvind Narayanan

PRIVACYCON

This research is funded by NSF grant CNS 1526353, by a research grant from Mozilla, and by an Amazon AWS Cloud Credits for Research grant.



To protect your privacy, Thunderbird has blocked remote content in this message.

From Steven Englehardt <[redacted]

Subject **Fw: CLEARANCE: Up to 60% off sheet pleas**

To Me

To protect your privacy, Thunderbird has blocked remote content in this message.

On Sunday, August 27, 2017 1:19 PM, Bed Bath & Beyond <BedBath&Beyond@emailbedbathandbeyond.com> wrote:

Wamsutta® sheets clearance. Shop now!

View as web page

Bed Bath & Beyond(R)	FREE SHIPPING ON ORDERS OVER $29 Get Details	IN-STORE PICKUP RESERVE ONLINE PAY IN STORE Learn More

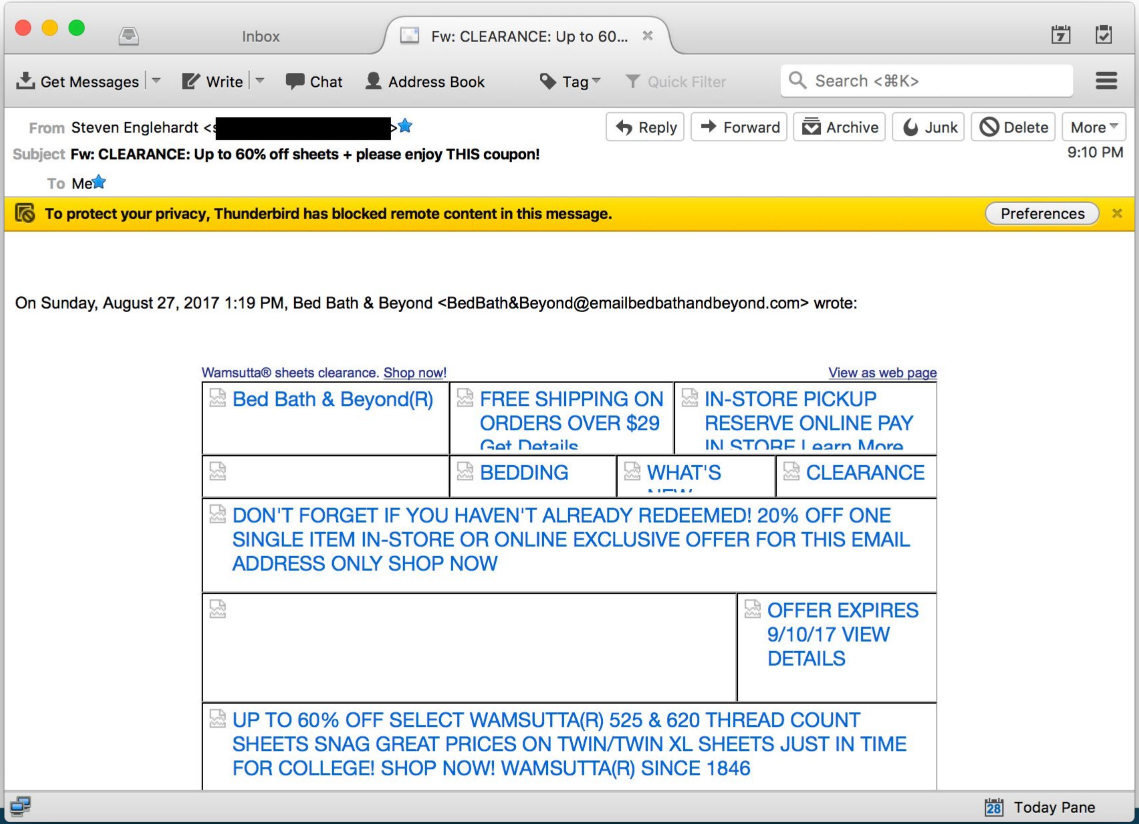
	BEDDING	WHAT'S	CLEARANCE

DON'T FORGET IF YOU HAVEN'T ALREADY REDEEMED! 20% OFF ONE SINGLE ITEM IN-STORE OR ONLINE EXCLUSIVE OFFER FOR THIS EMAIL ADDRESS ONLY SHOP NOW

OFFER EXPIRES 9/10/17 VIEW DETAILS

UP TO 60% OFF SELECT WAMSUTTA(R) 525 & 620 THREAD COUNT SHEETS SNAG GREAT PRICES ON TWIN/TWIN XL SHEETS JUST IN TIME FOR COLLEGE! SHOP NOW! WAMSUTTA(R) SINCE 1846

Who *doesn't* love reading email like this?



