

Computer and Network Security

Lecture 20: Web Privacy

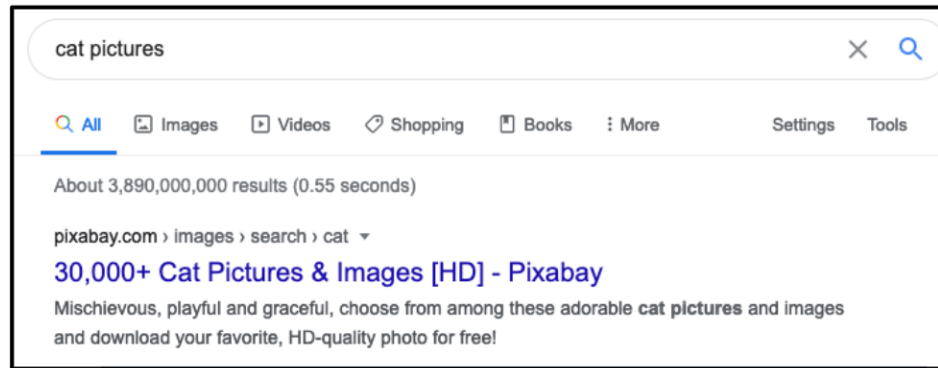
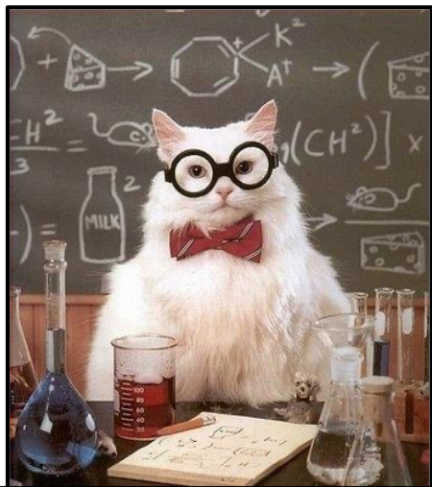
COMP-5370/6370
Fall 2025



What can it do?



The “web” was built to serve cat pictures.



What can it do?

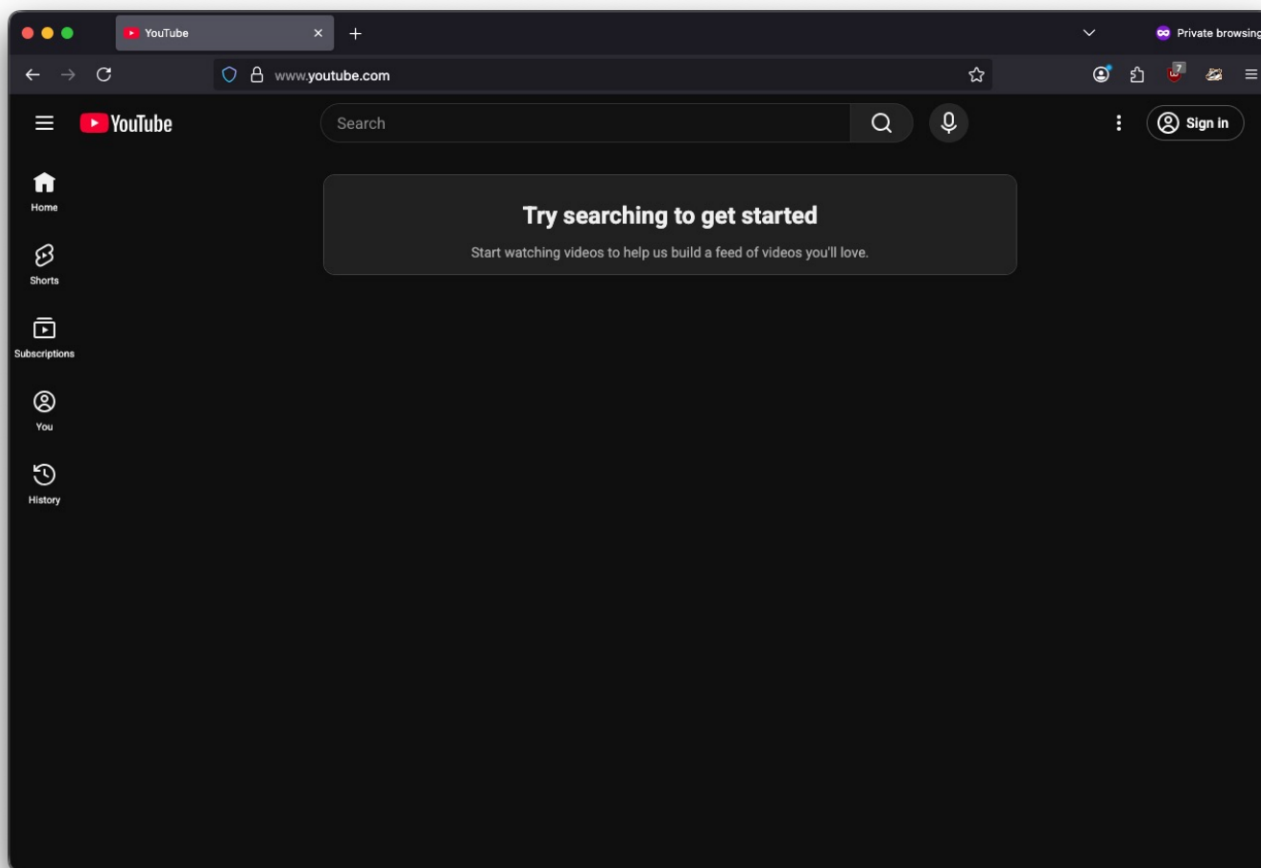


The “web” was built to serve cat pictures.

It was **NOT** build to serve cat pictures:

- In a secure way
- In a private way
- In a safe way
- In a trustworthy way

**The “web” is insecure
by-design and by-incentive.**





warhammer lore - YouTube

www.youtube.com/results?search_query=warhammer+lore

warhammer lore

Sign in

All Shorts Videos Unwatched Watched Recently uploaded Live Fantasy Total war Filters

Home
Shorts
Subscriptions
You
History

THE ENTIRE WARHAMMER 40,000 BACKSTORY WITH ANIMATIONS 51:42

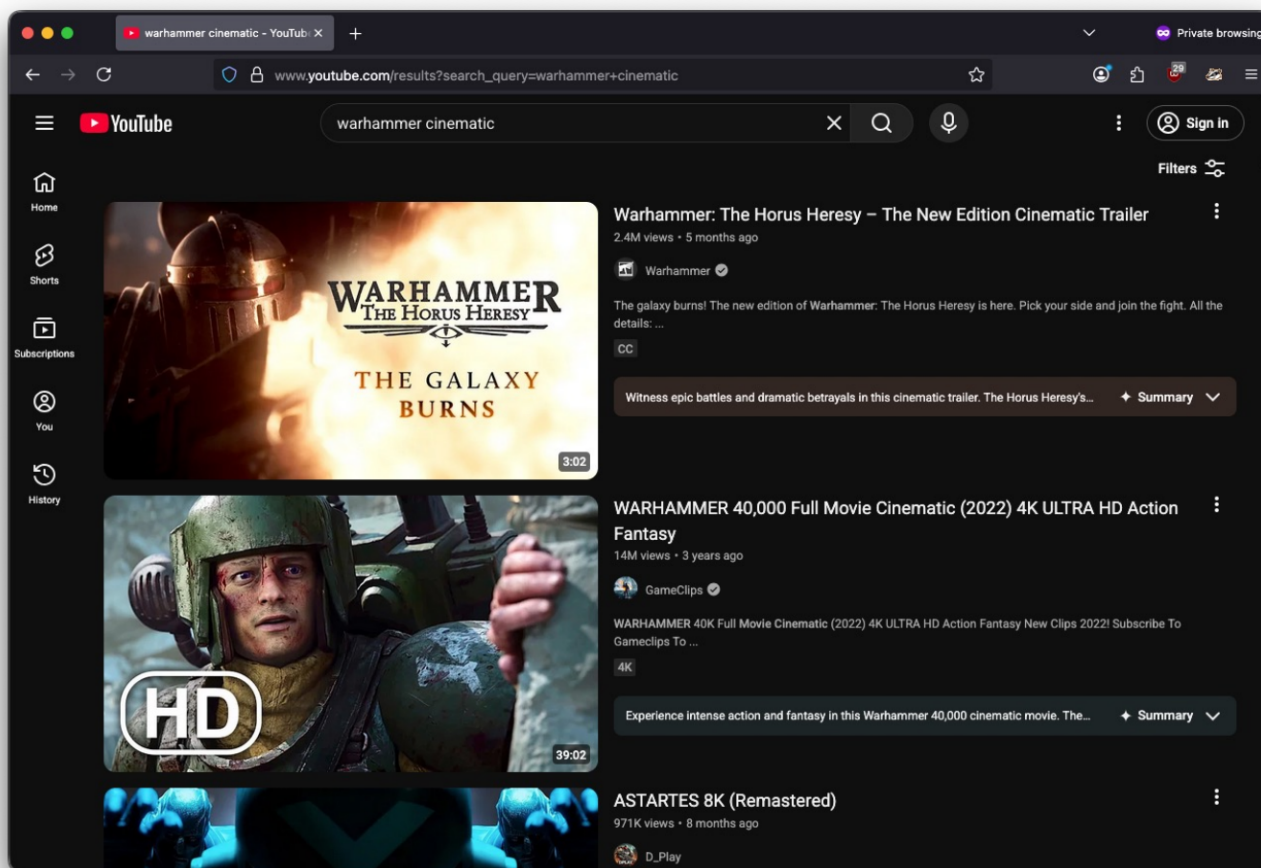
STORY AND LORE OF WARHAMMER 40K With ANIMATIONS | Every Faction Explained | The Whole Timeline
2M views • 2 years ago
Sandman of Terra
Fancy a PURITY SEAL by your name? Join the channel which also gives you exclusive access to our Discord commun...
CC
7 chapters AGE OF TERRA | AGE OF TECHNOLOGY | AGE OF STRIFE | UNIFICATION WARS | ...

