Digital Forensics
Lecture Week 3

Web Browsers
Web Tracking
Browser History

Readings

Our Focus today

- We think the suspect visited some interesting websites
- How can we check?
- Does a Web browser leave any traces?
- What files does a web browser open?
- What footprint does it leave in memory?
- Can we attribute the browser use to a person?

Objectives

- To use Web Browsers for Forensics
- To use web tracking for Forensics
- To locate and examine cookie files
- To locate and examine web browser history
- To locate and examine temporary internet files

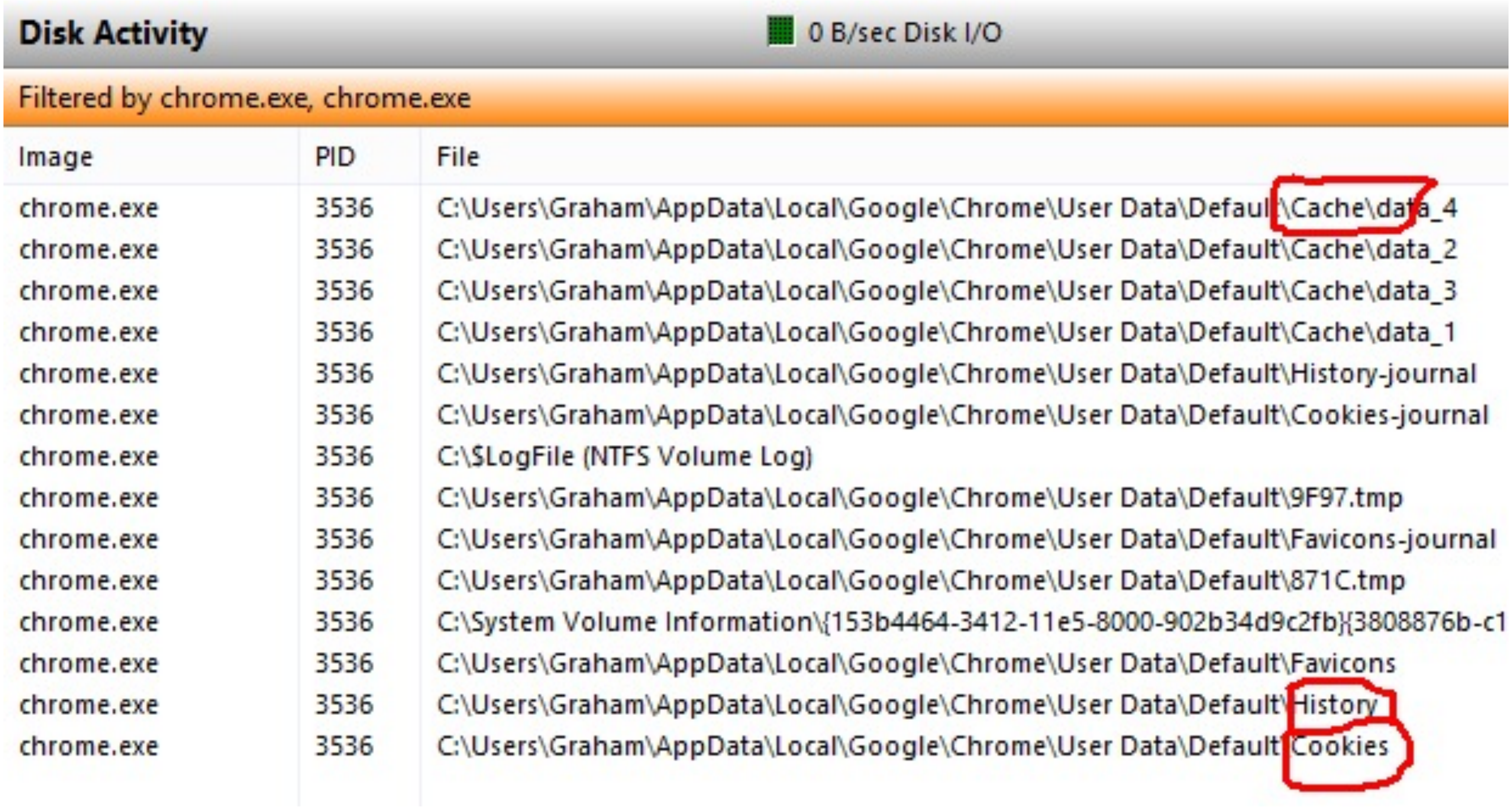
Forensics on browser data

- We want to locate evidence of a suspect visit to a website
- We want to locate the files involved
- We want to search the files post mortem
- This means **no** browser
- Where are the chrome files?
- We need to match a running process with its files

A web browser

- Quite a complex process
- several http conversations on different tcp ports
  - Nowadays encrypted as TLS
- html/xml rendering for the screen display
- Often multiple processes
- tabbed windows create more tcp ports and processes
- several files opened and locked

Windows Resource Monitor - PG

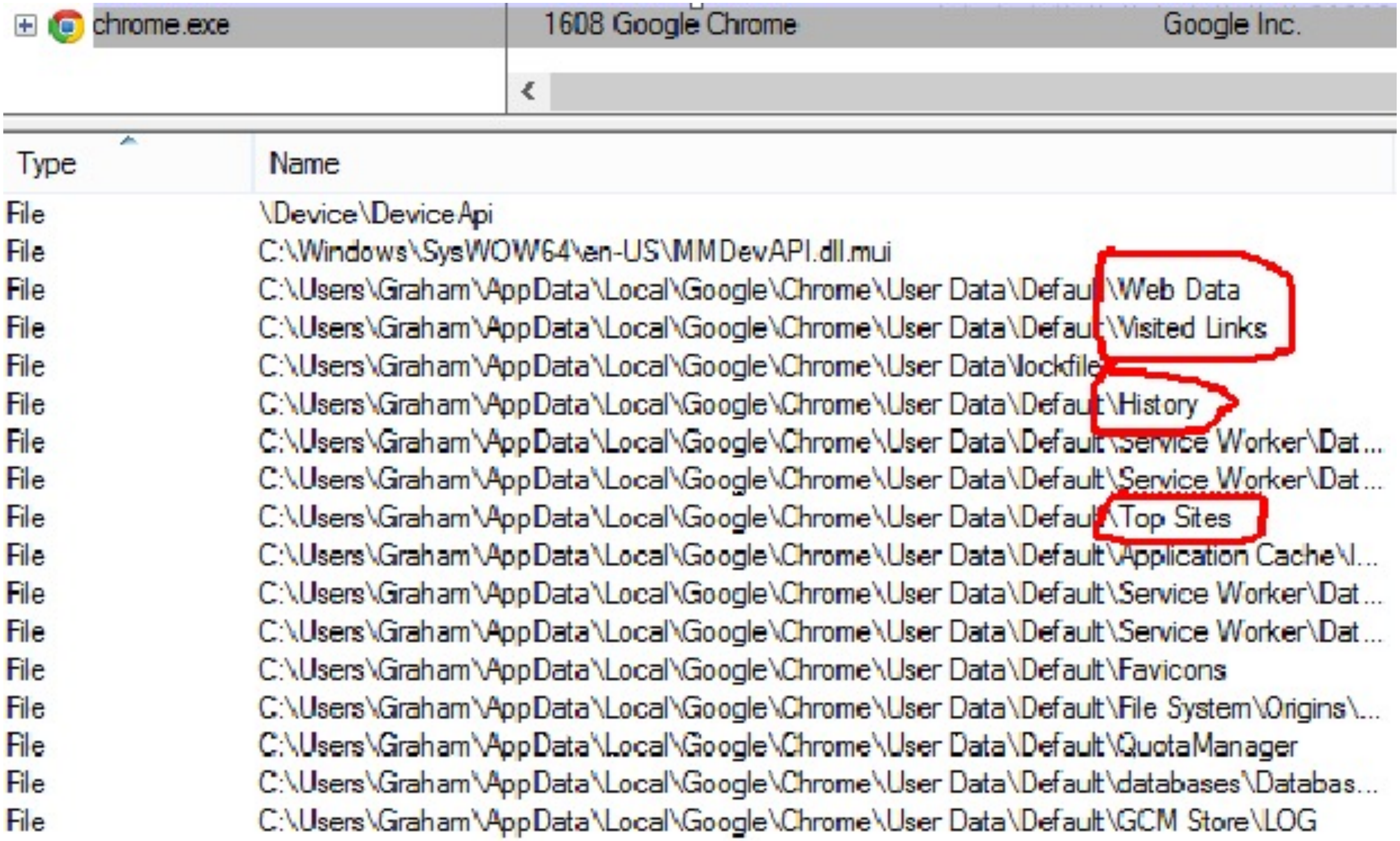


Disk Activity 🟩 0 B/sec Disk I/O

Filtered by chrome.exe, chrome.exe

Image	PID	File
chrome.exe	3536	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\Cache\data_4
chrome.exe	3536	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\Cache\data_2
chrome.exe	3536	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\Cache\data_3
chrome.exe	3536	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\Cache\data_1
chrome.exe	3536	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\History-journal
chrome.exe	3536	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\Cookies-journal
chrome.exe	3536	C:\$LogFile (NTFS Volume Log)
chrome.exe	3536	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\9F97.tmp
chrome.exe	3536	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\Favicons-journal
chrome.exe	3536	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\871C.tmp
chrome.exe	3536	C:\System Volume Information\{153b4464-3412-11e5-8000-902b34d9c2fb}{3808876b-c1
chrome.exe	3536	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\Favicons
chrome.exe	3536	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\History
chrome.exe	3536	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\Cookies