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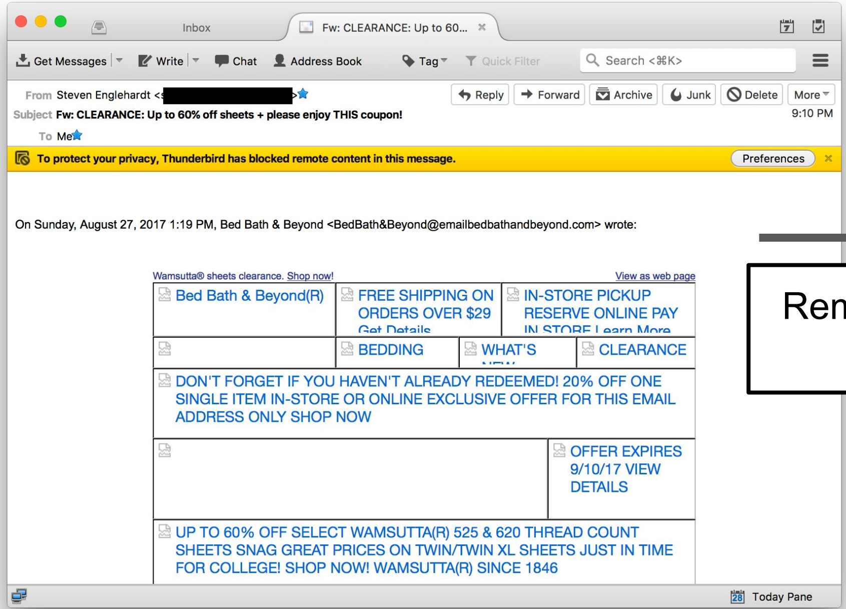
What are the privacy implications?



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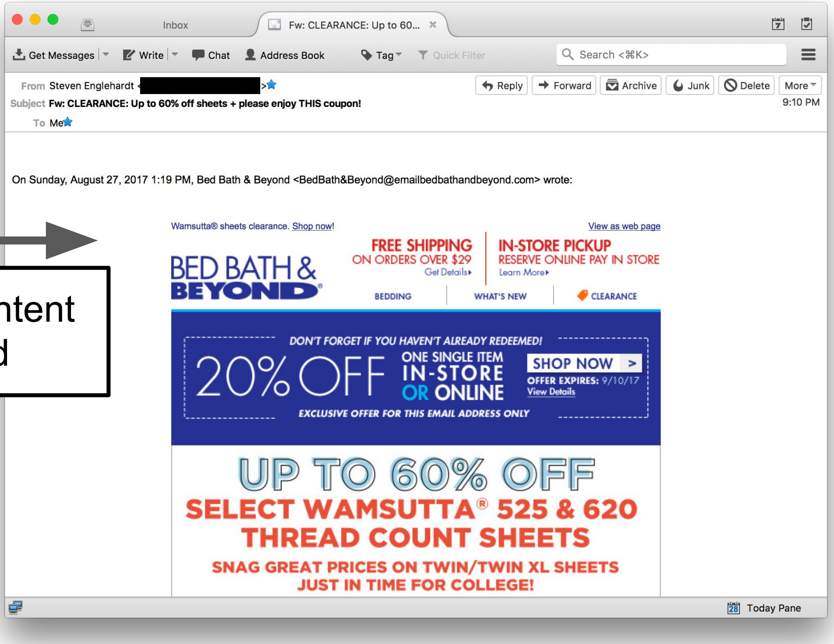
Remote content enabled