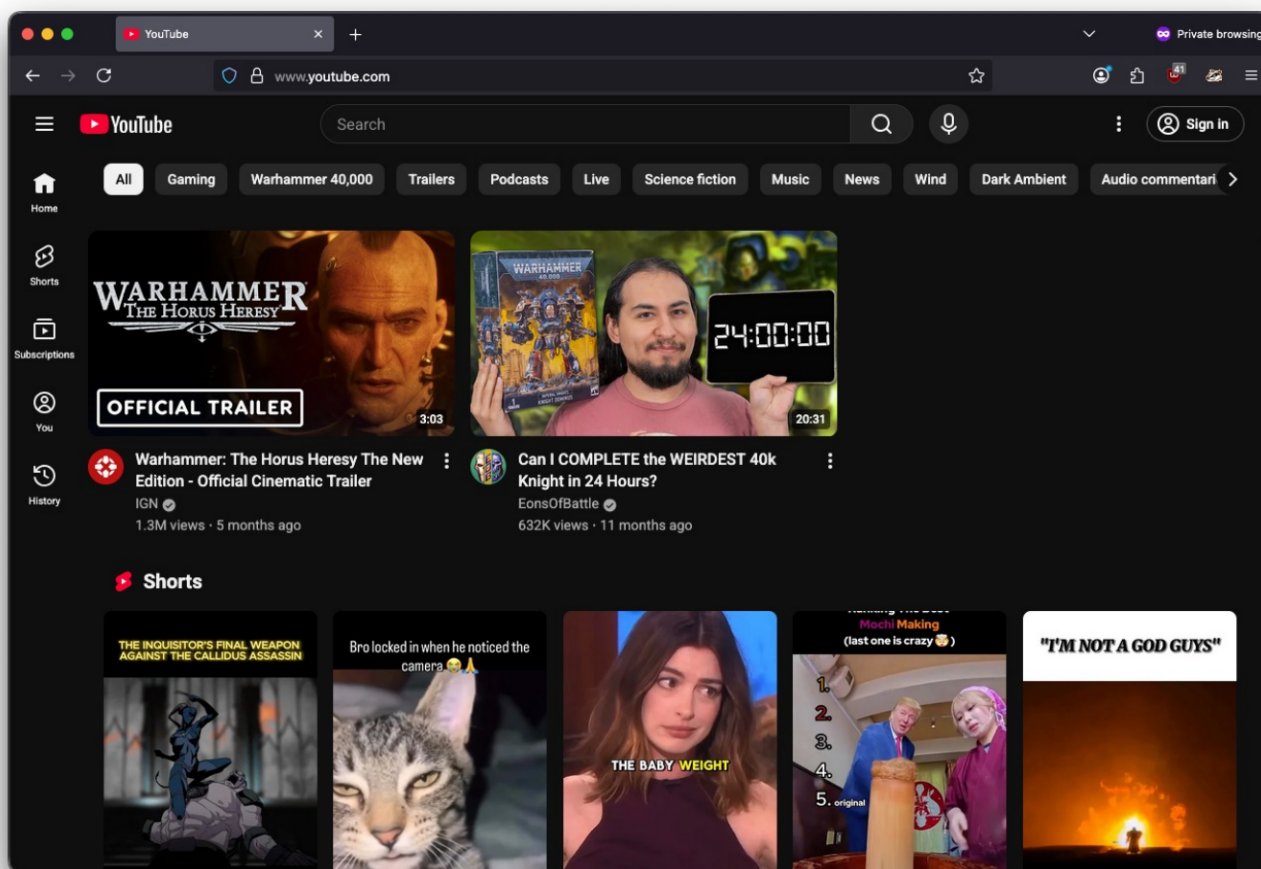
LT

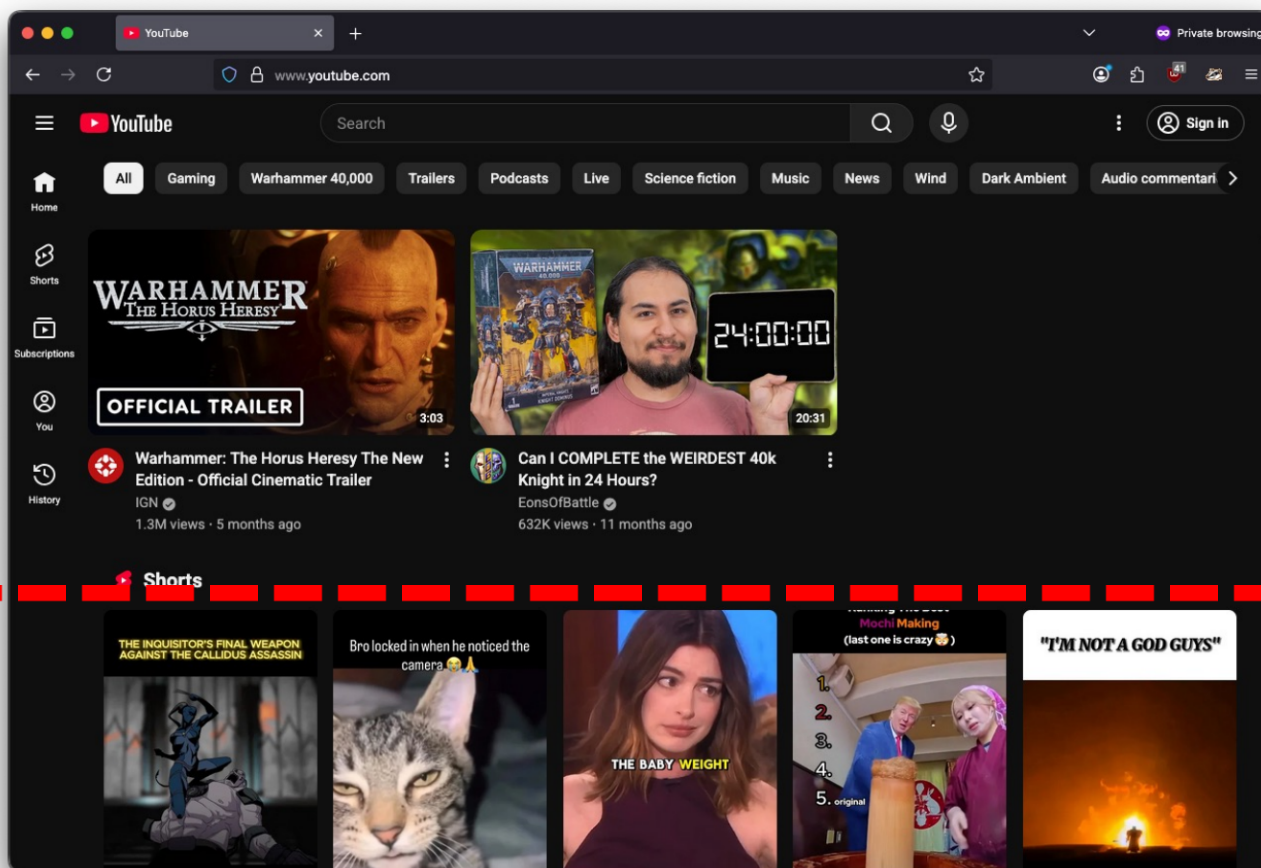
WTF IS 40K?

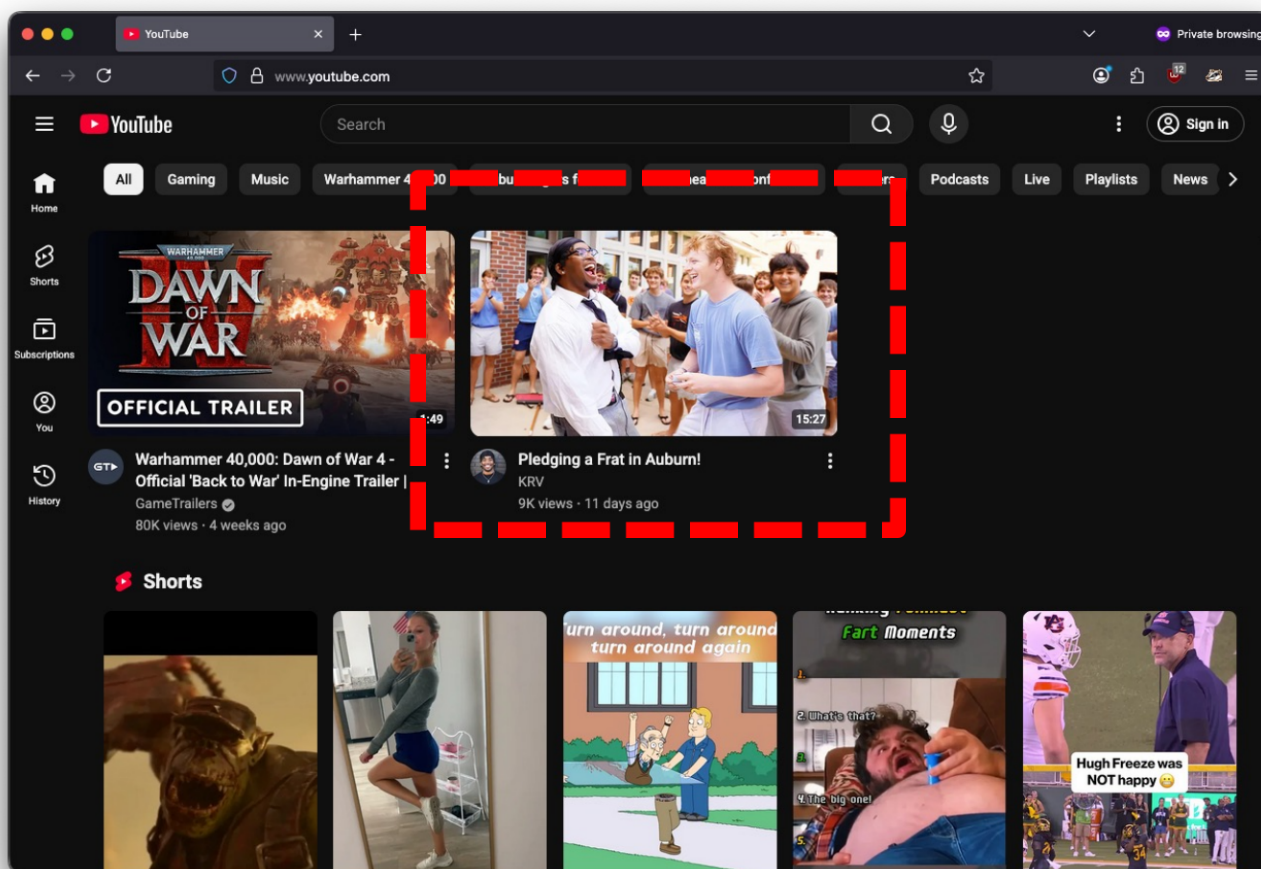
Luetin09 • 944K subscribers
Welcome to my Channel. I've been immersed in Warhammer 40000 for some 30 years now, my primary goal is to share that deep ...
Subscribe

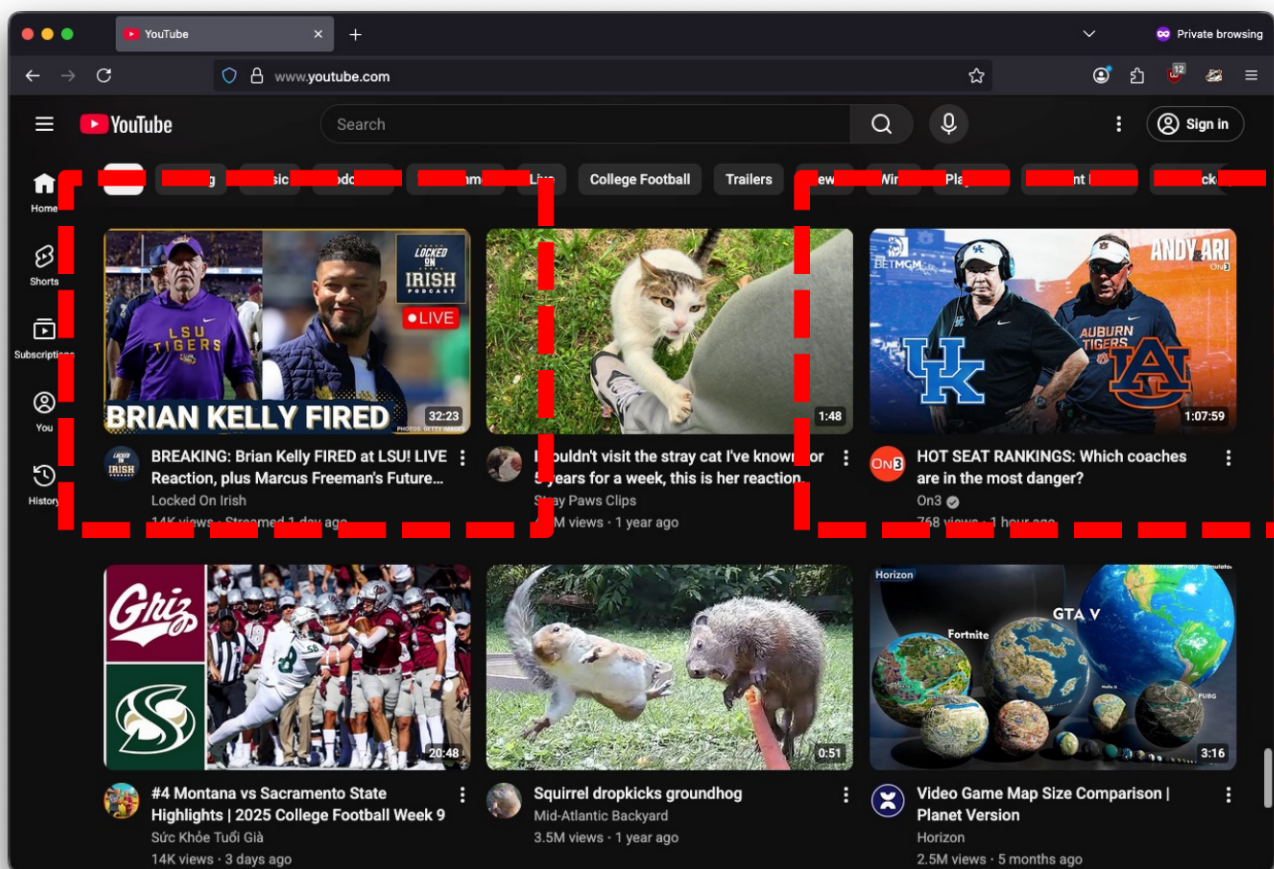
WARHAMMER 40,000 - LORE / HISTORY [In Order]
Luetin09 • Playlist • Updated 4 days ago
WTF IS WARHAMMER 40K? - EXPLAINED - FULL BEGINNER'S GUIDE + EVERY MAJOR FACTION | Lore/History - 22:20
DARK BEGINNINGS Necrons, Old Ones & Eldar | WARHAMMER 40,000 Lore / History - 18:50
View full playlist

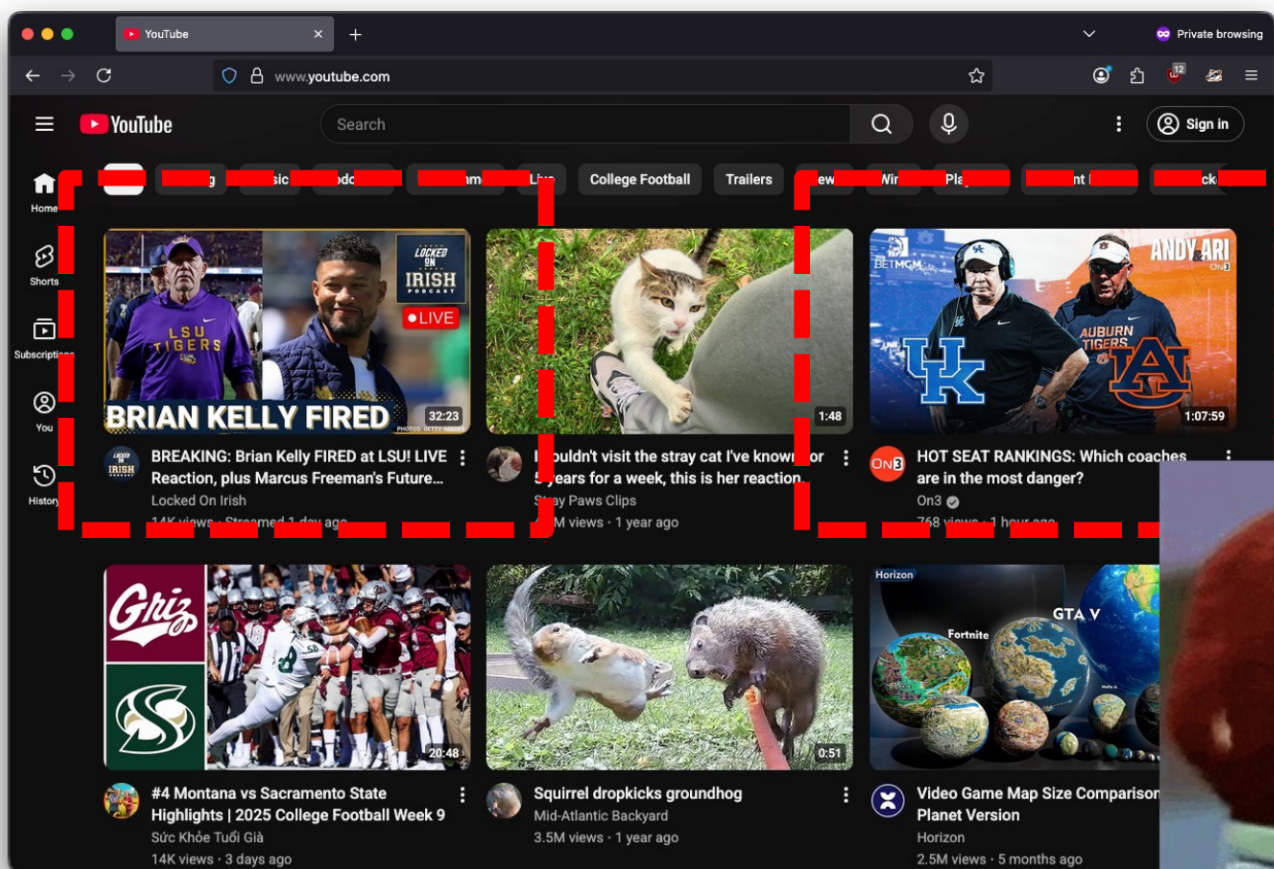














amazon

Delivering to Auburn 36830
Update location

All ▾

Search Amazon



EN ▾

Hello, sign in
Account & Lists ▾

Returns
& Orders

0 Cart

All Holiday Deals Medical Care ▾ Best Sellers Amazon Basics Prime ▾ New Releases Today's Deals Customer Support Registry Music Books Fashion Amazon Home Pharmacy Gift Cards

Save up to 50% on Blink home security systems



Limited-time offer



Try on Coach styles for free



Shop Coach with Prime Try Before You Buy

Top Deal



20% off Deal

College Apparel from Merch on Demand

See all deals

Explore sports gifts for kids



Shop kids' sports with free 2-day shipping

Sign in for the best experience

Sign in securely



Roll over image to zoom in

First Response Early Result Pregnancy Test, 3 tests, Packaging May Vary

by [First Response](#)

★★★★★ 486 customer reviews | 17 answered questions

#1 Best Seller in [Pregnancy Tests](#)



47 Amazon Students rated this highly



List Price: \$49.57

Price: **\$12.98** & Free Returns. [Details](#)

You Save: **\$6.59 (34%)**

Note: Available at a lower price from [other sellers](#), potentially without free Prime shipping.