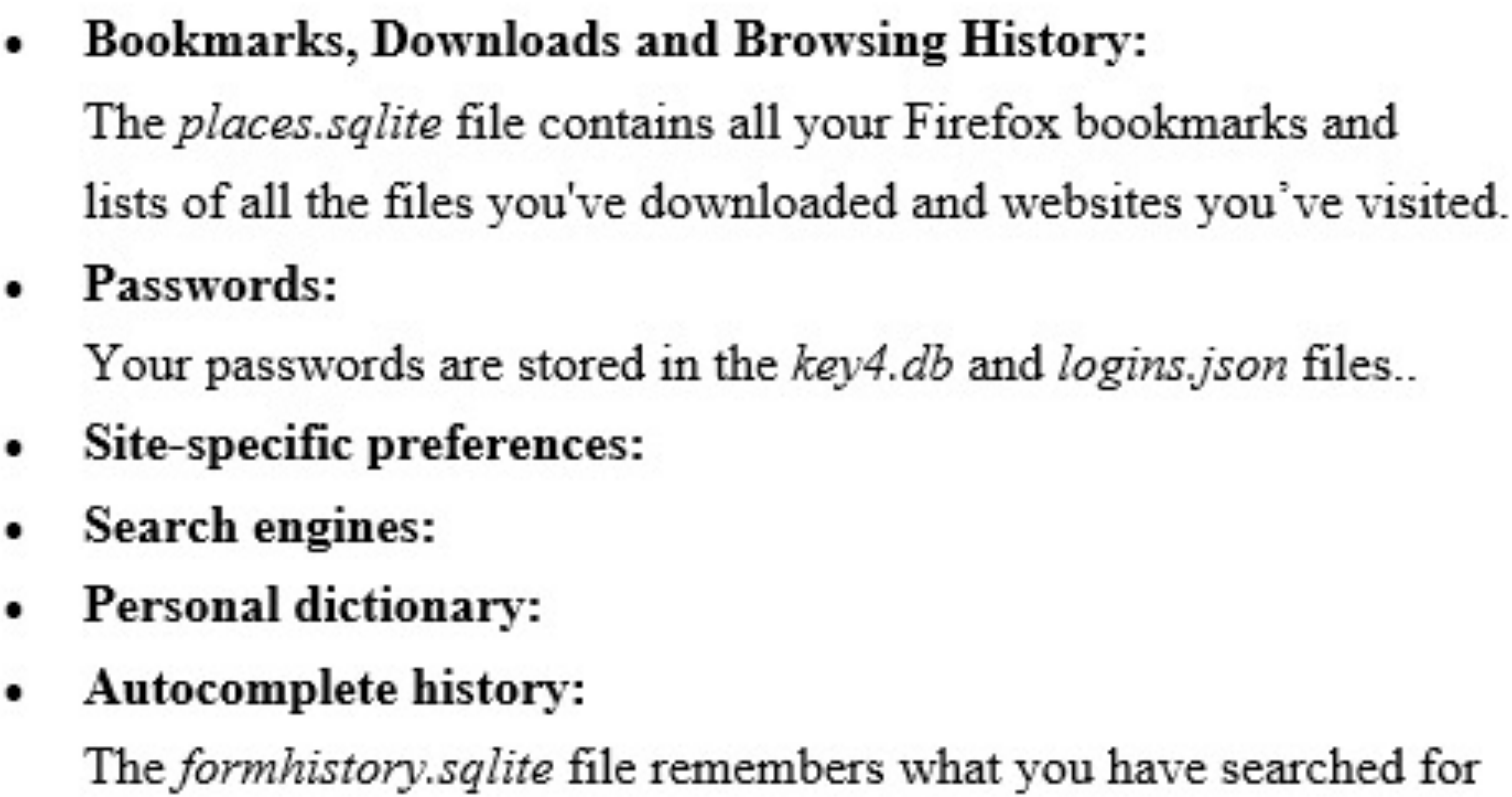
SysInternals Process Explorer - PG



chrome.exe 1608 Google Chrome Google Inc.

Type	Name
File	\Device\DeviceApi
File	C:\Windows\SysWOW64\en-US\MMDevAPI.dll.mui
File	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\Web Data
File	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\Visited Links
File	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\lockfile
File	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\History
File	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\Service Worker\Dat...
File	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\Service Worker\Dat...
File	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\Top Sites
File	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\Application Cache\I...
File	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\Service Worker\Dat...
File	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\Service Worker\Dat...
File	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\Favicons
File	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\File System\Origins\...
File	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\QuotaManager
File	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\databases\Databas...
File	C:\Users\Graham\AppData\Local\Google\Chrome\User Data\Default\GCM Store\LOG

Your Firefox Profile - 1



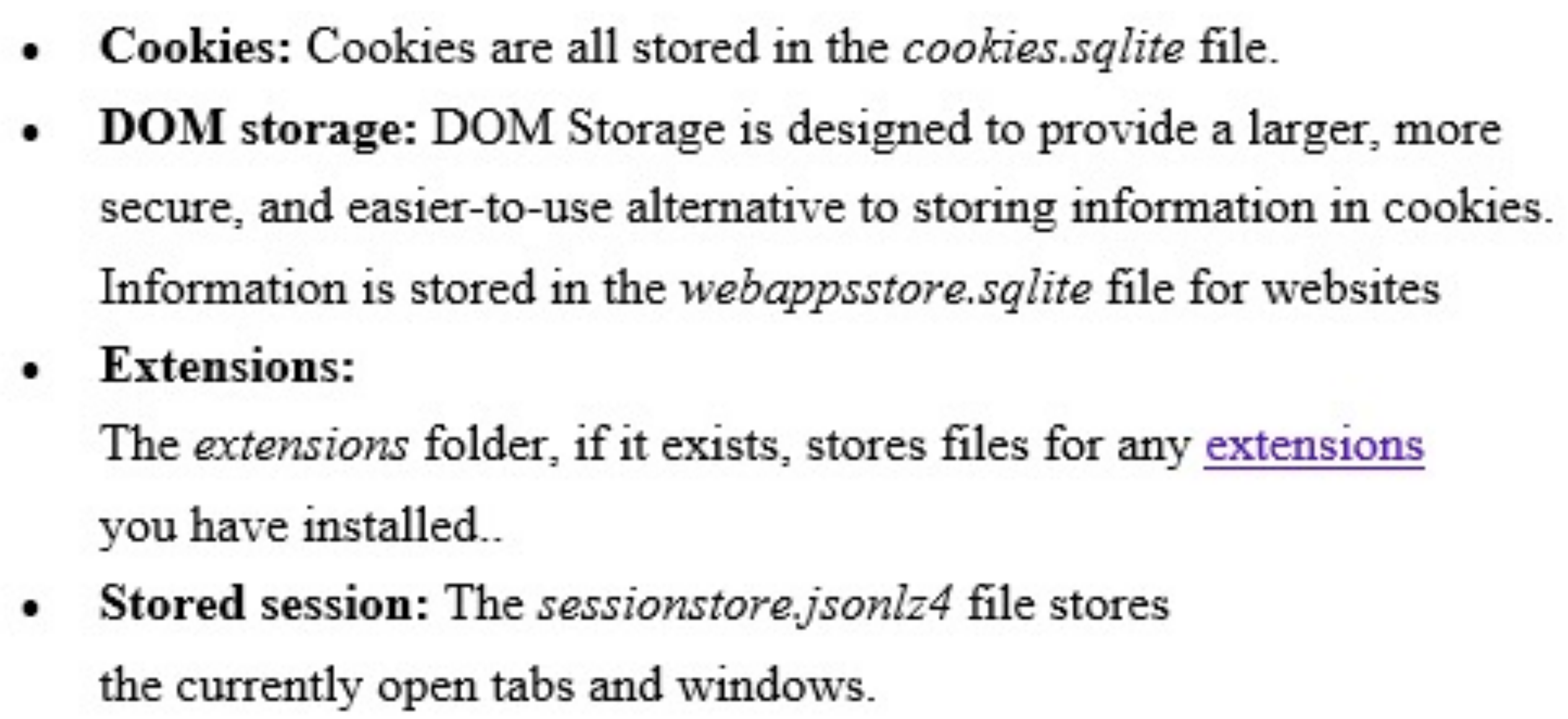
- **Bookmarks, Downloads and Browsing History:**

  The *places.sqlite* file contains all your Firefox bookmarks and lists of all the files you've downloaded and websites you've visited.
- **Passwords:**

  Your passwords are stored in the *key4.db* and *logins.json* files..
- **Site-specific preferences:**
- **Search engines:**
- **Personal dictionary:**
- **Autocomplete history:**

  The *formhistory.sqlite* file remembers what you have searched for

Your Firefox Profile - 2



- **Cookies:** Cookies are all stored in the *cookies.sqlite* file.
- **DOM storage:** DOM Storage is designed to provide a larger, more secure, and easier-to-use alternative to storing information in cookies. Information is stored in the *webappsstore.sqlite* file for websites
- **Extensions:**

  The *extensions* folder, if it exists, stores files for any extensions you have installed..
- **Stored session:** The *sessionstore.jsonlz4* file stores the currently open tabs and windows.