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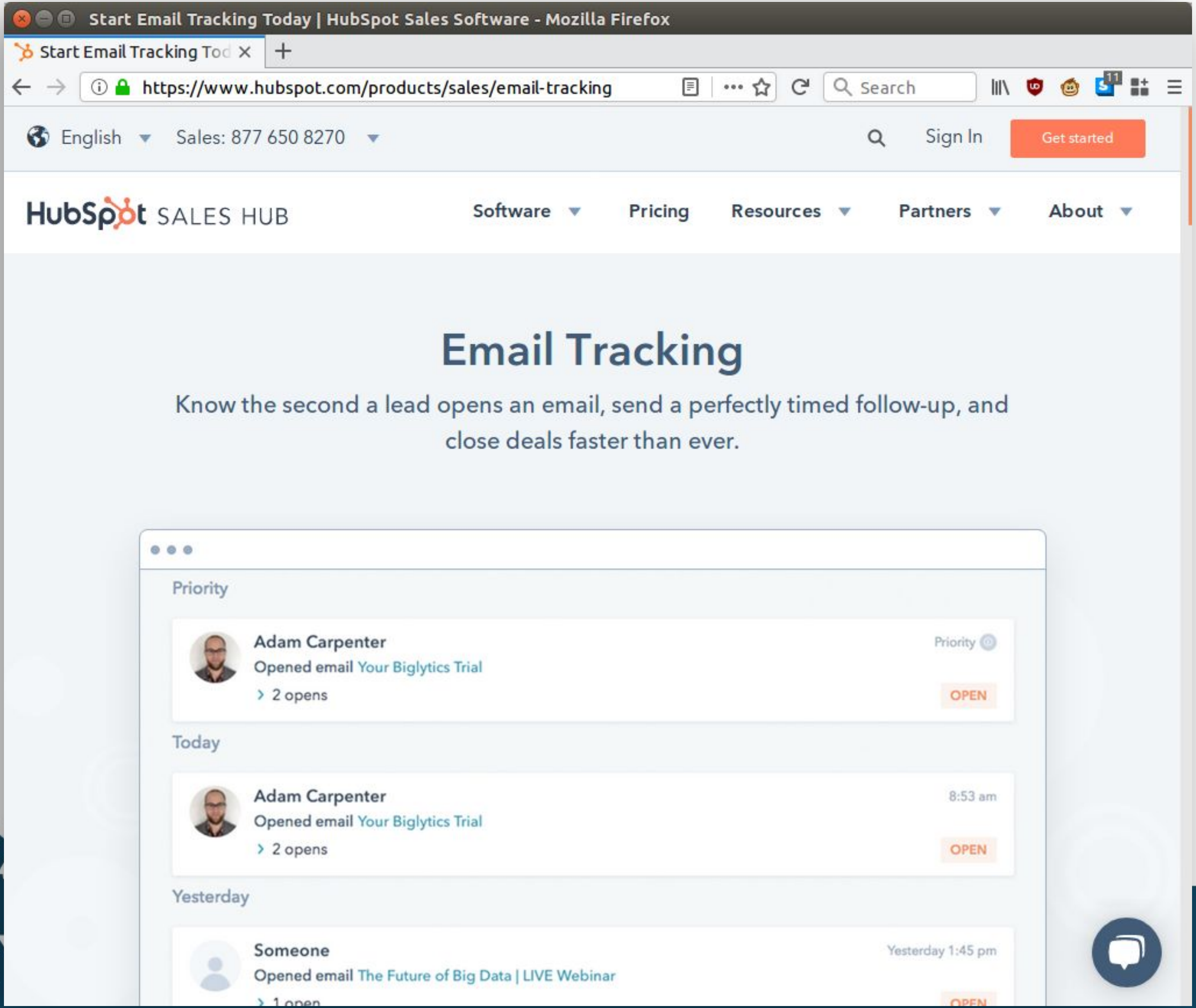


Email Tracking

Know the second a lead opens an email, send a perfectly timed follow-up, and close deals faster than ever.

Priority

Adam Carpenter
Opened email Your Biglytics Trial
› 2 opens
Priority
OPEN

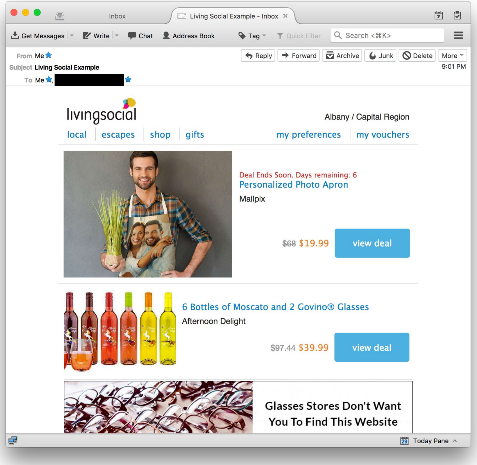
Today

Adam Carpenter
Opened email Your Biglytics Trial
› 2 opens
8:53 am
OPEN

Yesterday

Someone
Opened email The Future of Big Data | LIVE Webinar
› 1 open
Yesterday 1:45 pm
OPEN

PRIVAC



From Me
Subject Living Social Example
To Me, [redacted]
9:01 PM

livingsocial

Albany / Capital Region

local | escapes | shop | gifts | my preferences | my vouchers

Deal Ends Soon. Days remaining: 6
Personalized Photo Apron
Mailpix

~~$68~~ $19.99 view deal

6 Bottles of Moscato and 2 Govino® Glasses
Afternoon Delight

~~$97.44~~ $39.99 view deal

Glasses Stores Don't Want You To Find This Website

Emails are tracked far beyond send tracking

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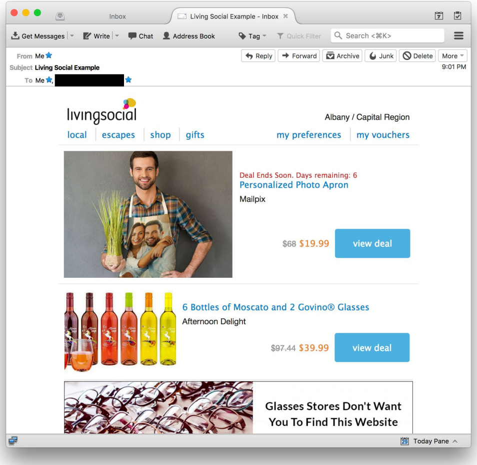


From Me
Subject Living Social Example
To Me, [redacted]
9:01 PM

livingsocial
Albany / Capital Region
local | escapes | shop | gifts
my preferences | my vouchers

Deal Ends Soon. Days remaining: 6
Personalized Photo Apron
Mailpix
~~$68~~ $19.99 view deal