In Stock.

Ships from and sold by Amazon.com. Gift-wrap available.

Want it Tuesday, March 24? Order within **29 hrs 56 mins** and choose **One-Day Shipping** at checkout. [Details](#)

Package Quantity: 1

1

\$12.98

2

\$41.00

3

\$57.99



Roll over image to zoom in

First Response Early Result Pregnancy Test, 3 tests, Packaging May Vary

by First Response

★★★★★ 486 customer reviews | 17 answered questions

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Package Quantity: 1

1

\$12.98 ✓Prime

2

\$41.00 ✓Prime

3

\$57.99

Customers Who Bought This Item Also Bought

Page 6 of 14 | [Start over](#)



VitaFusion Prenatal DHA and Folic Acid Gummy Vitamins, 180 Count
★★★★★ 140
\$20.25 ✓Prime



One A Day Women's Prenatal One Pill, 30 Count
★★★★★ 18
\$13.48 ✓Prime



Mayo Clinic Guide to a Healthy Pregnancy... the pregnancy experts...
★★★★★ 804
#1 Best Seller in Motherhood



Summer's Eve Cleansing Wash, Morning Paradise, 15 Ounce
★★★★★ 44
\$3.99



Nexcare 524560 Basal Digital Thermometer
★★★★★ 19
\$14.06 ✓Prime



Nature Made Prenatal Multi Vitamin Value Size, Tablets, 250-Count
★★★★★ 213
\$16.79 ✓Prime



Trojan Condom Pleasure Pack Lubricated, 40 Count
★★★★★ 126
\$18.12 ✓Prime



24 Things You Probably Didn't Know About Taylor Swift, But Should

She breaks records and changes the rules.



by **Ellie Bate**
BuzzFeed Staff

View All 64 Comments

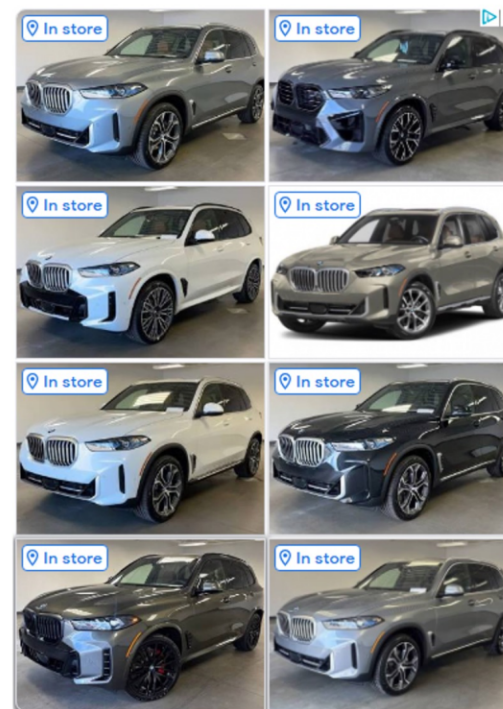


7 Gerber Printable Coupons!



THECOUPONINGCOUPLE.COM

ADVERTISEMENT



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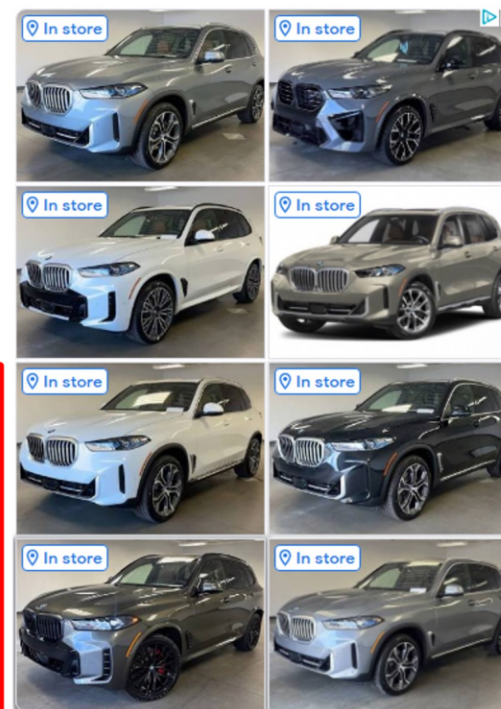


by **Ellie Bate**
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View All 64 Comments



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THECOUPONINGCOUPLE.COM 



\$2 off

Coppertone
Water Babies
sunscreen item
Excludes trial size



75¢ off

2+ to 8-pk.
Gerber Onesies



75¢ off

Johnson's
baby toiletry or
Desitin item
Excludes trial size and
Johnson's Buddies line



\$1 off

285-ct. Q-tips baby vanity pack
cotton swabs



\$1 off

Boudreaux's
baby care item
Excludes trial size



\$8 off

With purchase of two 1.37-lb. or larger
Similac powder infant formulas



\$1 off

Burt's Bees
baby Bee
toiletry item
Excludes trial size



\$1 off

California Baby
• 6.5-oz. natural bug
repellent spray or
• 2.9-oz. SPF 30+
sunscreen lotion or
• 5-oz. SPF 30+
sunblock stick



30¢ off

Ella's Kitchen organic baby food item



BABIES R US TOYS R US

Valid through 3/22/12

Save \$5

**ANY TWO 22-oz. or larger
powder formulas**

Brands cannot be combined.
Excludes Gerber Good Start Value Packs
and Unbeatable Price! items.



To redeem online, enter promotional code
#950347 at checkout. Online offer may vary.
Regular pricing applies if purchase requirement
not met. Not valid with any other "R" Us offer for
same item or on prior purchases. Coupon must
be surrendered at time of purchase and value is
forfeited if item is returned. We reserve the right
to limit quantities. Void where prohibited. By
MFR. Valid contiguous United States, Alaska and
Hawaii. Cash value 1/100 of 1¢.



\$10 off

Pampers Box Diapers
Super Pack, 74's to 94's, First 4



save on foods

PriceSmart foods

Present this coupon with your More Rewards card to the
cashier at time of purchase. Coupon cannot be combined
with any other Overstock Food Group coupon offer on
this product or redeemed for cash. Offer excludes reduce-to-clear items.
No substitutions. While supplies last.

Overwartea Foods

Cooper's Foods

Coupon valid January 4 to 9, 2014

Real-World Example



The Incredible Story Of How Target Exposed A Teen Girl's Pregnancy



GUS LUBIN
FEB. 16, 2012, 10:27 AM

Target broke through to a new level of customer tracking with the help of statistical genius Andrew Pole, according to a [New York Times Magazine](#) cover story by Charles Duhigg.

Pole identified 25 products that when purchased together indicate a woman is likely pregnant. The value of this information was that Target could send coupons to the pregnant woman at an expensive and habit-forming period of her life.

Plugged into Target's customer tracking technology, Pole's formula was a beast. Once it even exposed a teen girl's pregnancy:



Internet Privacy in 2025





Privacy



Privacy, at an extremely simplistic level, is the fundamental right to control what people know about you.

Article 12

No one shall be subjected to arbitrary interference with his privacy, family, home or correspondence, nor to attacks upon his honour and reputation.

Everyone has the right to the protection of the law against such interference or attacks.

The 4th Amendment

The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no Warrants shall issue, but upon probable cause, supported by Oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized.

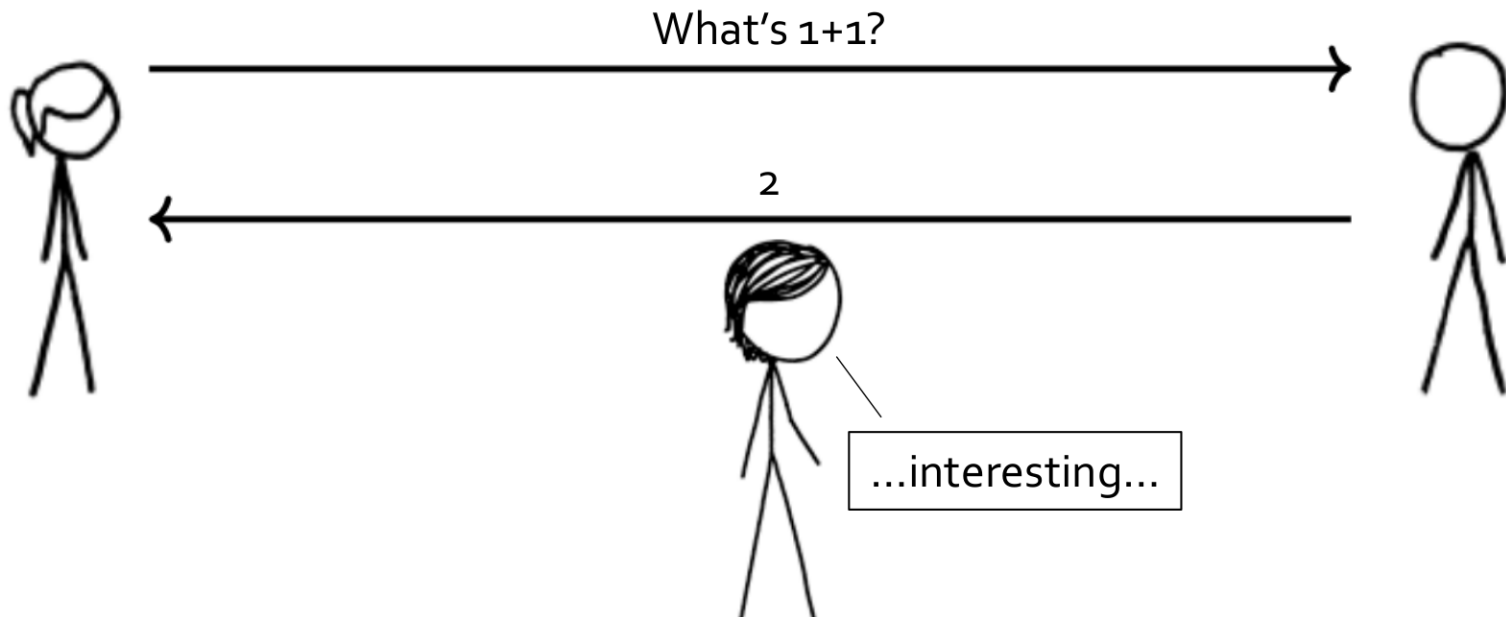
Internet Privacy



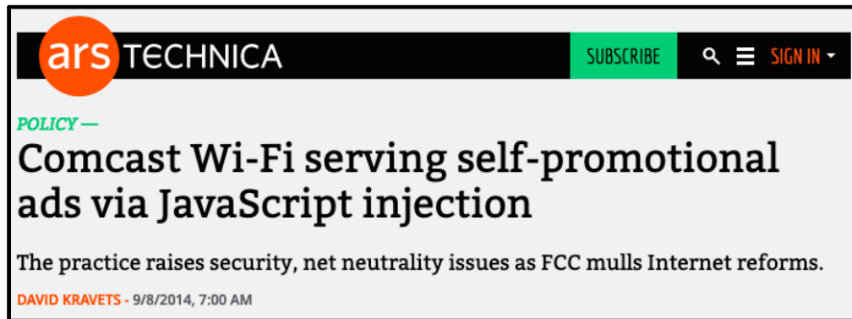
Internet privacy is the the right to control what data you share, when you share it, and who it is shared with.

- ***Different*** from Internet security but is ***related*** in important ways

A Communications Channel

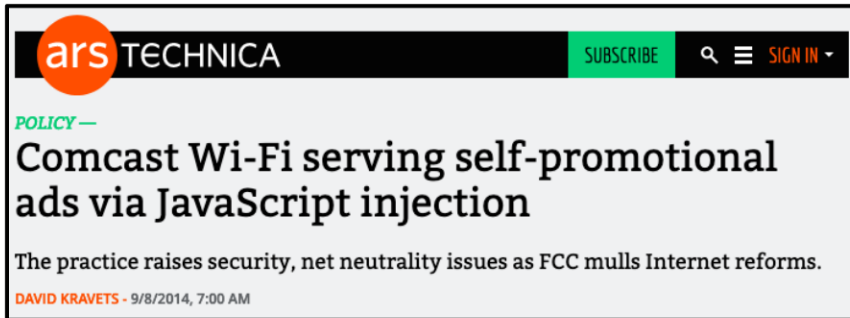


Network-Level Injection



- ISPs caught inserting content into customers' traffic to serve ads

Network-Level Injection



- ISPs caught inserting content into customers' traffic to serve ads



- ISPs caught inserting user-identifiers into customers' traffic to allow others to track

Network-Level Monitoring



- ISPs passively monitor customers' traffic for tracking

Philadelphia

BUSINESS
BizPhilly

Q&A: How Comcast May Still Sell Your Online Data Even Though It's Promised Not To

Wharton business ethics Professor Kevin Werbach weighs in on the state of online privacy following Congress's controversial repeal of privacy protections.

by **FABIOLA CINEAS** • 4/14/2017, 11:08 a.m.