Web forms in Firefox

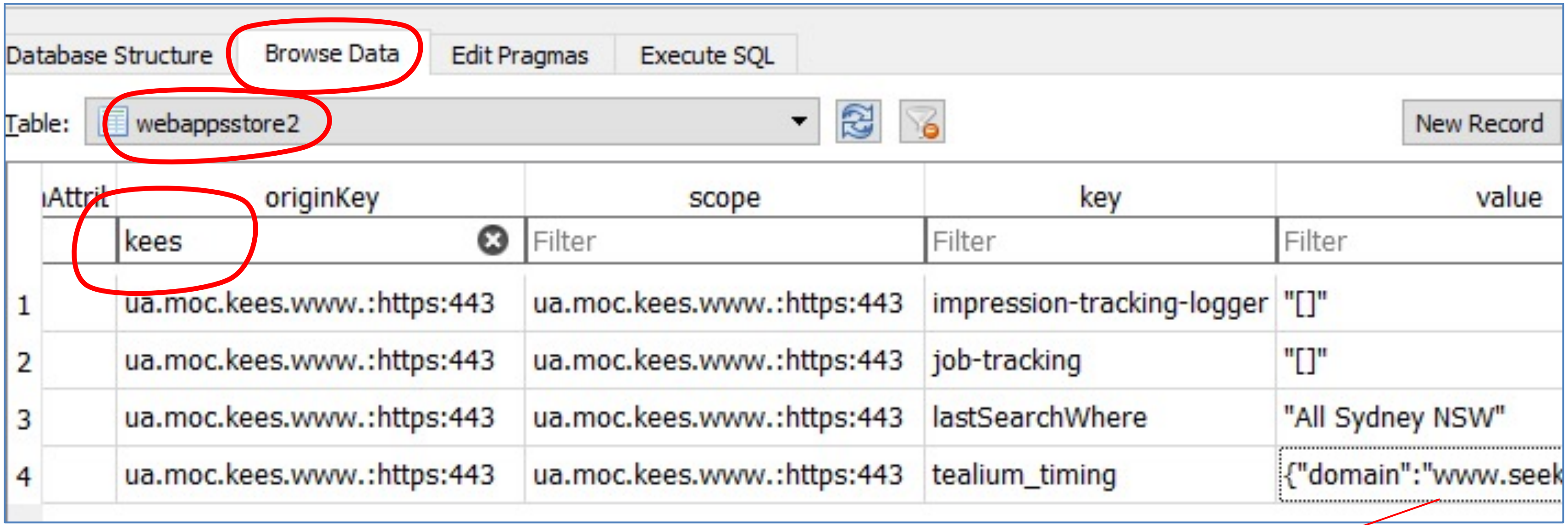
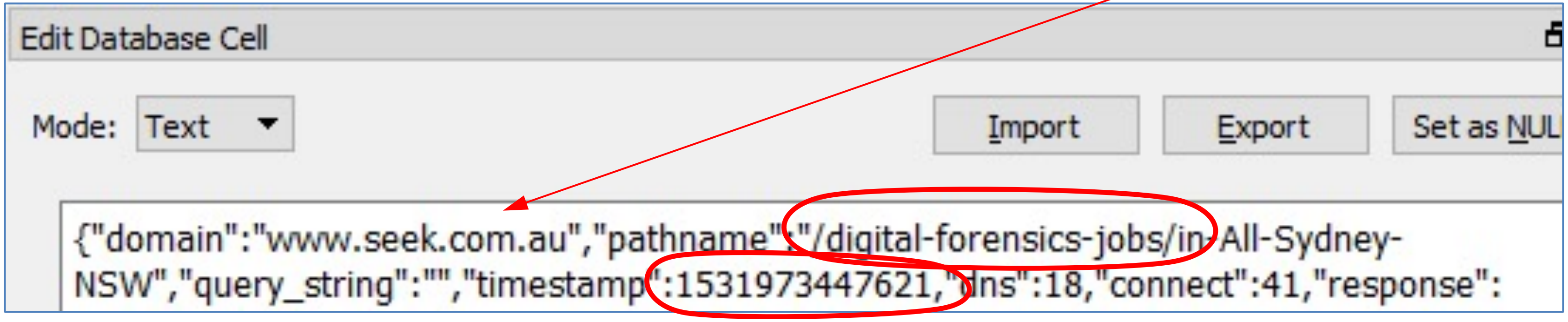


Table: webappsstore2

	Attrib	originKey	scope	key	value
		kees	Filter	Filter	Filter
1		ua.moc.kees.www.:https:443	ua.moc.kees.www.:https:443	impression-tracking-logger	"[]"
2		ua.moc.kees.www.:https:443	ua.moc.kees.www.:https:443	job-tracking	"[]"
3		ua.moc.kees.www.:https:443	ua.moc.kees.www.:https:443	lastSearchWhere	"All Sydney NSW"
4		ua.moc.kees.www.:https:443	ua.moc.kees.www.:https:443	tealium_timing	{"domain":"www.seek



Mode: Text

{"domain":"www.seek.com.au","pathname":"/digital-forensics-jobs/in-All-Sydney-NSW","query_string":"","timestamp":1531973447621,"dns":18,"connect":41,"response":

Identifying a Web Client

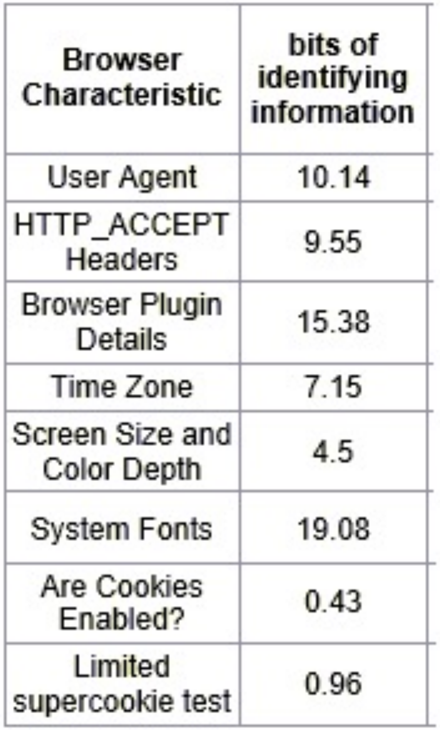
- We are given a packet capture file (pcap)
- We are told to look for forensic evidence
- The first step is to identify the Web Client and the OS
  - Preferably before we examine the pcap file
- How can we do this?
- One way is to use the browser to access a special device fingerprinting website
  - (After we acquire and save an image of the device)

Identifying a Web Client #2

- The http request string is informative

- The detail may identify a suspect’s PC
  - Even with inprivate browsing
- This process is called device fingerprinting
- It can be used to regenerate deleted cookies.