6 Bottles of Moscato and 2 Govino® Glasses
Afternoon Delight
~~$97.44~~ $39.99 view deal

Glasses Stores Don't Want You To Find This Website

Your device contacts 24 companies
→ 20 can track you (if supported)
→ 10 receive an MD5 hash of your email address

Receives MD5(email address) & Sets a Cookie

American List Counsel (alcmpn.com)
LiveIntent (liadm.com)
Oracle (nexac.com)
Acxiom (rlcdn.com, pippio.com, acxiom-online.com)
Criteo (criteo.com)
Conversant Media (dotomi.com)
V12 Data (v12group.com)
VideoAmp (videoamp.com)
<Unknown> (alocdn.com)

Sets a Cookie

OpenX (openx.net)
comScore (scorecardresearch.com, voicefive.com)
Oracle (bluekai.com)
Google (doubleclick.net)
Realtime Targeting Aps (mojn.com)
MediaMath (mathtag.com)
TapAd (tapad.com)
IPONWEB (bidswitch.net)
AOL (advertising.com)
Centro (sitescout.com)
The Trade Desk (adsrvr.org)
Adobe (demdex.net)

Receives MD5(email addr.)

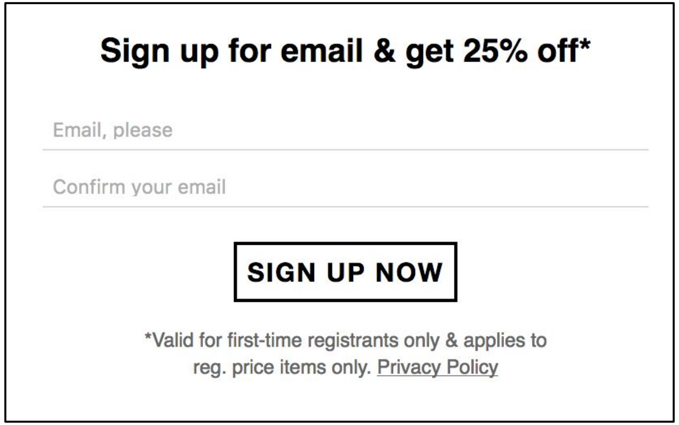
Criteo (emailretargeting.com)
Neustar (agkn.com)

Receives Bare Request

LiveIntent (licasd.com)
Google (2mdn.net)
Akamai (akamai.net)

Email Tracking ≈ Web Tracking - Javascript

Measuring email tracking at scale



Sign up for email & get 25% off*

Email, please

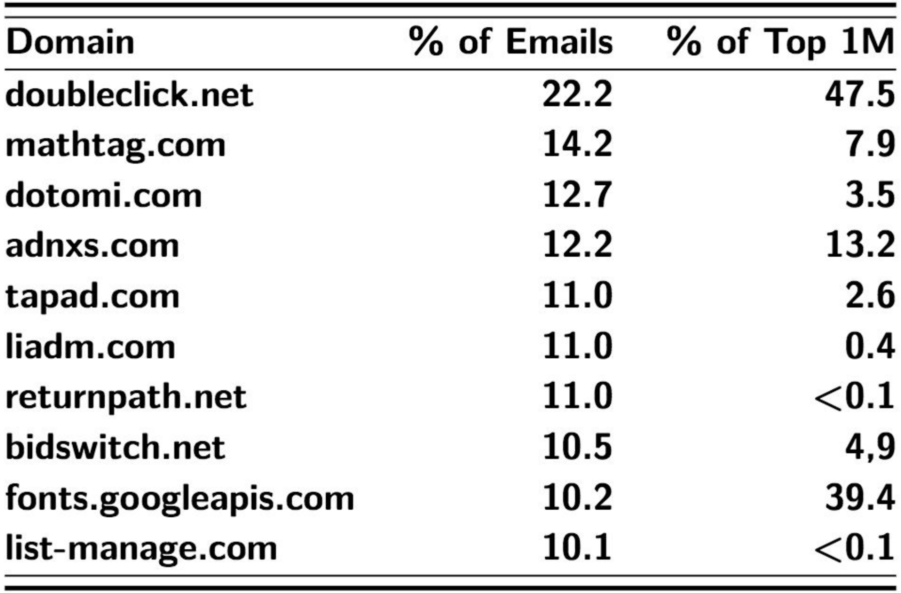
Confirm your email

*Valid for first-time registrants only & applies to reg. price items only. Privacy Policy

1. Crawled 15,700 sites
2. Signed up for mailing lists
3. Received 13,000 emails from ~900 sites
4. Measured tracking with OpenWPM