WIRED BACKCHANNEL BUSINESS CULTURE GEAR IDEAS MORE ▾

RYAN SINGEL SECURITY 05.30.2007 12:00 AM

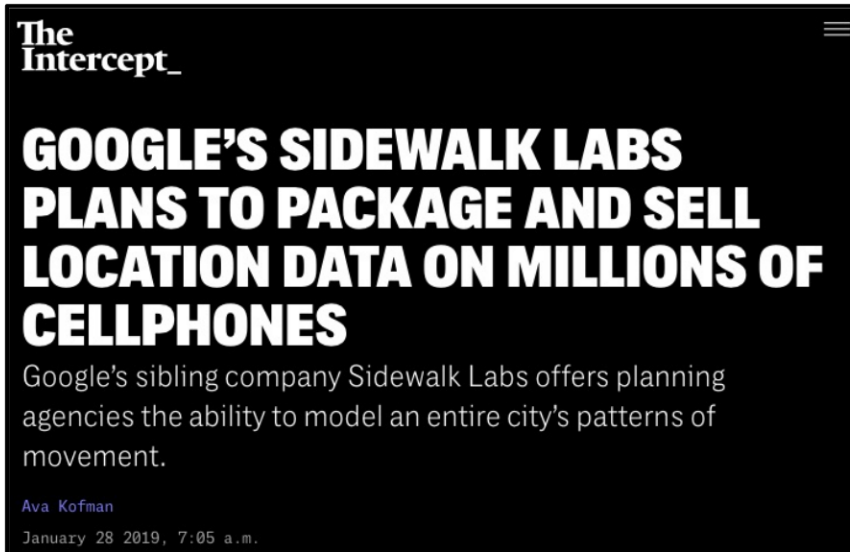
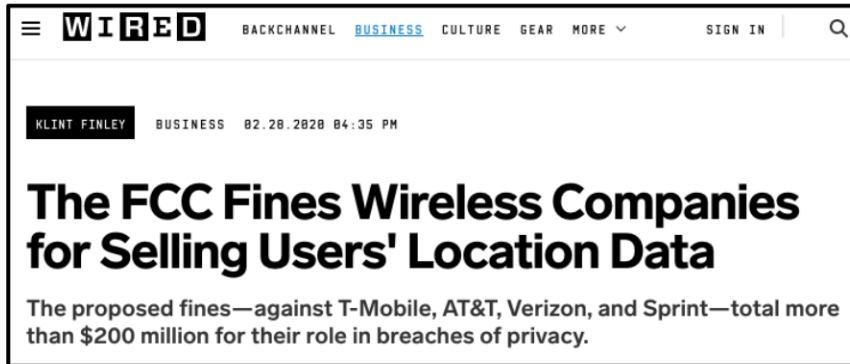
Which ISPs Are Spying on You?

Understanding website privacy policies is a challenge, but it's important to wade through your internet service provider's -- the company that ferries all your traffic to and from the internet, from search queries to BitTorrent uploads, flirty IMs to porn.



- ISPs passively monitor customers' traffic for tracking
- User agrees to thousand-page ToS which hides usage

Network-Level Monitoring



- ISPs passively monitor customers' traffic for tracking
- User agrees to thousand-page ToS which hides usage
- Companies treats as new revenue source

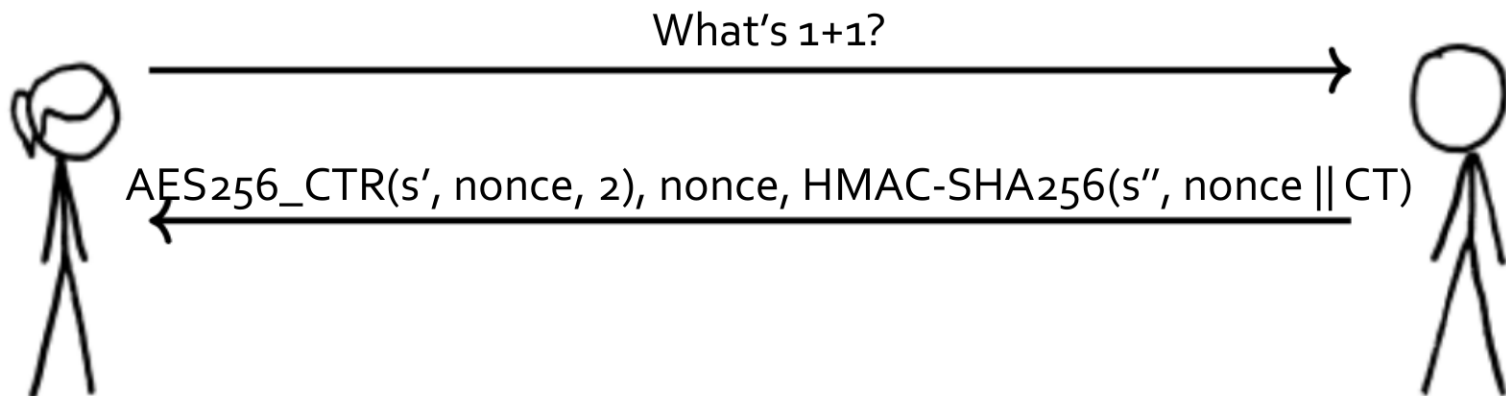
Building a Secure Channel



Confidentiality

Message Integrity

Sender Authenticity



Content Confidentiality



9.f...J...C.'j3. .s. .3.Z..j.[l...`tfl...A)..t=e..05*b.....-.....(.....[x.....;.....:6...l..A.6...]
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..v.f...N...q42...{^u..&..n~.C.....A...@SY[~...Ze}3?nb..(.....Z.....2..DZ.....
'.....k.g!.s...
.....
..|.x....(.f.7.ohy..T..5.....u.....5?&0...M[.....`..u..Y.-.....X1H.....C.N.....>Y..~oB..b.3{.....Z[...y..GT...12.....J...<..~s>J!..@Z.P.v...@\\....4...'.f;:x!...9K...X..^0d..
OfC...A.S+.N;:v|BM.V.....V...qo.0#~...!+./w!>.Xp9.F]*...v@.9.&*.n.n.`"<x;..#..L"*k..r..=.....ED1.0.<../.*l>.....H..q....yQ...'.X...U/@/g...a0...i..ZS.0..F...;L..M[
b...Pdv.M9.)5]...Tju2.:7z.P.l...>^[W'ch.Q..je...;|:..(..f.B.i.....9.....L.....A..*...?DS...*.X.J..m.....&.r.....e:ww...U{...B.S.:
t@.P..A>3]..f.F..r.A/.....z.0..).ecd(.q..l.....Jlcy..
..`..Y..p.t.3v.q.H.....G...5..0.0..F.v@)..:C.m.w..?)\*..+a..1X.....s.....T.....\_..t...}.GG..."`..Pgi..U1.%1F=.u.G...`f...5;U..9.%L.....'X.....D.TH.....W..v^C3o..F
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Iw./6-...y.b...../...m2z"%..v"N..QA..C..u.D.....t.D.K!..x..C.....u/_..oF...1g..7N0G..!..&@P...k{..&.f...0..F
.....h.....8./4..14Q+...sW.....G.Pe.j.6<...D..o.W(T.....~.....ZC./U..)}9.m..QW....._|..A..r.h.....3.....?.....?.....L"s..?..x.....!nN.....g.Z.&..P..D...
.....lz}9..+..{L^.....>.r.Jhp.m..l..J.e..-..n.....Ab.....W.F.PD...W..!..-..j/.....-..(!{2.AU
G..u....bG.C..".f..f..#.....\\..0#L..b..{..1\$B.<n.sgz....\$.u6[v...].#~.q;:Q.k..AXe..?..{}t>b...;@...Ux.....5...P..N.....K.....m.....^gR..s.;...R<..{..S..(..\\..
..:.....*.3..4s.....)k6s.{&.6..2.w.2.<.Le.....S.....\\i.ul.P..2..Rp.....z.c.....J.....a.IS.C).V
RI\\T!.....S...{..).a^0..}&uMY...X.R.....{..7..}...@.q..o
?.wK.ZbJ.%..@S.A..Y.%..8.....);a...Cb^J_#..X.A.R.T..1.]3.....(=>..B.c...D..F...E*..??I).Z..W.%.."n'.)?q?6G.k<~H..}...oN...;oeTVn.k.....6...1l...#.N.h
..Q=k..'..R[Z.j.?:Ub..J@:.....S...<..\$.....^..9J)...CL...d.TY.>?.[...t...[.v~.=f..Y.."\...q.^.[Z!0...*.r.g..}E~H.....u...0+.....~..?..BJ.]E... ..[\$
D.m.E=..#%IN...2-Y..d.p.T...W..*..T.....c]d...B...bo...
..6.....=...dU.Y[l:B..].u8...v..y../......\\..3..C..<j.....e9...K..Z.D..B..t.T.6..N{..A..R,..<.+/.@A#...e..N]v'.&.T.LX.....[k.r.5q_m.j]-...7...M...<...H
y.t.g..%.I.?..10...l6..}|0.d..!..3.H..{.|.z.]Ro..n.D.5("0
f.E..%fb..3..P..b...v..T.#.u.S..8.w..h..1..9Q...q...1..nU..9i.d022...I.....<../~N.<...%\$r.....1.....jK9...n..0^L..x.....^..@...}.nc.....}.S.r.
gm.t.%..k...y...e..S..X.....y8S...z.;r"h...9>=...Y.2.&.0.....\\r6..J_..9..n...a..`WRe..L\\.u&...)T!.U.Q....W..M.....~.....~.....H.^\$n..D...53..[...P...X/...w3..-
n..JZo..";...9xD...%.S..^..Q.o...:a..{.Y)..-..k...B.....&.X..H..*..^.....mp..
.4.{1...<..l3\$.i.....'...}%.....i..a..J.....&.\\f..09..Wn.q.....T.....Z..c61Y..F...*.UN.....`MdM...8..0.8I..(Tf.w..(t...
.E?..F..70.....t..t..\\..SN!X..._g..I!mV.1..+...b..dJ.>?..'.u.7..(wA@.N3[...p...:H.i..1.j[j..=j.A~...-..m..}.b.v..-R9...".7.....:v...%...&^9..2...{J.z.

End-Point Confidentiality



```

  ✓ Transport Layer Security
    ✓ TLSv1.3 Record Layer: Handshake Protocol: Client Hello
      Content Type: Handshake (22)
      Version: TLS 1.0 (0x0301)
      Length: 512
    ✓ Handshake Protocol: Client Hello
      Handshake Type: Client Hello (1)
      Length: 508
      Version: TLS 1.2 (0x0303)
      Random: 31bcfa8d853cabd02164668112e80be73c3c20cf565501ab530954cf5df68e2a
      Session ID Length: 32
      Session ID: 8b4741ce538f3a0a2b8ff57688707b629edafac91f747520737cd09ffcf280aa
      Cipher Suites Length: 34
      > Cipher Suites (17 suites)
      Compression Methods Length: 1
      > Compression Methods (1 method)
      Extensions Length: 401
    ✓ Extension: server_name (len=31)
      Type: server_name (0)
      Length: 31
    ✓ Server Name Indication extension
      Server Name list length: 29
      Server Name Type: host_name (0)
      Server Name length: 26
      Server Name: mozilla.cloudflare-dns.com

```

End-Point Confidentiality



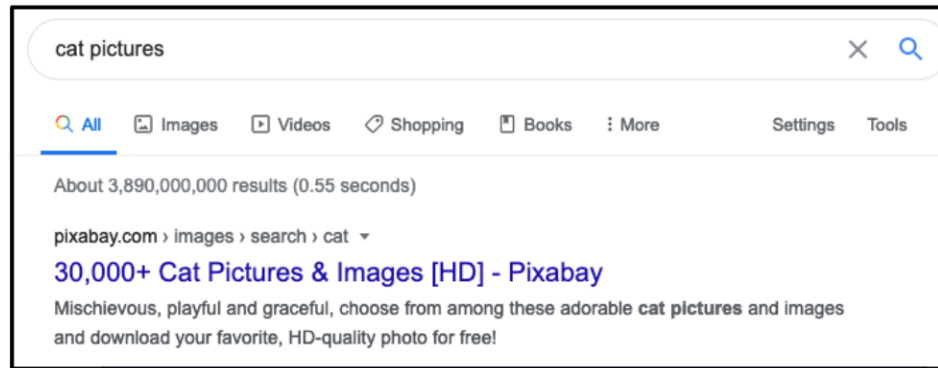
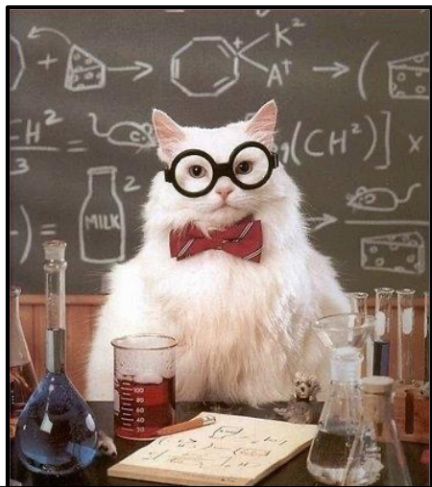
```
✓ Domain Name System (query)
  Transaction ID: 0x1c70
  > Flags: 0x0100 Standard query
    Questions: 1
    Answer RRs: 0
    Authority RRs: 0
    Additional RRs: 0
  ✓ Queries
    ✓ mozilla.cloudflare-dns.com: type A, class IN
      Name: mozilla.cloudflare-dns.com
      [Name Length: 26]
      [Label Count: 3]
      Type: A (Host Address) (1)
      Class: IN (0x0001)
      \[Response In: 156\]
```



What can it do?