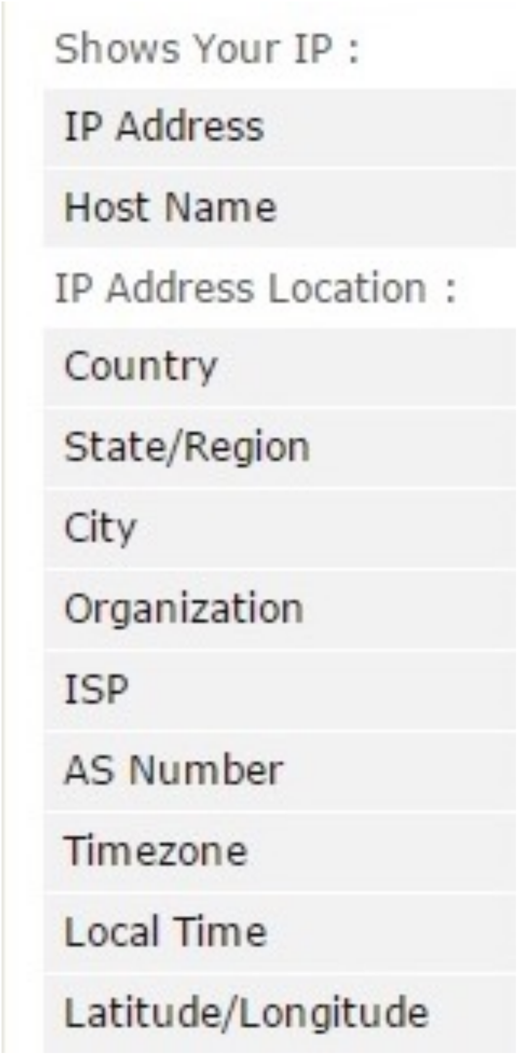
- We need to access the PC to confirm identity.
- https://www.browserleaks.com/
- https://coveryourtracks.eff.org/learn



Browser Characteristic	bits of identifying information
User Agent	10.14
HTTP_ACCEPT Headers	9.55
Browser Plugin Details	15.38
Time Zone	7.15
Screen Size and Color Depth	4.5
System Fonts	19.08
Are Cookies Enabled?	0.43
Limited supercookie test	0.96

The BrowserLeaks website

- Web Browser Fingerprinting
- Displays personal identity data leaked when the suspect surfs the Internet
- https://www.browserleaks.com/



Shows Your IP :

IP Address

Host Name

IP Address Location :

Country

State/Region

City

Organization

ISP

AS Number

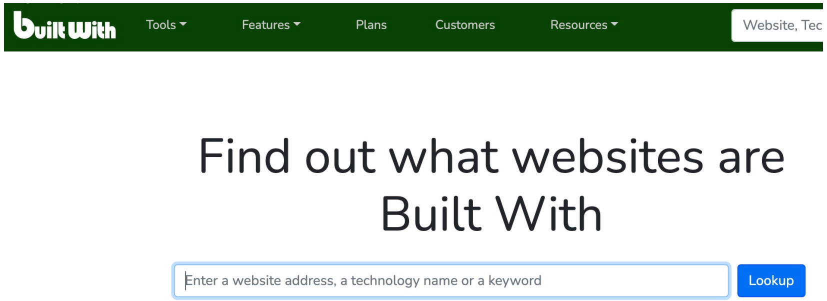
Timezone

Local Time

Latitude/Longitude

Web Servers

- Lots of tracking software
  - Linked to Social Media and Search Engines
  - Analysis by builtwith.com
- Lots of Technologies
  - Analysis by W3Techs.com

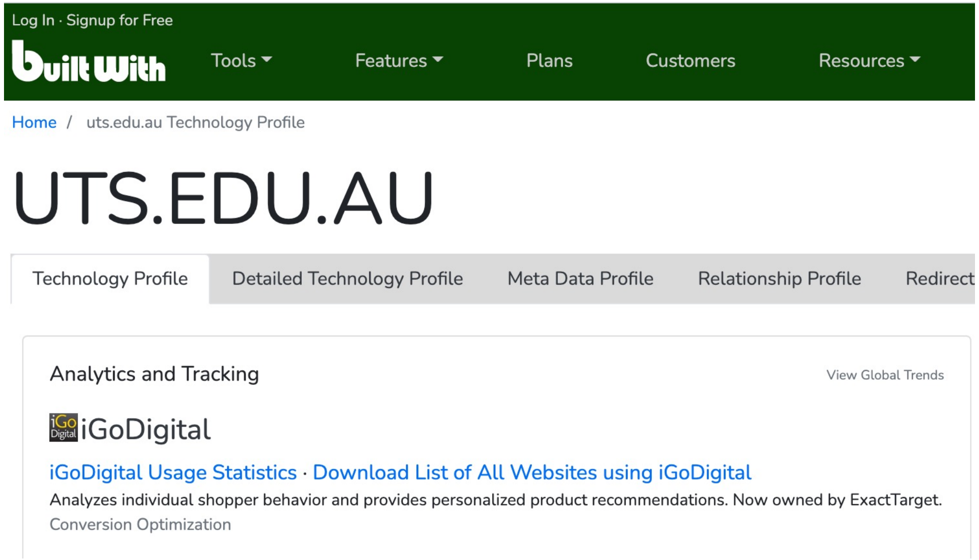


Find out what websites are Built With

Enter a website address, a technology name or a keyword

- Very detailed logs of visitors
  - Often Apache2
  - /var/**log/apache2**/access.**Log**

Builtwith analysis of UTS.edu.au



UTS.EDU.AU

Analytics and Tracking

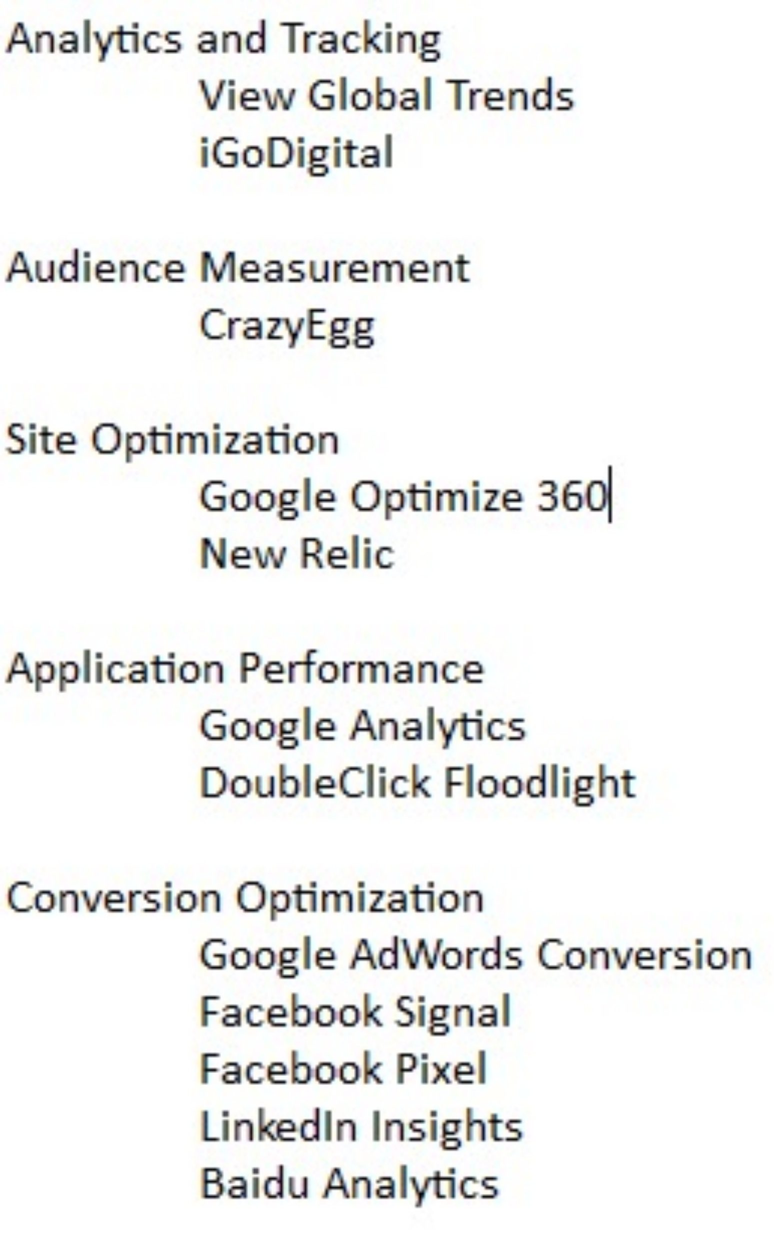
View Global Trends

iGoDigital

iGoDigital Usage Statistics · Download List of All Websites using iGoDigital

Analyzes individual shopper behavior and provides personalized product recommendations. Now owned by ExactTarget.