Our Findings

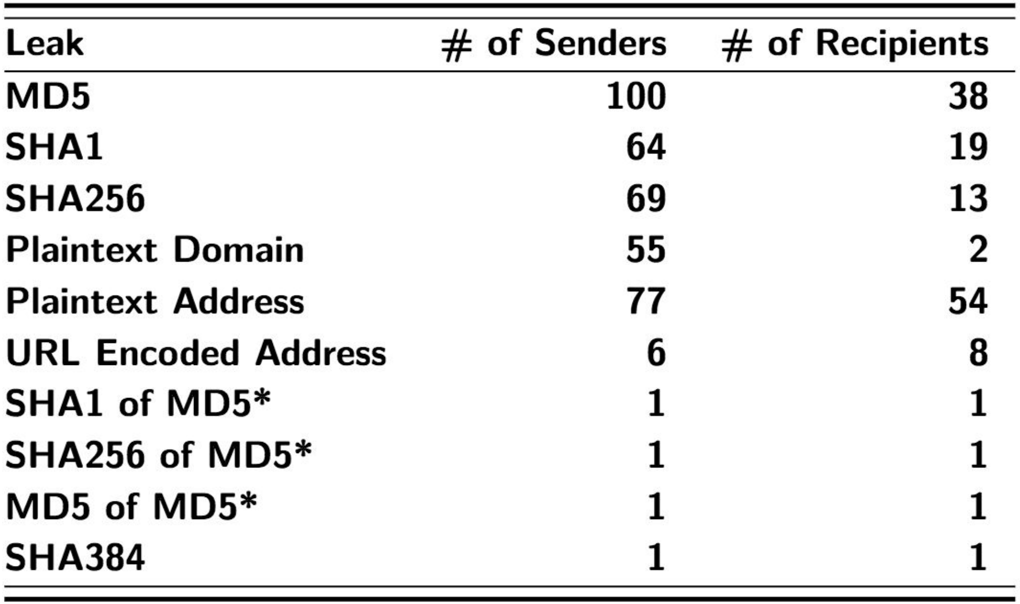
Many of the top web trackers are in emails



Domain	% of Emails	% of Top 1M
doubleclick.net	22.2	47.5
mathtag.com	14.2	7.9
dotomi.com	12.7	3.5
adnxs.com	12.2	13.2
tapad.com	11.0	2.6
liadm.com	11.0	0.4
returnpath.net	11.0	<0.1
bidswitch.net	10.5	4,9
fonts.googleapis.com	10.2	39.4
list-manage.com	10.1	<0.1

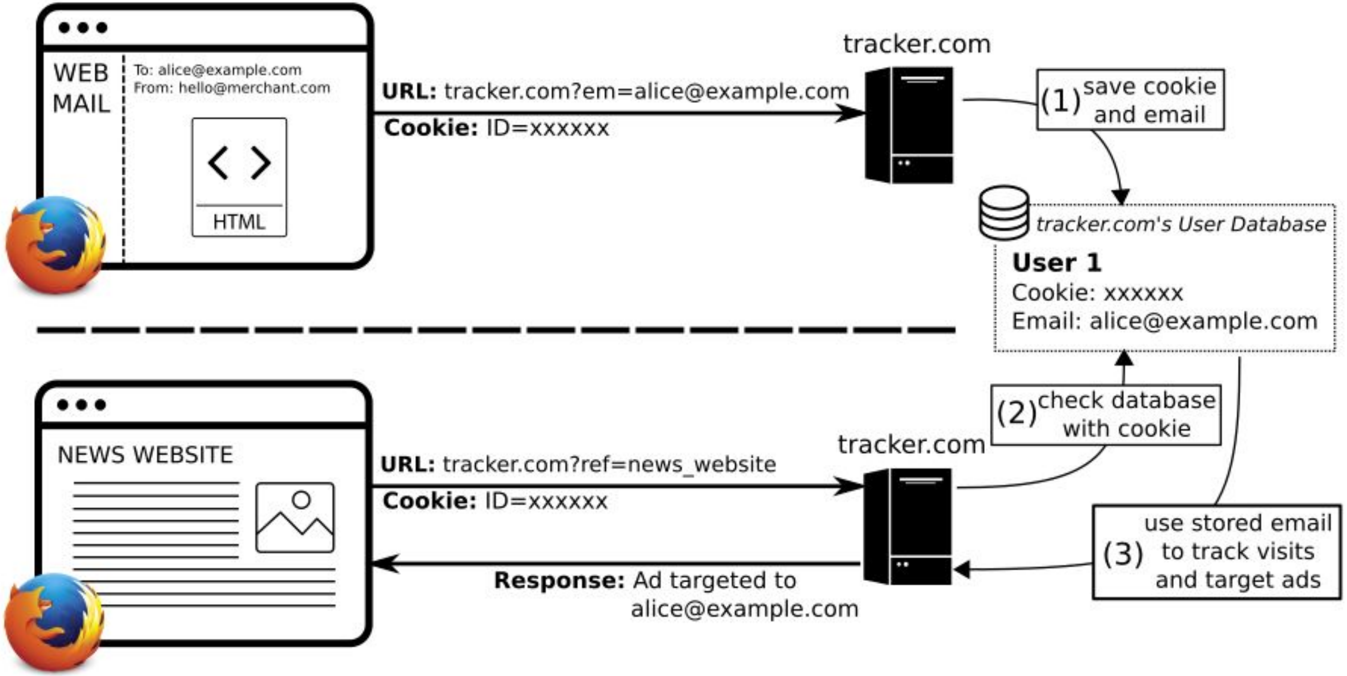
85% of emails embed third parties (with an average of 5 per email)