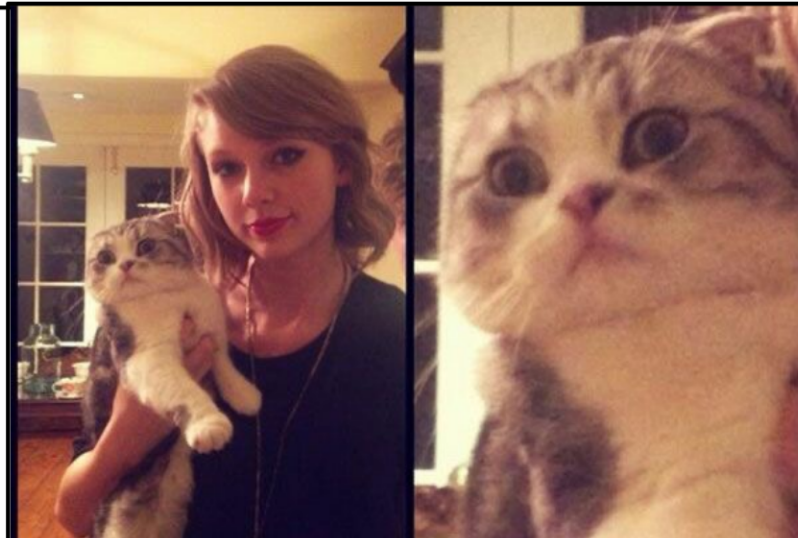
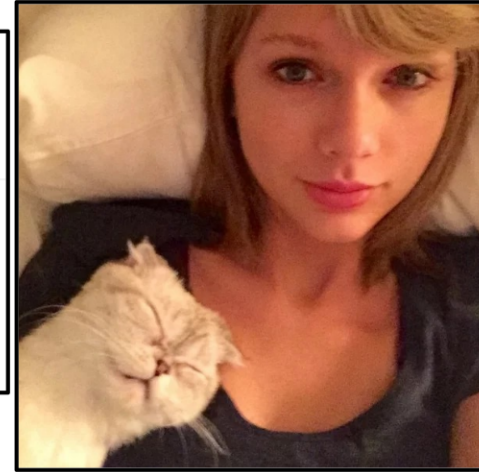
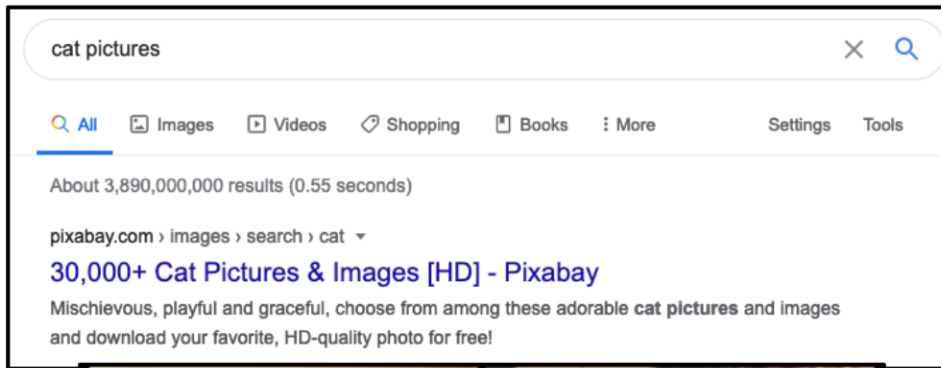
The “web” was built to serve cat pictures.



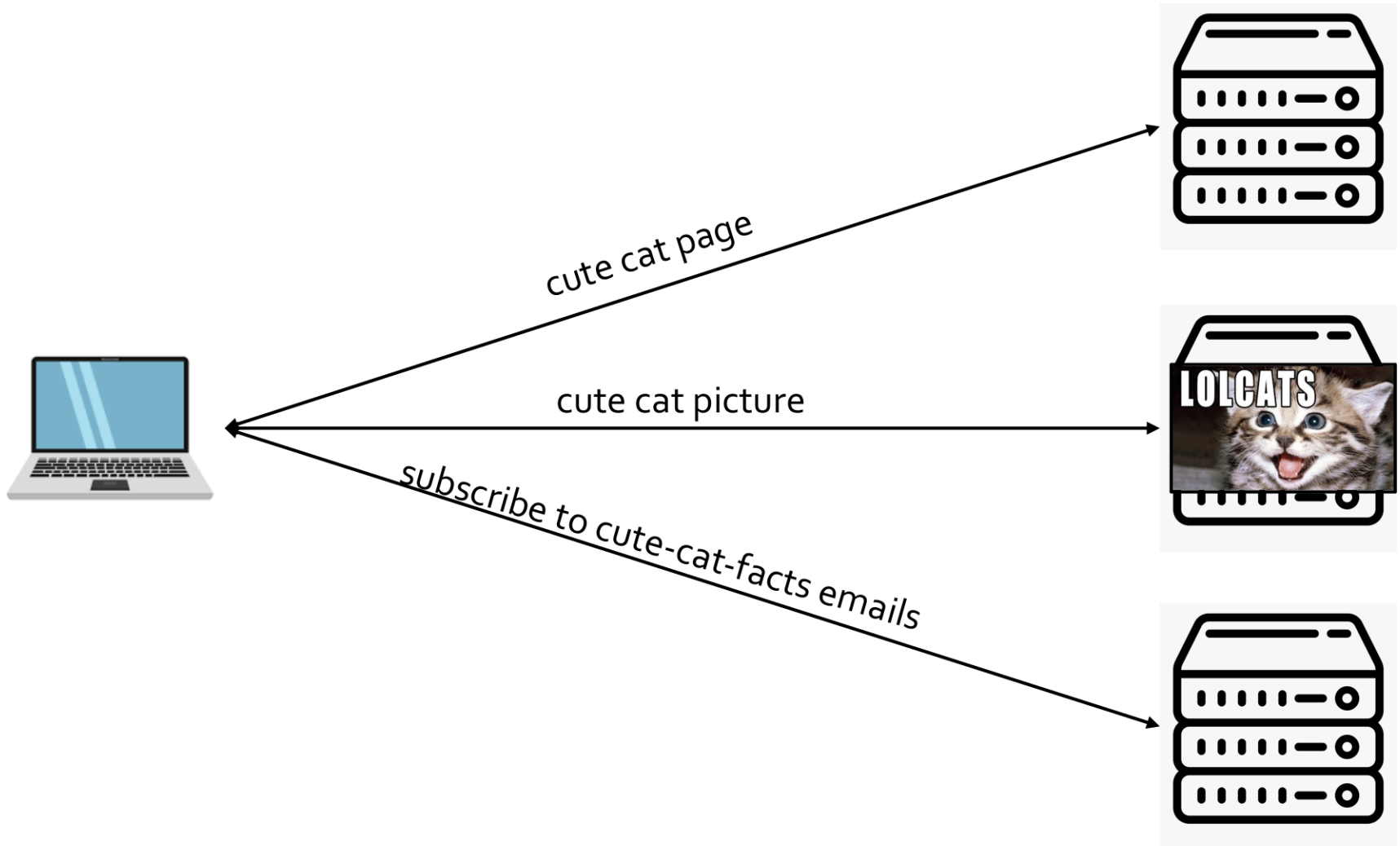
What can it do?



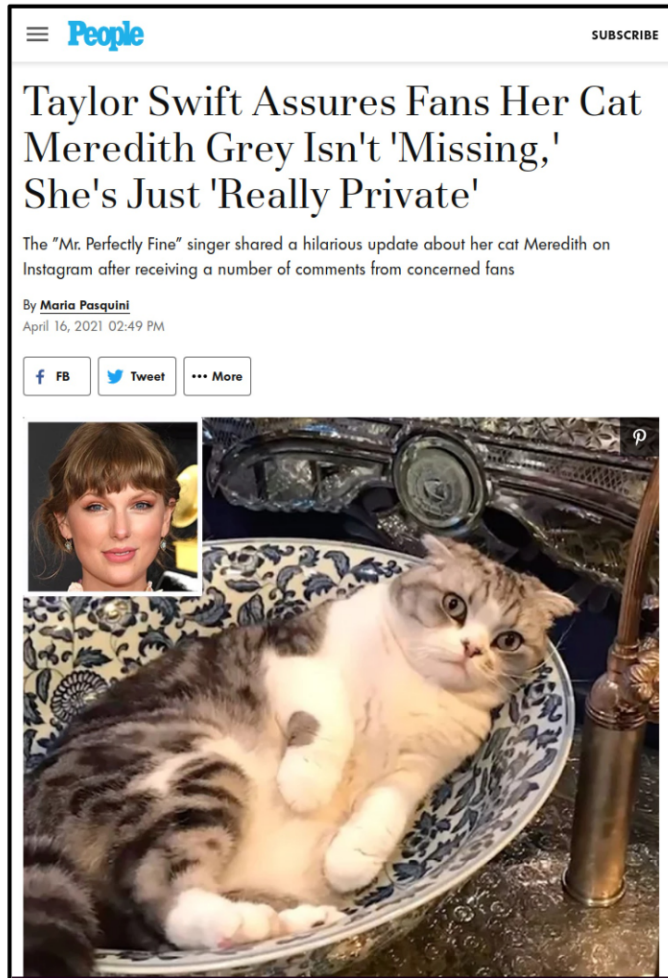
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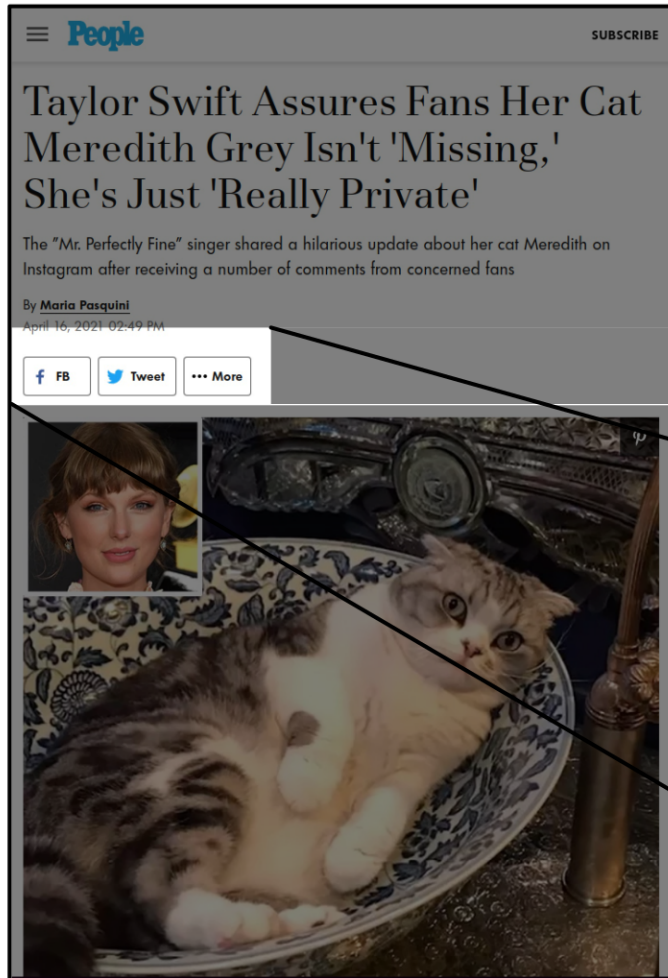
HTML Resource Fetching



Remote Content Fetching

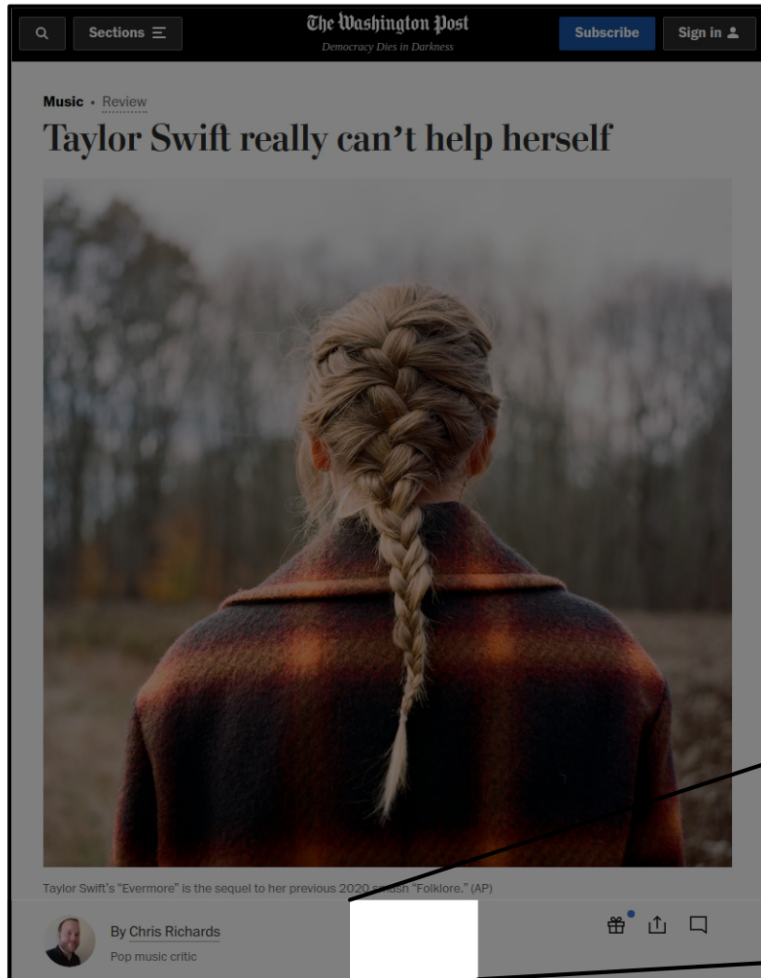


Remote Content Fetching



```
<iframe
  src="facebook.com/share-ui"
/>
<iframe
  src="twitter.com/share-ui"
/>
```


Tracking Pixels



Tracking Pixels are images which encode cookie-like identifiers into the image URL.