Conversion Optimization



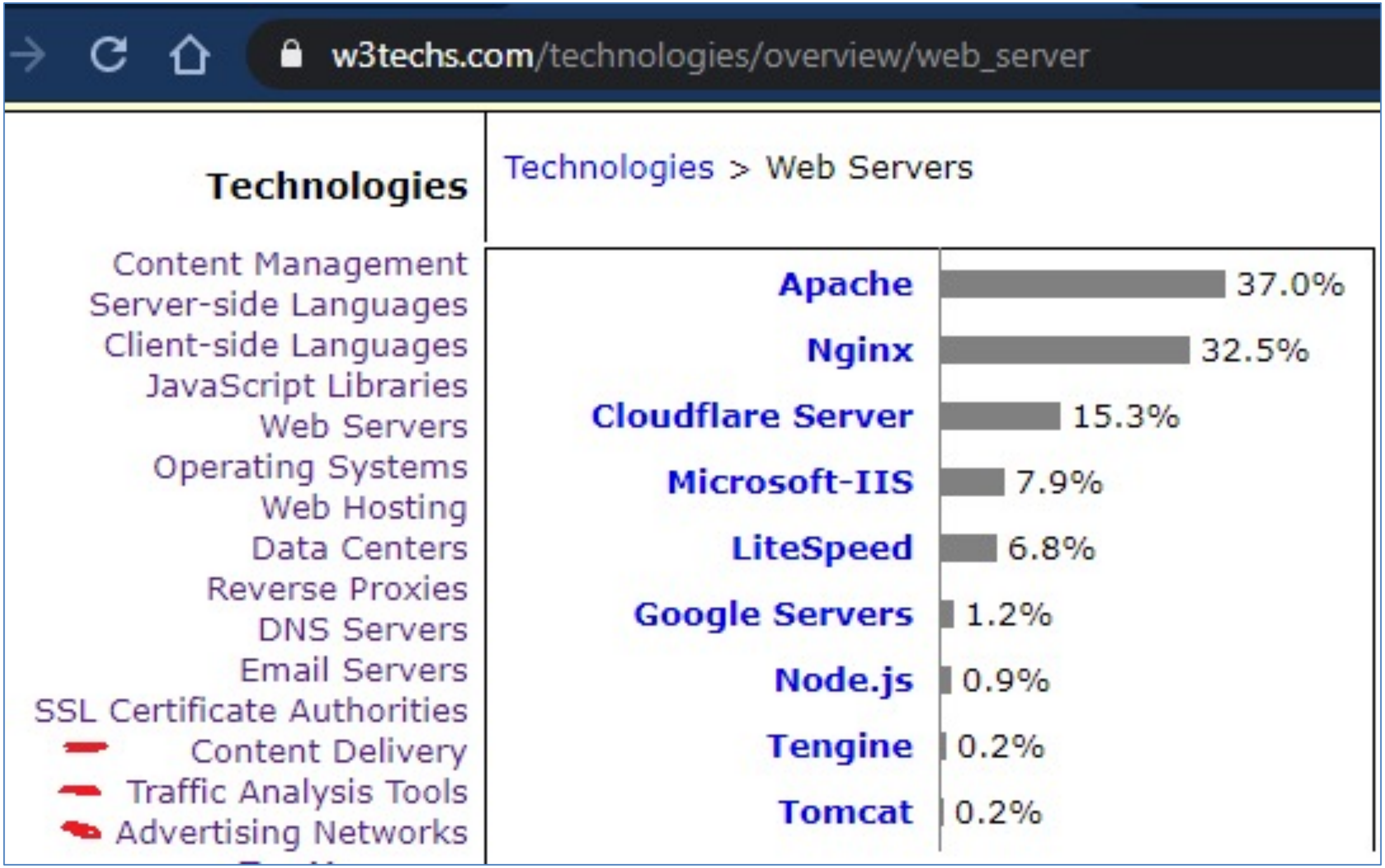
Analytics and Tracking
- View Global Trends
- iGoDigital

Audience Measurement
- CrazyEgg

Site Optimization
- Google Optimize 360
- New Relic

Application Performance
- Google Analytics
- DoubleClick Floodlight

Conversion Optimization
- Google AdWords Conversion
- Facebook Signal
- Facebook Pixel
- LinkedIn Insights
- Baidu Analytics



w3techs.com/technologies/overview/web_server

Technologies

- Content Management
- Server-side Languages
- Client-side Languages
- JavaScript Libraries
- Web Servers
- Operating Systems
- Web Hosting
- Data Centers
- Reverse Proxies
- DNS Servers
- Email Servers
- SSL Certificate Authorities
- Content Delivery
- Traffic Analysis Tools
- Advertising Networks

Technologies > Web Servers

Apache	37.0%
Nginx	32.5%
Cloudflare Server	15.3%
Microsoft-IIS	7.9%
LiteSpeed	6.8%
Google Servers	1.2%
Node.js	0.9%
Tengine	0.2%
Tomcat	0.2%

Objectives

- To use Web Browsers for Forensics
- To use web tracking for Forensics
- To locate and examine cookie files
- To locate and examine web browser history
- To locate and examine temporary internet files

User Tracking

- A web server needs to track a web client
- by ip address
- by the http referer tag
- by a cookie saved on the target
  - http cookie, web cookie, browser cookie
    - three names for the same thing
    - Cookies have gone out of fashion as insecure.
- by embedded code on the web page
  - Tracking on the website
  - Using third parties to do remote tracking

Web Analytics

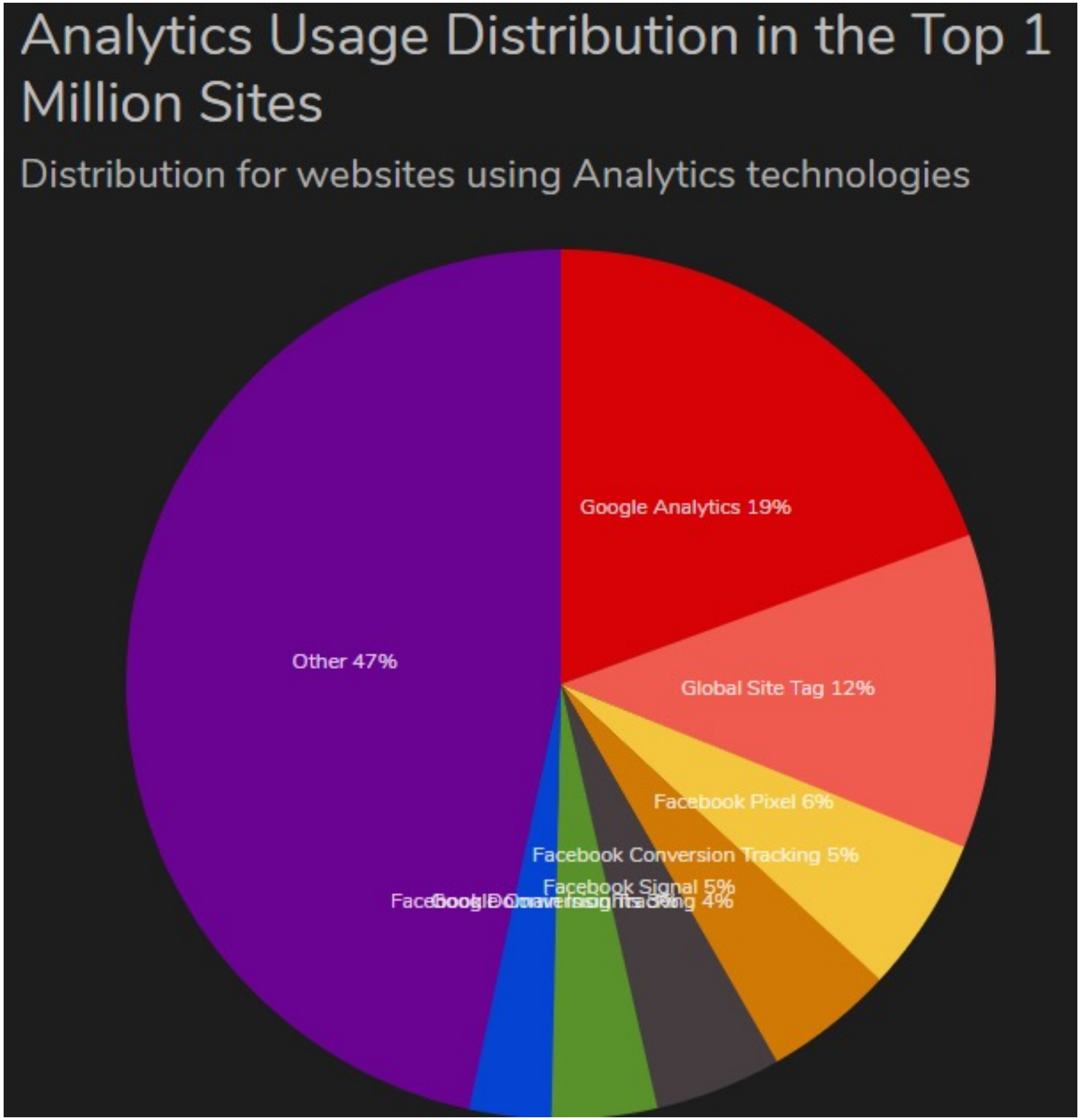
- Web Page Tracking is also used by Advertisers
- A lot of time, money and effort goes into tracking
- See this week's Journey Mapping reading.
- See this week's Web Analytics reading.
- The user profile is an important marketing tool
  - See social networking websites

User tracking for profit

- If you analyse now a user got to your website and purchased an item you will be able to entice many more too follow.
- By combining your visits to many websites many times, the analytics company will be able to understand and influence your future behaviour.
- We can use these results for forensics

Journey Mapping

- Follow the target as they navigate the internet and end up purchasing an item.
- Visits to Social Media and Search Engines are converted into a visit to the website
- Build a timeline based on the time stamp of every stage.
- The person is called the actor.
- The scenario identifies the expectations of the actor
- Opportunities arise to entice further purchases