29% of emails (from 19% of senders) leak the email address to third parties



Leak	# of Senders	# of Recipients
MD5	100	38
SHA1	64	19
SHA256	69	13
Plaintext Domain	55	2
Plaintext Address	77	54
URL Encoded Address	6	8
SHA1 of MD5*	1	1
SHA256 of MD5*	1	1
MD5 of MD5*	1	1
SHA384	1	1

Trackers can correlate email and web tracking


WEB
MAIL
To: alice@example.com
From: hello@merchant.com
< >
HTML
URL: tracker.com?em=alice@example.com
Cookie: ID=xxxxxx
tracker.com
(1) save cookie and email
tracker.com's User Database
User 1
Cookie: xxxxxx
Email: alice@example.com
(2) check database with cookie
NEWS WEBSITE
URL: tracker.com?ref=news_website
Cookie: ID=xxxxxx
tracker.com
Response: Ad targeted to alice@example.com
(3) use stored email to track visits and target ads

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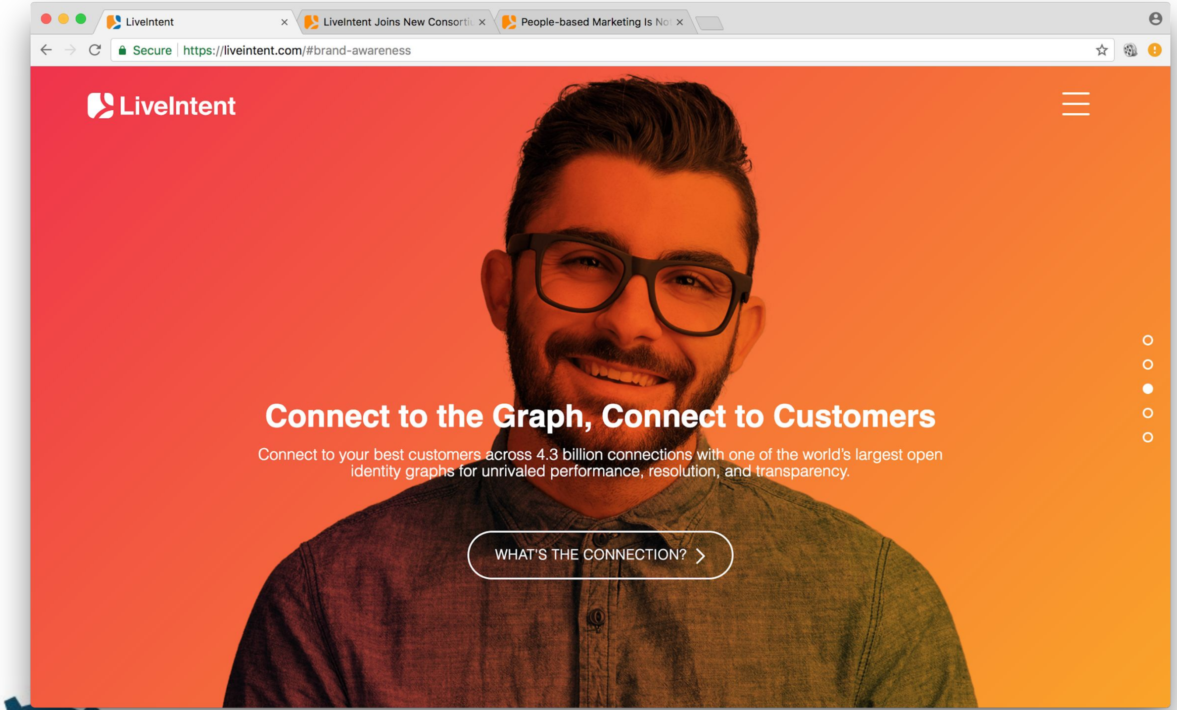
“People-based” Marketing


LiveIntent
LiveIntent Joins New Consorti
People-based Marketing Is No
Secure
https://liveintent.com/#brand-awareness
LiveIntent
WHAT'S THE CONNECTION?

Connect to the Graph, Connect to Customers

Connect to your best customers across 4.3 billion connections with one of the world’s largest open identity graphs for unrivaled performance, resolution, and transparency.

LiveIntent Blog Post

Source: https://blog.liveintent.com/people-based-marketing-not-complicated/

> As an identifier, email is both deterministic and persistent. That is, when a consumer gives out a verified email, it usually belongs to only that consumer. That can't be said of all typical advertising identifiers. Cookies, for example, live on desktop browsers that are often shared with no way to distinguish who's using it. And whereas email is cross-device, cookies aren't.