- Usually 1-5 pixels large
- Usually transparent

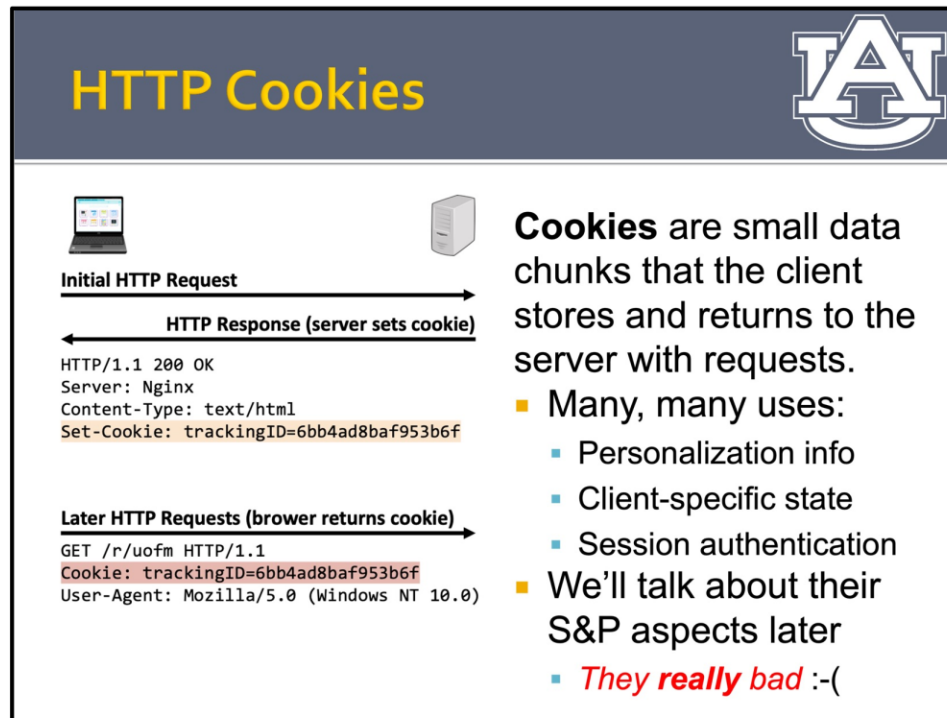
```

```

3rd Party Web Cookies



Third-Party Cookies are mechanism which allow non-obvious/undesired websites to track web clients across various 1P websites.



How 3rd Party Cookies Work



facebook

Cookie: ID=784c39
Referer: cnn.com/...



- User loads cnn.com
- CNN directs to load button from FB
 - Sets FB cookie



facebook

Cookie: ID=784c39
Referer: reddit.com/...



- User loads reddit.com
- Reddit directs to load button from FB
 - Reads FB cookie

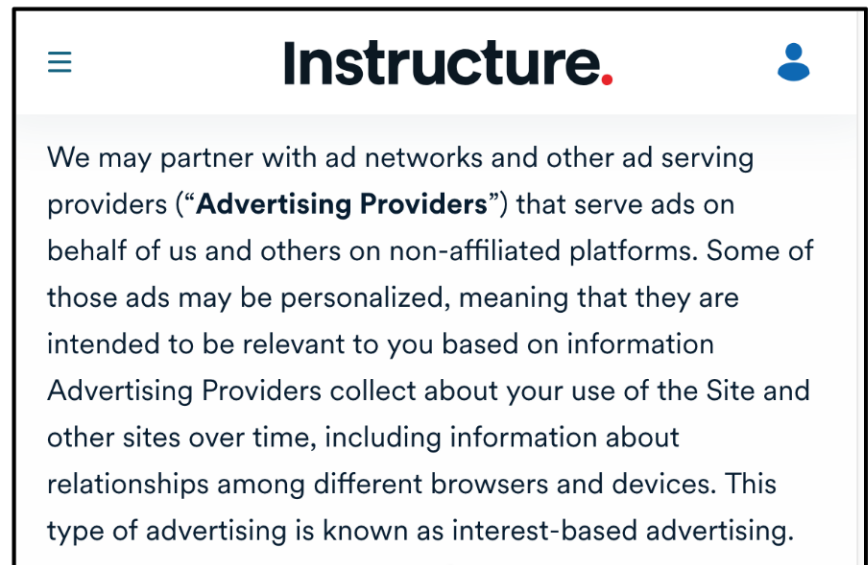
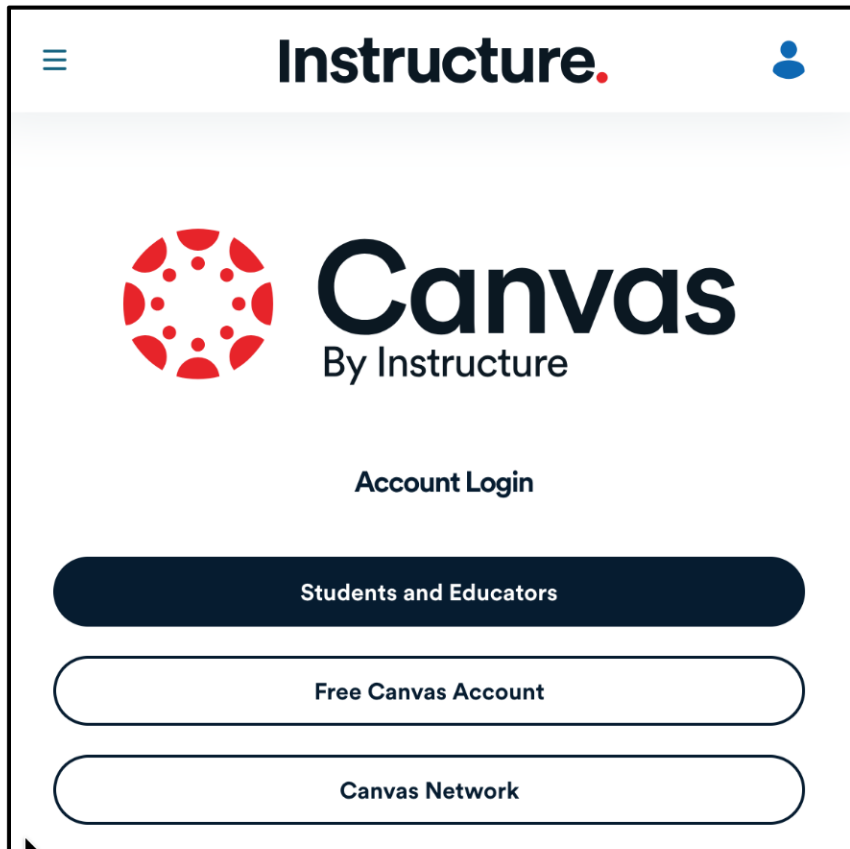
How 3rd Party Cookies Work



- User logs into Facebook
- FB cookie is sent along with credentials
- FB correlates ID/username

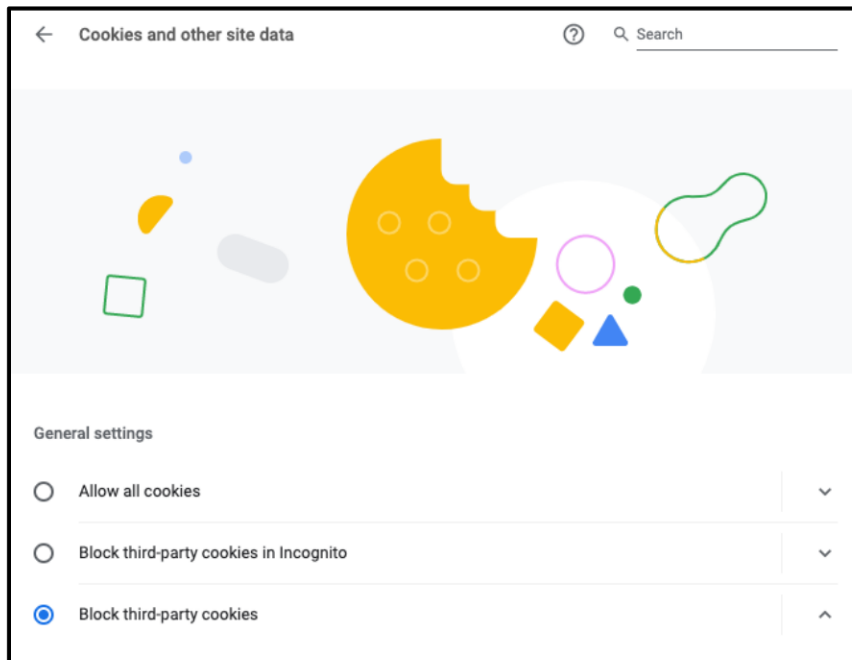
FB knows Alice went to CNN and Reddit

Advertising Cookies are EVERYWHERE





Blocking 3rd Party Cookies



- Requests still made but no cookies sent
- Relatively few websites break if disabled
- Personal Experience: *Requiring 3P cookies for basic functionality is a **giant red-flag***

Blocking 3rd Party Cookies



- Requests still made but no cookies sent

- Relatively few

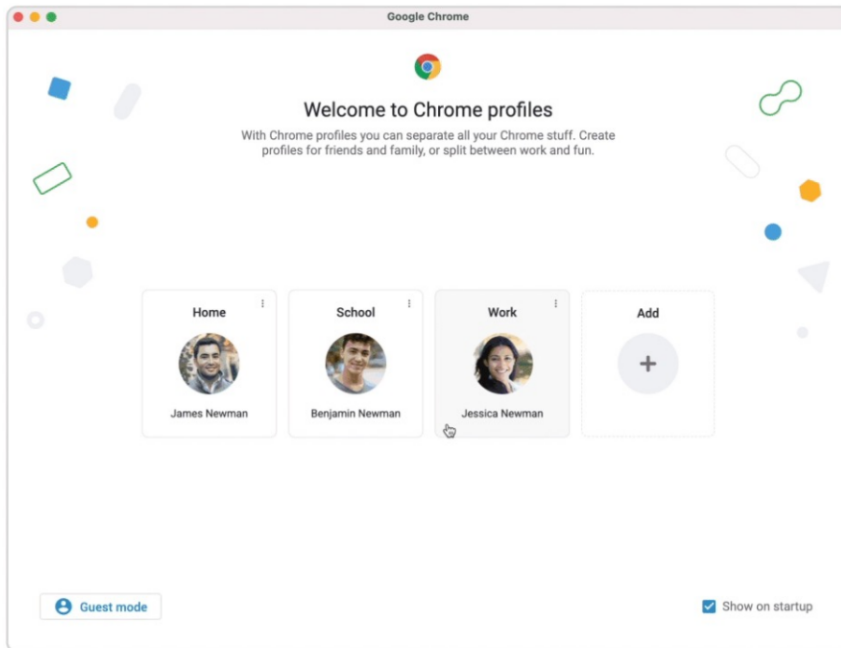
The image is a screenshot of a web browser. At the top, a 'Cookies and other site data' settings panel is open, showing options for 'Allow all cookies', 'Block third-party cookies', and 'Block all cookies'. The 'Block third-party cookies' option is selected. Below this, a course page for '202110 COMP-5370-001 > Fall 2020 - Computer And Network Security (COMP-5370-001)' is visible. The page has a dark blue sidebar with icons for Account, Dashboard, Courses, Calendar, Inbox, and a clock. The main content area has a blue header with the 'Honorlock' logo and a 'Need help?' button. Below the header, there is a white box titled 'Honorlock Issue' and a blue box with the text: 'Your course integration with Honorlock has encountered an issue. Please contact Honorlock support for further assistance.' At the bottom, a white box contains the message: 'An error occurred (Code: 2000). Please make sure your browser is not blocking third-party cookies. Please contact Honorlock support for further assistance.'

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Browser-Level Isolation

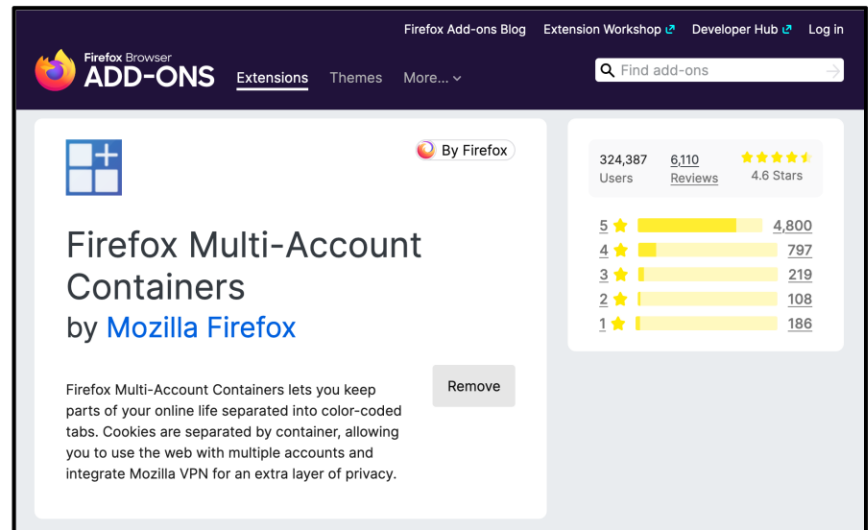


“Profiles”



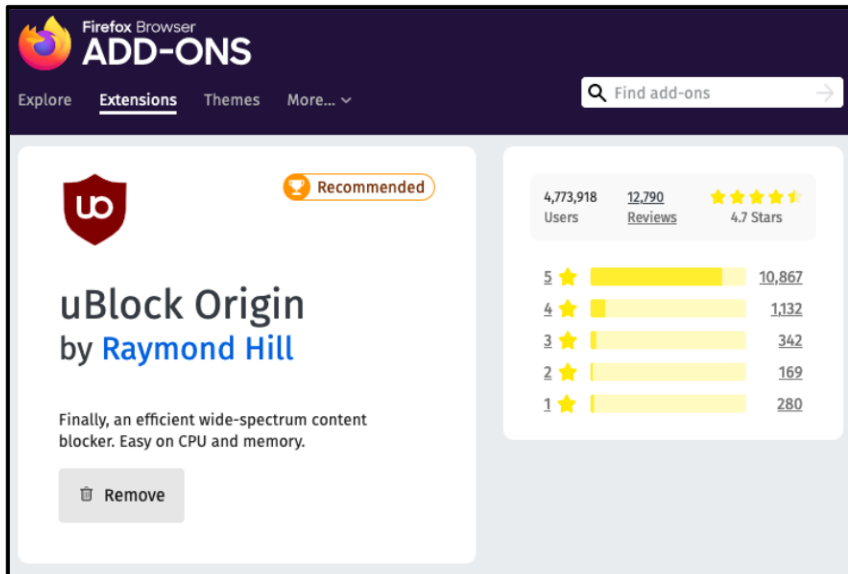
- Manually-switched browser instances

“Containers”



- Auto-switched cookies stores

Use an Ad-Blocker



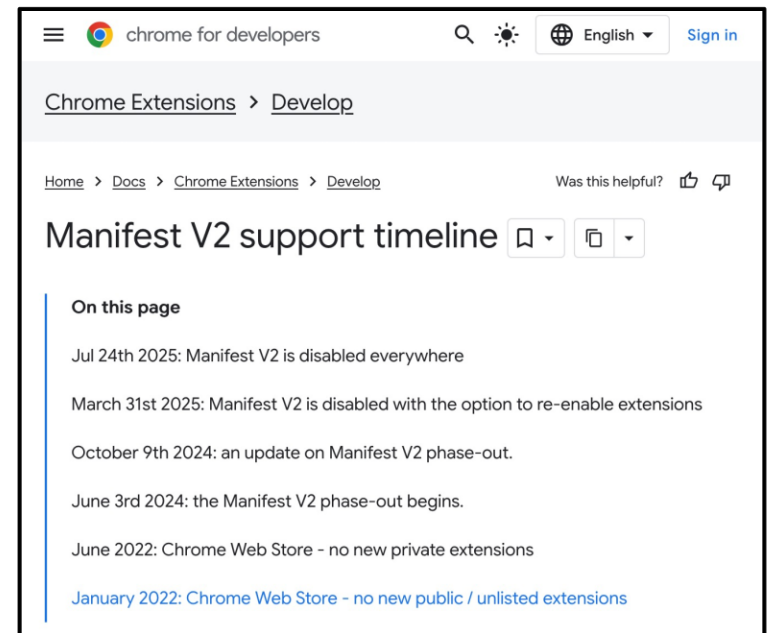
- Contains a list of known domains and URL patterns
- If a web request matches that list, it is blocked within the browser
- Very, very, very few websites break

Chromium Manifest v3



With the deprecation of Manifest API v2, ad-blockers have become significantly less-useful in all Chromium-based browsers.