Analytics Usage Distribution in the Top 1 Million Sites

Distribution for websites using Analytics technologies

Google Analytics

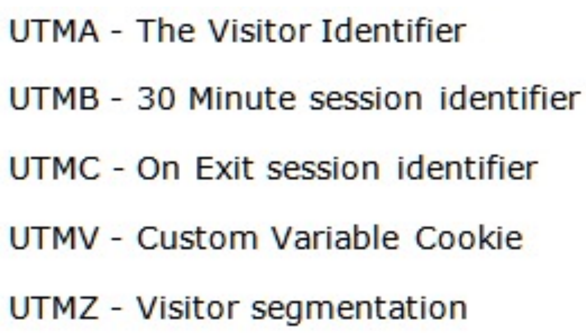
- Two methods using two different JavaScript libraries
- ga.js drops a set of _utm cookies.
  - Good forensics but now out of fashion due to privacy.
- analytics.js drops two cookies

-ga	lifetime 2 years
-gid	lifetime 1 day

poor forensics but popular as little private detail is visible

UTM Cookie Formats

- Google bought Urchin Software in 2005
- Google Analytics (GA) uses UTM
- Urchin Tracking Module (UTM) codes
- UTMA tracks dates and visits
- UTMB/C indicate session expired
- UTMZ is for tracking the user
  - Referer, keyword, ad campaign, etc
- More detail in readings