LiveIntent Privacy Policy

Source: https://liveintent.com/services-privacy-policy

> LiveIntent may also receive non-personal information from online and offline sources, including the types described below, from our business partners

LiveIntent Privacy Policy

Source: https://liveintent.com/services-privacy-policy

> To de-identify this information, either we or our business partners [hash it].

Criteo Privacy Policy

Source: https://www.criteo.com/privacy/

> we use a double hashing method ... to ensure the non-reversibility of your information. A hash of your email corresponds to a series of characters that does not permit your identification.

Does hashing protect user privacy?

Tracker Database

Email Hash

b5184f3fb0fe35e4319b729f05017f6e

Tracking Data

- https://www.**webmd.com**/cancer/default.htm
- http://www.**foxnews.com**/
- Livingsocial *Healthy Living* email campaign
- $105 in *Personal Health* purchases from CVS
- $55 purchase from Babies”R”Us

Does hashing protect user privacy?

Tracker Database

Email Hash	**Tracking Data**
b5184f3fb0fe35e4319b729f05017f6e	● https://www.**webmd.com**/cancer/default.htm ● http://www.**foxnews.com**/ ● Livingsocial *Healthy Living* email campaign ● $105 in *Personal Health* purchases from CVS ● $55 purchase from Babies”R”Us

Run a “re-identification attack” yourself! Open your terminal and enter:

```
Linux: echo -n ste@cs.princeton.edu | md5sum

MacOS: echo -n ste@cs.princeton.edu | md5
```

Easy ste@cs.princeton.edu → b5184f3fb0fe35e4319b729f05017f6e

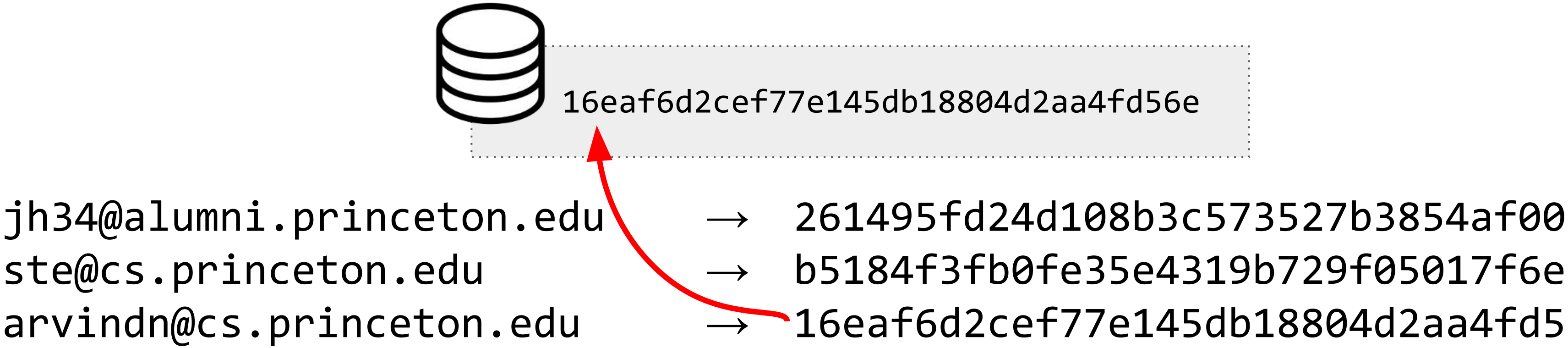
Hard b5184f3fb0fe35e4319b729f05017f6e → ste@cs.princeton.edu

Easy ste@cs.princeton.edu → b5184f3fb0fe35e4319b729f05017f6e

~~Hard~~ b5184f3fb0fe35e4319b729f05017f6e → ste@cs.princeton.edu

Easy (when you can guess the possible inputs)

16eaf6d2cef77e145db18804d2aa4fd56e

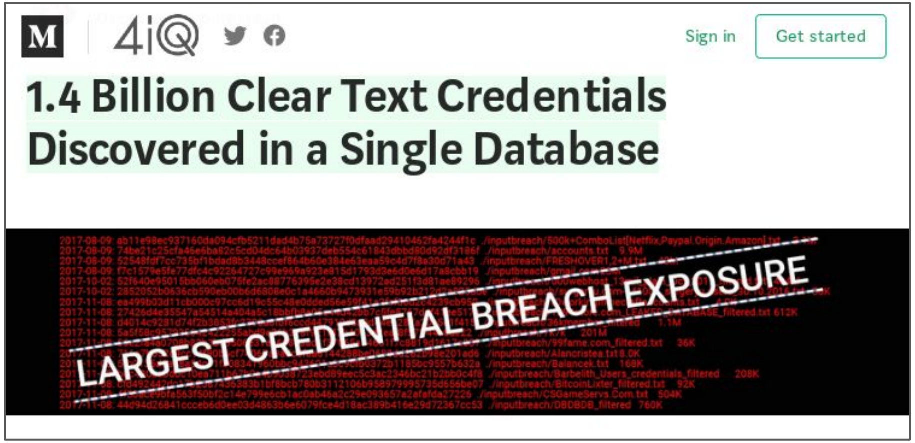


16eaf6d2cef77e145db18804d2aa4fd56e

jh34@alumni.princeton.edu → 261495fd24d108b3c573527b3854af00
ste@cs.princeton.edu → b5184f3fb0fe35e4319b729f05017f6e
arvindn@cs.princeton.edu → 16eaf6d2cef77e145db18804d2aa4fd5

Email addresses aren’t secrets!