- Chromium, Chrome, Edge, Brave, etc
- Safari & Firefox not affected (directly)



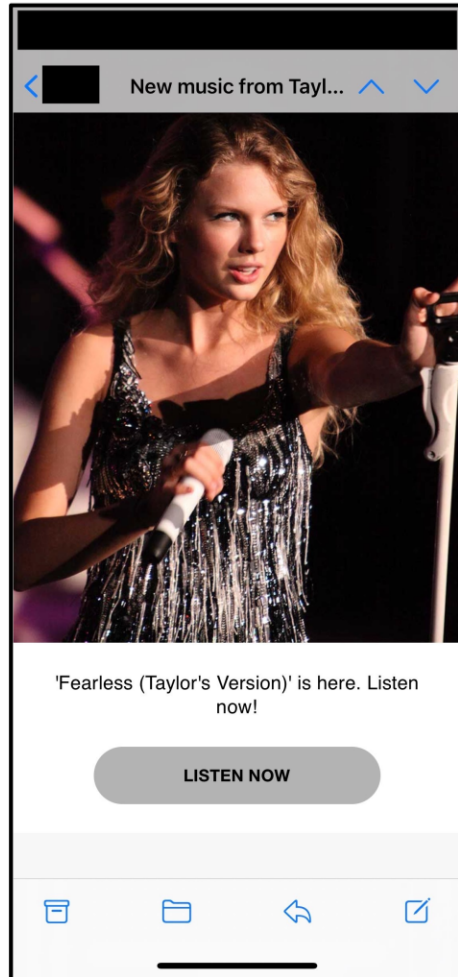


Dynamic Privacy Extensions

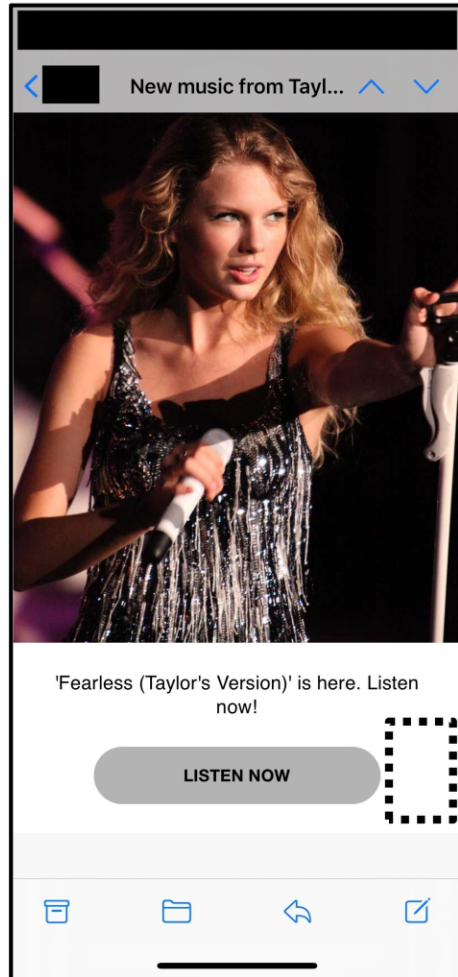


- Dynamically decides whether to allow cookies and dynamic content
 - Most are ***behavior-based*** and not ***rule-based***

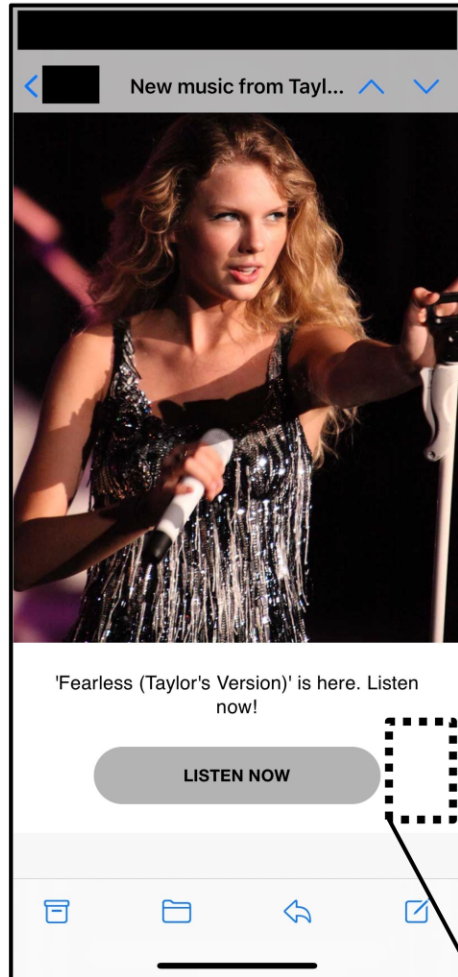
Web Within the Web (email)



Email Tracking



Email Tracking



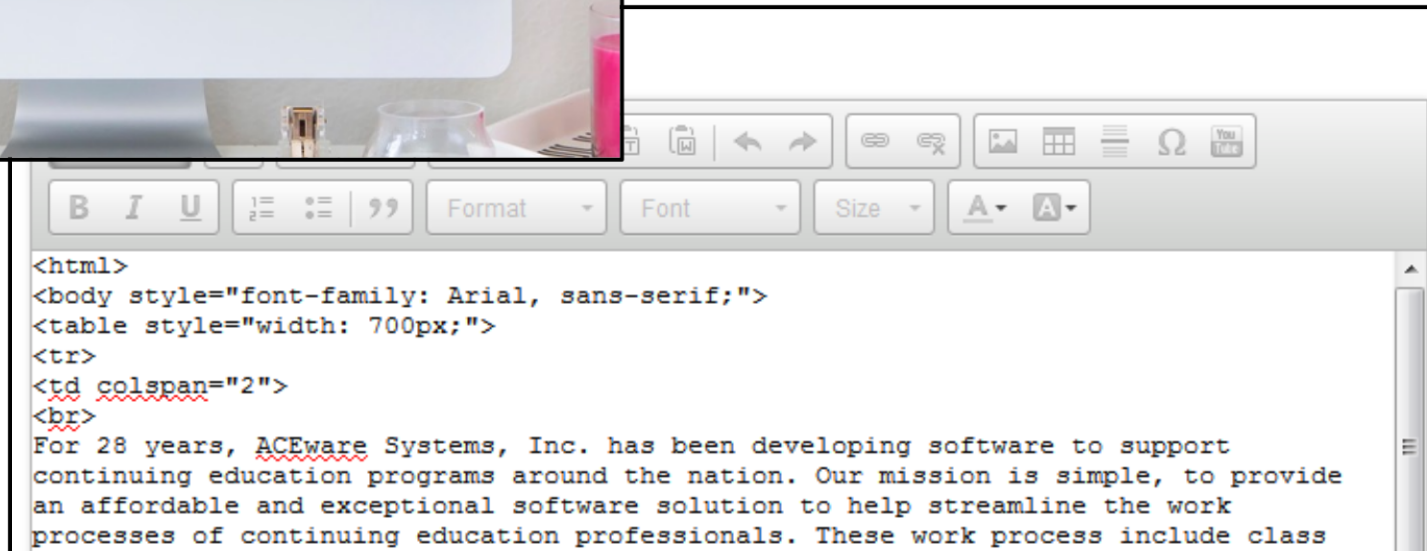
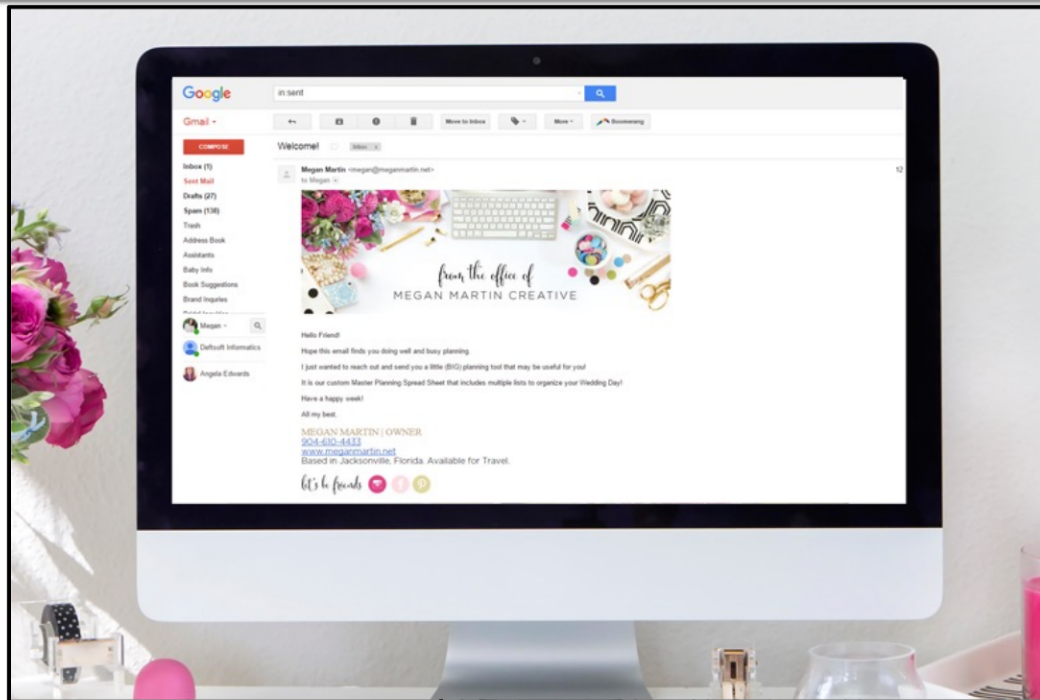
- Small, unnoticeable image in emails
- Image fetched by client when email is opened

**LITERALLY HAVE NO
OTHER PURPOSE**

```

```

Email Tracking





Disable Email Images



macOS Client

☐ Load remote content in messages
Email messages may contain images or content stored on remote servers.

Gmail

Images: ☐ Always display external images - [Learn more](#)
☒ Ask before displaying external images - This option also disables dynamic email.

OUTLOOK

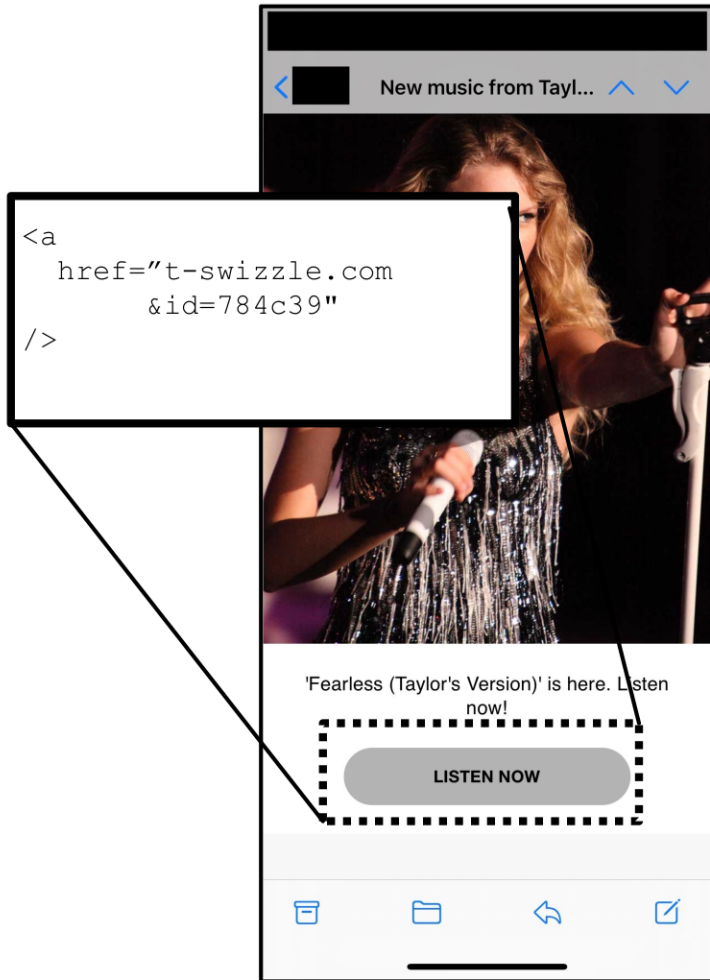
External images

Some external images can pose a security risk. Outlook helps protect your data by loading these images through our service. If you choose not have Outlook load your images, you risk exposing your device to malicious content.
[Learn more](#)