UTMA - The Visitor Identifier

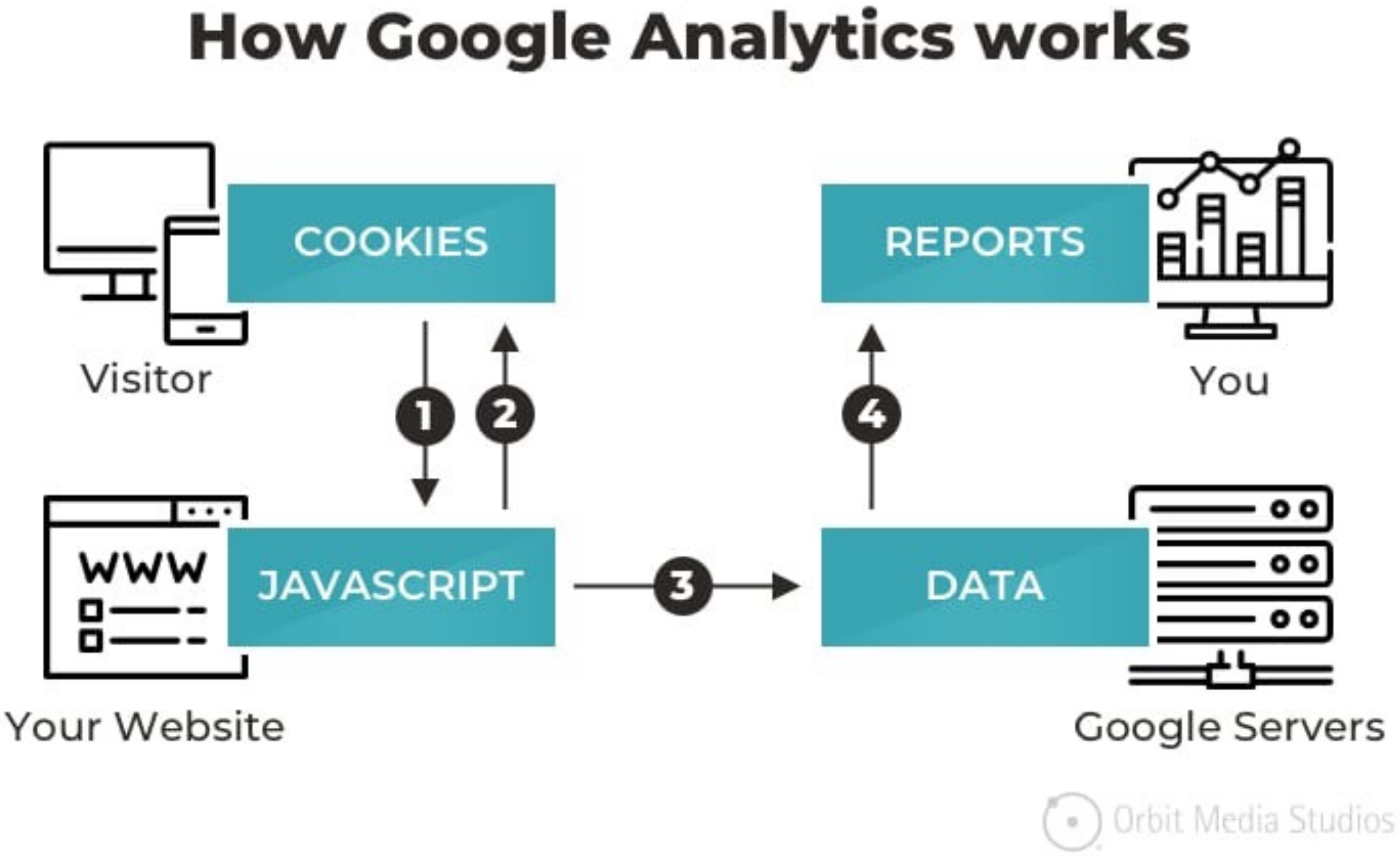
UTMB - 30 Minute session identifier

UTMC - On Exit session identifier

UTMV - Custom Variable Cookie

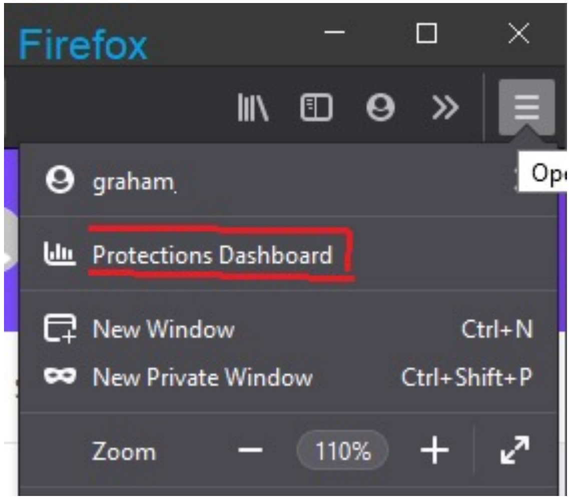
UTMZ - Visitor segmentation

GA data flow

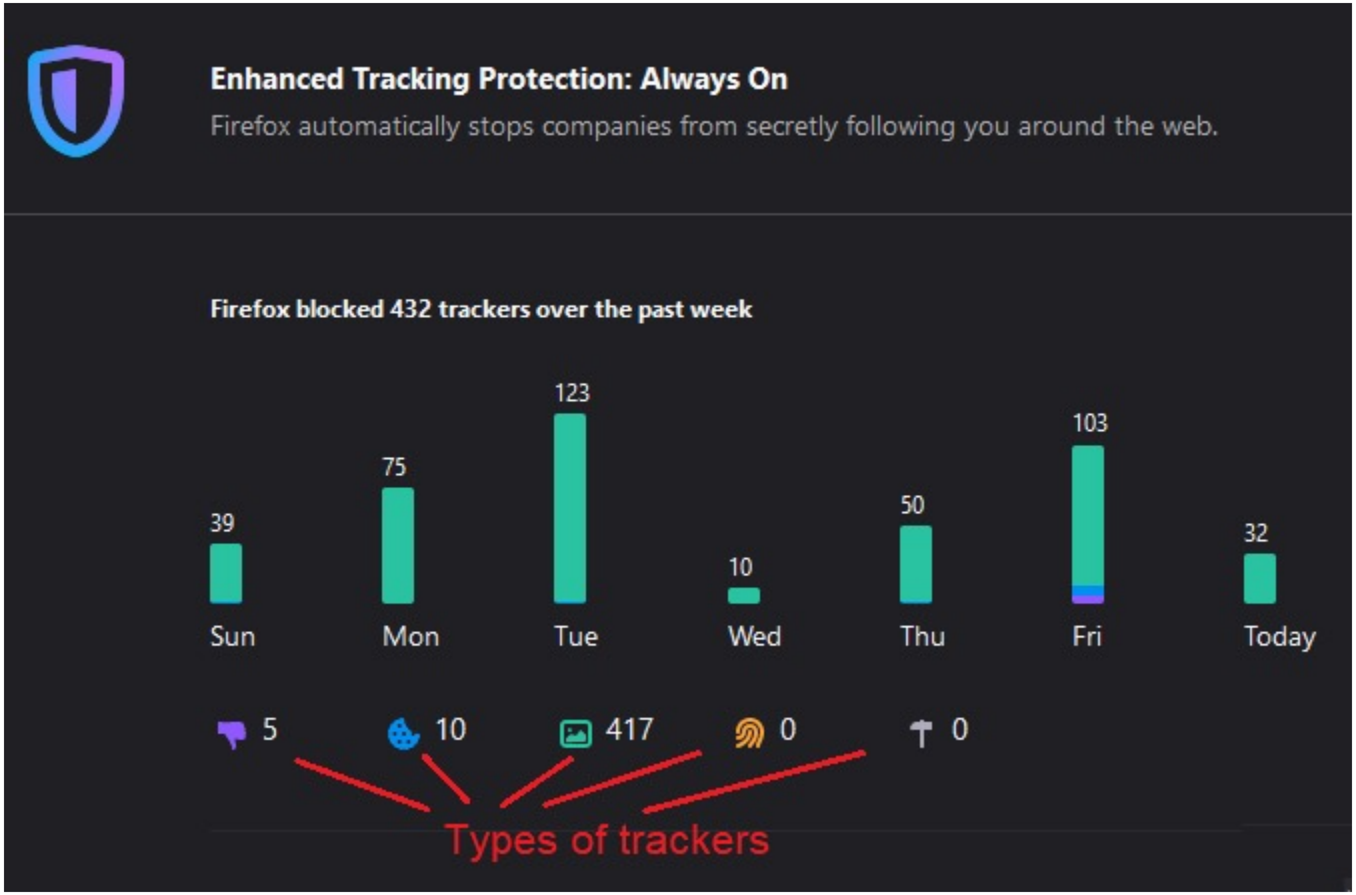

How Google Analytics works
COOKIES
Visitor
REPORTS
You
1
2
4
JAVASCRIPT
3
DATA
Your Website
Google Servers
Orbit Media Studios

Firefox Protection Dashboard

- Firefox can block trackers with its Protections Dashboard
- Provides tracking protection for a desktop or mobile device
- Provides analytics on the blocked trackers
- Uses an addon from Disconnect
  - https://disconnect.me/
- There are more than 2500 tracking websites



Tracking Analytics

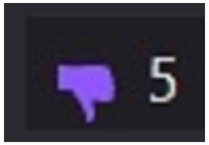


Enhanced Tracking Protection: Always On

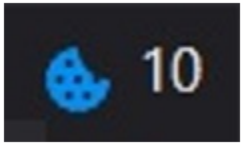
Firefox automatically stops companies from secretly following you around the web.

Firefox blocked 432 trackers over the past week

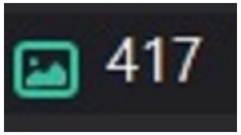
Tracker types



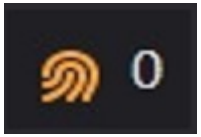
- Social Media
  - Social networks place these trackers on other websites to follow you.



- Cross Site Tracking cookies
  - Analytics companies place these trackers to follow you



- Tracking Content
  - The website loads external contect targeted at you



- Fingerprinters
  - Collect browser settings to identify you

- Cryptominers – use your device to mine money

Objectives

- To use Web Browsers
- To use web tracking
- To locate and examine cookie files
- To locate and examine web browser history
- To locate and examine temporary internet files

A forensic traces example

- 1988: Prosecutors upgraded the charges against a suspect to murder on the basis of evidence of premeditation found on his office computer.
- Tech Support had done a routine investigation during an upgrade and checked the suspect’s cookies
- They found websites with cookies that were refered from Google.
- The search terms included kill+spouse, accidental+death, smother, poison, homicides and murder

Reason for Cookies

- Web Pages are transferred over the Internet using HTTP (Hypertext Transfer Protocol)
- HTTP is Stateless so we need some method of saving viewer choices
- Cookies save state on the client as a file on disk
  - *Cookies are small and fast (lightweight)*
- Cookies are also used to save state for session key negotiation (Wireless and VPNs)

More reasons for Cookies

- Personalisation
  - The server remembers what you liked on your last visit
- Data Capture
  - The server remembers what you asked for
- Sales tracking using a shopping basket
  - cannot be undone (do not click the back button!)
- Authentication
  - no need for a password for a repeated login

Cookie forensics

- Deleting cookies will disable many websites
- Modern web sites only drop very basic cookies
- Viewing Cookies is a useful forensic tool
  - websites visited
  - actions taken/pages visited
  - date of first visit
  - date of last visit
  - number of visits

Setting cookies

- The web client asks for a web page using http
  - GET /index.html HTTP/1.1
- The web server sets a cookie when it replies
  - HTTP/1.1 200 OK
  - Set-Cookie: name=value
- The cookie is returned each time the page is accessed
- The server keeps a log of cookies to track viewers
- viewer=ip address+referer+cookie
- See Readings, http cookies

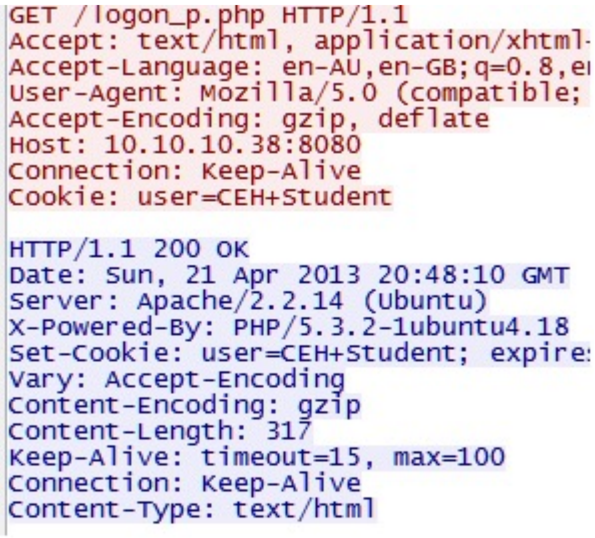
Set-Cookie

- Server has code to set the cookie

```
<?php
 $expire=time()+60*60*24*90;
 setcookie("user", "CEH Student",
$expire);
 ?>
```

- Browser asks for the server page

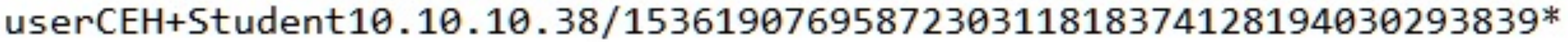
- Server sets the cookie



```
GET /logon_p.php HTTP/1.1
Accept: text/html, application/xhtml
Accept-Language: en-AU,en-GB;q=0.8,e
User-Agent: Mozilla/5.0 (compatible;
Accept-Encoding: gzip, deflate
Host: 10.10.10.38:8080
Connection: Keep-Alive
Cookie: user=CEH+Student

HTTP/1.1 200 OK
Date: Sun, 21 Apr 2013 20:48:10 GMT
Server: Apache/2.2.14 (Ubuntu)
X-Powered-By: PHP/5.3.2-1ubuntu4.18
Set-Cookie: user=CEH+Student; expire
Vary: Accept-Encoding
Content-Encoding: gzip
Content-Length: 317
Keep-Alive: timeout=15, max=100
Connection: Keep-Alive
Content-Type: text/html
```

- Cookie file appears on client PC
  - the dates are in cookie format



```
userCEH+Student10.10.10.38/1536190769587230311818374128194030293839*
```