Use email database leaks...



1.4 Billion Clear Text Credentials Discovered in a Single Database

...and just guess the rest.

GPU cloud computer: $24.48 / hour
→ 450 billion MD5 hashes / second

~4.7 billion email addresses total. If we generate a real address every 1 in 1 million guesses, **we can generate the entire space for less than $75**.

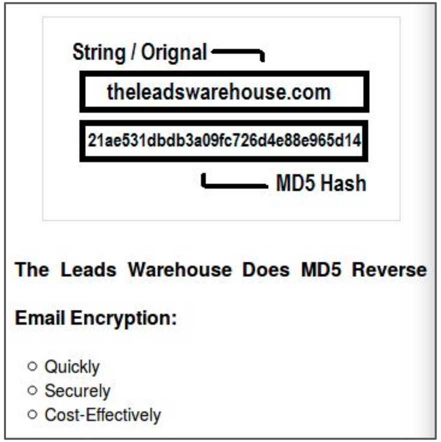
Past research recovered 45-70% of emails.

More info:
https://freedom-to-tinker.com/2017/09/28/i-never-signed-up-for-this-privacy-implications-of-email-tracking/

The pitfalls of hashing for privacy. https://www.comp.nus.edu.sg/~amrit/papers/pitfalls.pdf

Don’t want to guess? Reverse hashes for $0.04/email

theleadswarehouse.com



String / Orignal

theleadswarehouse.com

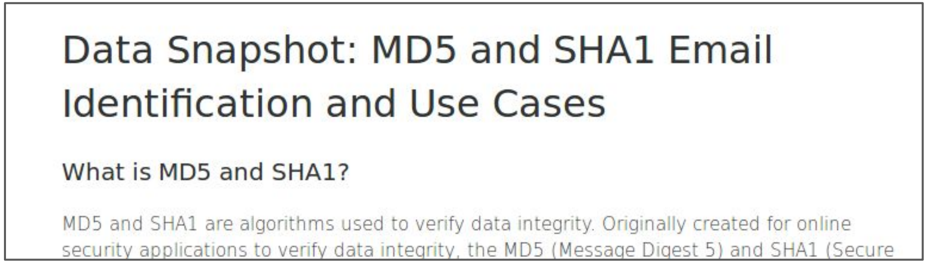
21ae531dbdb3a09fc726d4e88e965d14

MD5 Hash

The Leads Warehouse Does MD5 Reverse Email Encryption:

- Quickly
- Securely
- Cost-Effectively

infutor.com

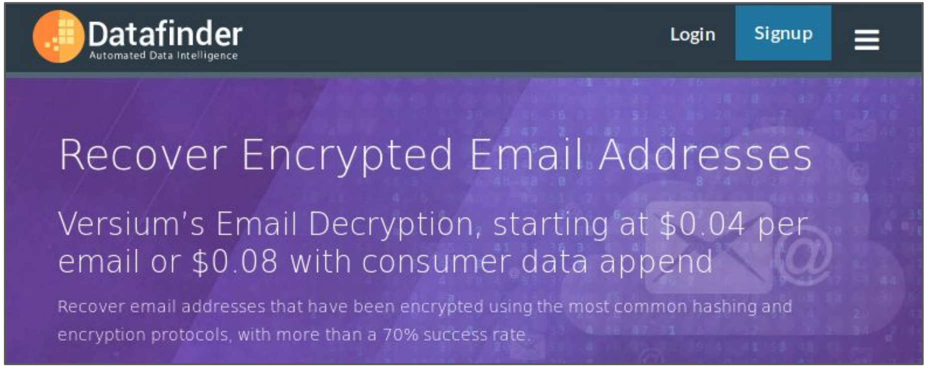


Data Snapshot: MD5 and SHA1 Email Identification and Use Cases

What is MD5 and SHA1?

MD5 and SHA1 are algorithms used to verify data integrity. Originally created for online security applications to verify data integrity, the MD5 (Message Digest 5) and SHA1 (Secure

datafinder.com



Recover Encrypted Email Addresses

Versium’s Email Decryption, starting at $0.04 per email or $0.08 with consumer data append

Recover email addresses that have been encrypted using the most common hashing and encryption protocols, with more than a 70% success rate.

Takeaways

1. The line between email and web tracking is blurry
2. Email addresses are commonly leaked to trackers in emails
3. Claims of “de-identification” are suspect

More Info

- **Full paper:** https://senglehardt.com/papers/pets18_email_tracking.pdf
- **More on identity leaks:** https://freedom-to-tinker.com/tag/noboundaries/

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