☒ Always use the Outlook service to load images
☐ Don't use the Outlook service to load images

- Some services and clients allow you to block images
- Sometimes they can but ignore setting
- Some pretend to offer but only have partial support

Link Tracking



- Shady entities send custom link to users
- Used to connect email + 1P cookies
 - Service sets cookieX without knowing user
 - Service sends custom URL to Alice
 - When clicked service sees URL + cookieX

Browser Fingerprinting



- Computers are not 100% deterministic
- Anything unique is a side-channel to the HW/SW used
- Uniqueness is an is an implicit identifier of user/computer/etc

GPU Fingerprinting Example



```
var screenshotTarget = document.body;  
var imageCanvas = target.html2canvas(screenshotTarget);  
var imgString = imageCanvas.toDataURL("image/png");  
var ident = createHash('sha256').update(imageCanvas).digest();
```

- Browser uses GPU to render picture
- GPU introduces uniqueness to image
- JS takes screenshot of image as shown
- Hash of screenshot is unique identifier for that computer's GPU

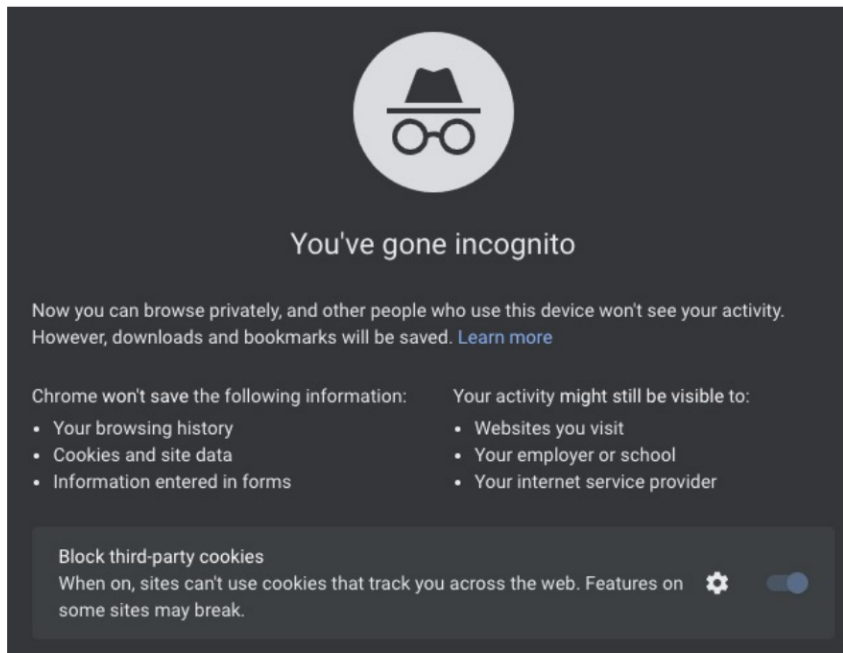




Sometimes, you don't want the server to know/remember who you are.

A screenshot of a Google search interface. The search bar contains the text 'taylor swift cat breed'. A dropdown menu shows related search suggestions. Below the search bar, there are several image thumbnails showing Taylor Swift with her cats. A 'View more images' button is visible. At the bottom, there is a 'People also ask' section with four questions related to Taylor Swift's cats. The entire interface is framed by a dark border.

Private-Browsing Mode



- Meant for short-term usage
- Each **instantiation** is completely isolated
 - No cookies shared
 - No history
 - No cache
- Opening and closing profile clears most identifiers

Anonymity



Anonymity is the *concept* that any piece of information can not be tied to a real-world identity which it describes.

- Lots and lots of trade-offs when adding
- Lots of techniques but many are far-less useful than they appear

Anonymity in Datasets



Replacing Identifiers



BEFORE: Alice likes to look at cat pictures

AFTER: user-123 likes to look at cat pictures

2006: AOL published “anonymized” queries

4417749 clothes for age 60
4417749 60 single men
4417749 best retirement city
4417749 jarret arnold
4417749 jack t. arnold
4417749 jaylene and jarrett arnold
4417749 gwinnett county yellow pages
4417749 rescue of older dogs
4417749 movies for dogs
4417749 mini strokes
4417749 dog that urinates on everything

A Face Is Exposed for AOL Searcher No. 4417749

By MICHAEL BARBARO and TOM ZELLER Jr.
Published: August 9, 2006

Buried in a list of 20 million Web search queries collected by AOL and recently released on the Internet, the identity of AOL user No. 4417749. The number was assigned by the company to protect the searcher's anonymity, but it was not a shield.



No. 4417749 conducted hundreds of searches over a three-month period, ranging from “numb fingers” to “60 single men” to “dog that urinates on everything.”

And search by search, click by click, the identity of AOL user No. 4417749 was easier to discern. There are queries for “landscapers in Lilburn, Ga.,” “homes sold in shadow lake subdivision gwinnett county,” and “jarrett arnold.”

It did not take much investigating to follow that data trail to T. L. Arnold, who lives in Lilburn, Ga., frequently researches her friends' medical records. “I know what are my searches,” she said, after a reporter read part of the list.

AOL removed the search data from its site over the weekend after the publication of the article.

Removing Identifiers



BEFORE: Alice likes to look at cat pictures

AFTER: A user likes to look at cat pictures

*2019: NYC published
dataset for cab rides
including pickup/drop-off
location and other data*

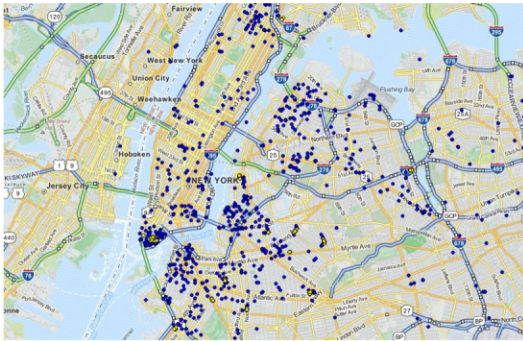
High Volume License Number	License Number	Base Name	App Company Affiliation
HV0002	B02914	VULCAN CARS LLC	Juno
HV0002	B02907	SABO ONE LLC	Juno
HV0002	B02908	SABO TWO LLC	Juno
HV0002	B03035	OMAHA LLC	Juno
HV0005	B02510	TRI-CITY,LLC	Lyft
HV0005	B02844	ENDOR CAR & DRIVER,LLC.	Lyft
HV0003	B02877	ZWOLF-NY, LLC	Uber
HV0003	B02866	ZWEI-NY,LLC	Uber
HV0003	B02882	ZWANZIG-NY,LLC	Uber
HV0003	B02869	ZEHN-NY,LLC.	Uber
HV0003	B02617	WEITER LLC	Uber
HV0003	B02876	VIERZEHN-NY, LLC	Uber
HV0003	B02865	VIER-NY,LLC	Uber
HV0003	B02512	UNTER LLC	Uber
HV0003	B02888	SIEBZEHN-NY,LLC	Uber
HV0003	B02864	SIEBEN-NY,LLC	Uber
HV0003	B02883	SECHZEHN-NY, LLC	Uber
HV0003	B02875	SECHS-NY, LLC	Uber
HV0003	B02682	SCHMECKEN LLC	Uber
HV0003	B02880	NEUNZEHN-NY, LLC	Uber
HV0003	B02870	NEUN-NY,LLC	Uber
HV0003	B02404	KUCHEN,LLC	Uber
HV0003	B02598	HINTER LLC	Uber

Removing Identifiers



BEFORE: Alice likes to look at cat pictures

AFTER: A user likes to look at cat pictures



Addresses of pickups for rides that ended at strip clubs.

Tracking celebrities who people spotted getting into a cab at a particular place and time.



Bradley Cooper

Jessica Alba

K-Anonymity



K-anonymity is a less-awful way to anonymize data that *generalizes* it until no longer re-identifiable to a chosen degree.

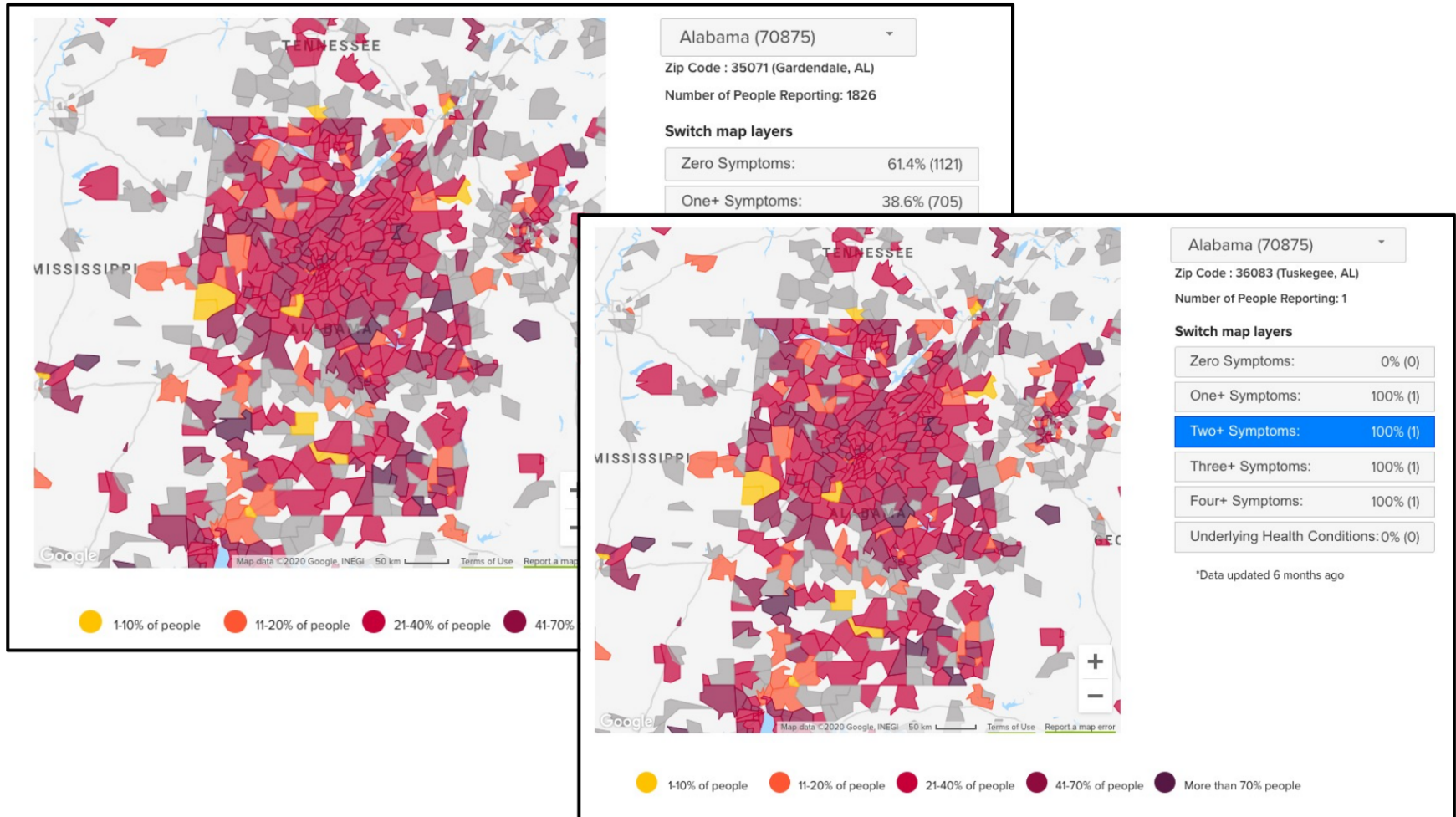
BEFORE: Alice likes to look at cat pictures

AFTER: In AL 8 ppl like to look at cat pictures

- Works well when questions are already known
- Other questions can't be answered due to granularity

ZIP	DOD	Disease
902**	1987	Cancer
902**	1987	Cancer
902**	1987	Cancer
902**	1954	Heart Disease
902**	1954	GI Disease
902**	1954	Died of poison apple
904**	1978	Heart Disease
904**	1978	Cancer
904**	1978	Cancer

K-Anonymity Depends on K

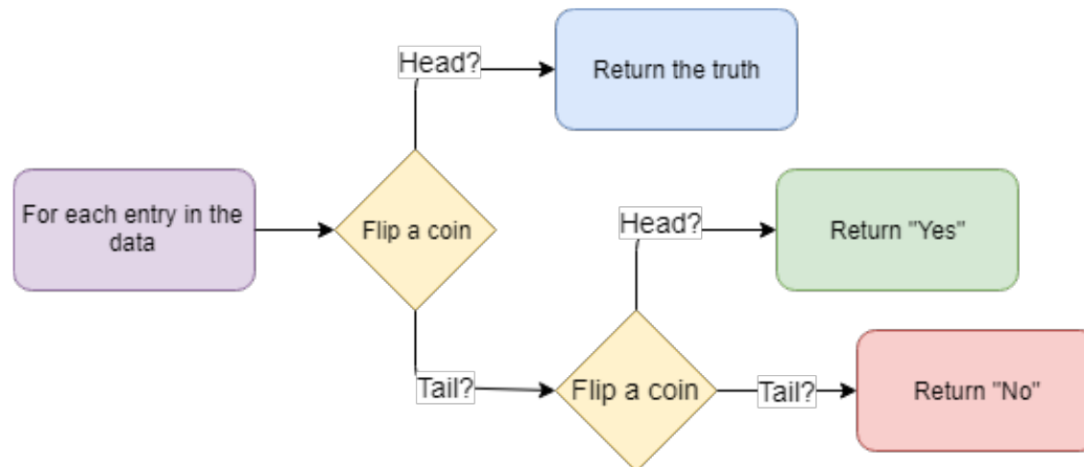


Differential Privacy



Differential Privacy is a technique in which a dataset can contain partially incorrect data on an individual but it is simultaneously:

- Guaranteed to be correct as-a-whole
- Impossible to attribute to an individual



Math is cool :-)

Computer and Network Security

Lecture 20: Web Privacy

COMP-5370/6370
Fall 2025