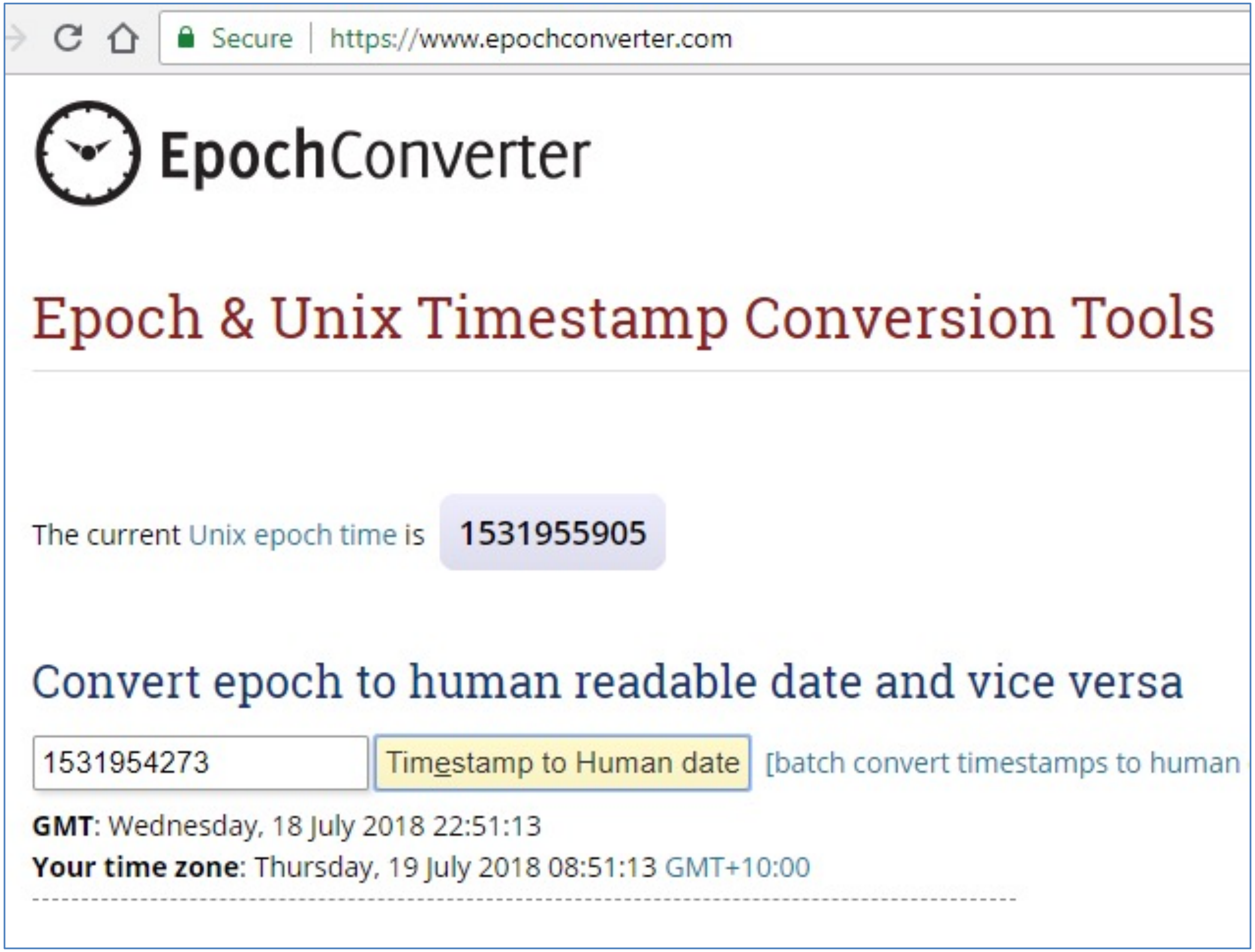
Cookie types

- Session cookie
  - no expiry date, deleted by the browser when the session ends
- Persistent cookies (tracking cookies)
  - expiry date in the future
- Secure cookie
  - sent encrypted using https
- Third party cookies
  - set from a different URI domain

GA _gid cookie example

- GA1.3.1180290148.1531954273
- GA = Google Analytics
- 1.3 = Version
- 1180290148 = random number session ID
- 1531954273 = Unix timestamp (visit)

Unix Date format



Secure | https://www.epochconverter.com

EpochConverter

Epoch & Unix Timestamp Conversion Tools

The current Unix epoch time is 1531955905

Convert epoch to human readable date and vice versa

GMT: Wednesday, 18 July 2018 22:51:13
Your time zone: Thursday, 19 July 2018 08:51:13 GMT+10:00

Some cookie data examples

- _ga cookie
  - GA1.3.0164af9713b500100f85468f61190004e00a500d00bd0
  - SHA Hash
- GUID
  - Globally Unique ID (see Week 6 - Registry)
  - 3b83fca5-3223-342c-459f-64e0fcf78633
  - 5 parts
- % Encoded
  - To treat control characters as plain text
  - %5B%5B%27SEM-GGL-SRC-FY16Q3-5463%27%2C%271531954291555%27%5D%5D
  - [['SEM-GGL-SRC-FY16Q3-5463','1531954291555’]]

Goodhart’s Law

- People try and rort the system.
- A salesman will distort the sales figures so the analytics will give her more attribution and thus more bonuses.
- Goodhart’s Law
- when a measure becomes a target it ceases to be a measure.
- A famous example is the Cobra bounty

The Cobra Effect

- In British India there were many deaths due to Cobra snake bites
- The government set a bounty on cobra heads
- Farmers started to breed many cobras
- The cobra bounty was cancelled
- The farmers released their cobras
- Many more people died from cobra bites

Third Party Cookies

- Third Parties provide content
  - advertisements
  - like me on Facebook
- This is done to make money
  - The Pay per click (PPC) business model
- User details are sent to the third party
  - used for marketing
- This can be stopped by InPrivate/Incognito Filtering

Blocking Cookies

- Browsers have add-ons that block certain cookies
- Firefox Ghostery for example
- Blocks Advertisements
- Stops data tracking to preserve privacy
- Provides a viewer to show add/tracking activity
- One million users

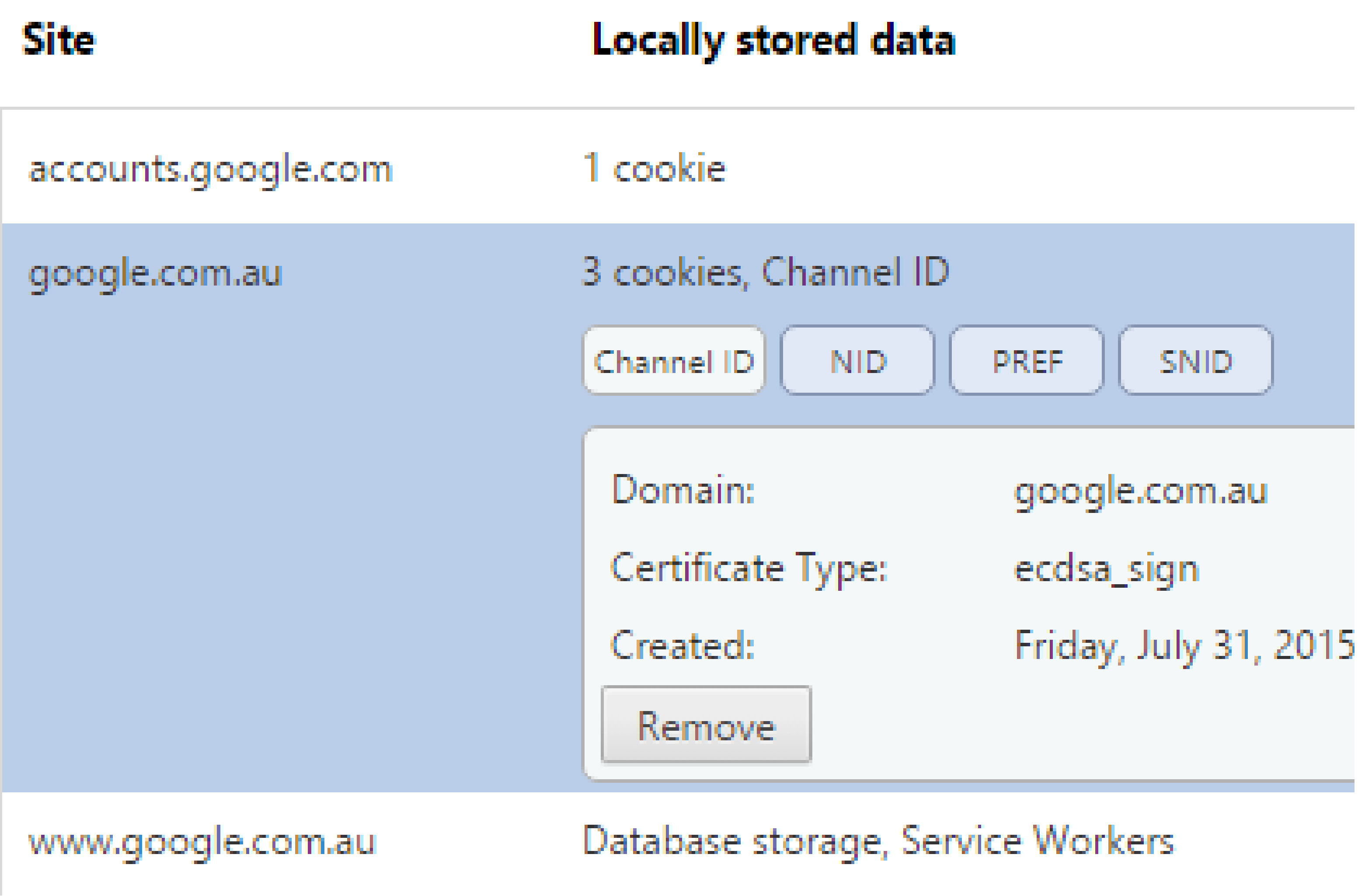
Google Third party cookies

- Do not relate to the page visited
- Designed to encourage you to buy an unrelated product
- Include
  - adwords.com
  - doubleclick.net
  - googleadservice.com
  - gstatic.com
  - youtube.com

Cookie storage

- Each browser maintains its store of cookies separately
- Cookies are saved in a compressed format for speed
- We can use the browser cookie manager to view its cookies
- We can use third party cookie viewers when the browser is not running
- Each user has a separate cookie store

Chrome Cookies



Site	Locally stored data
accounts.google.com	1 cookie
google.com.au	3 cookies, Channel ID
www.google.com.au	Database storage, Service Workers

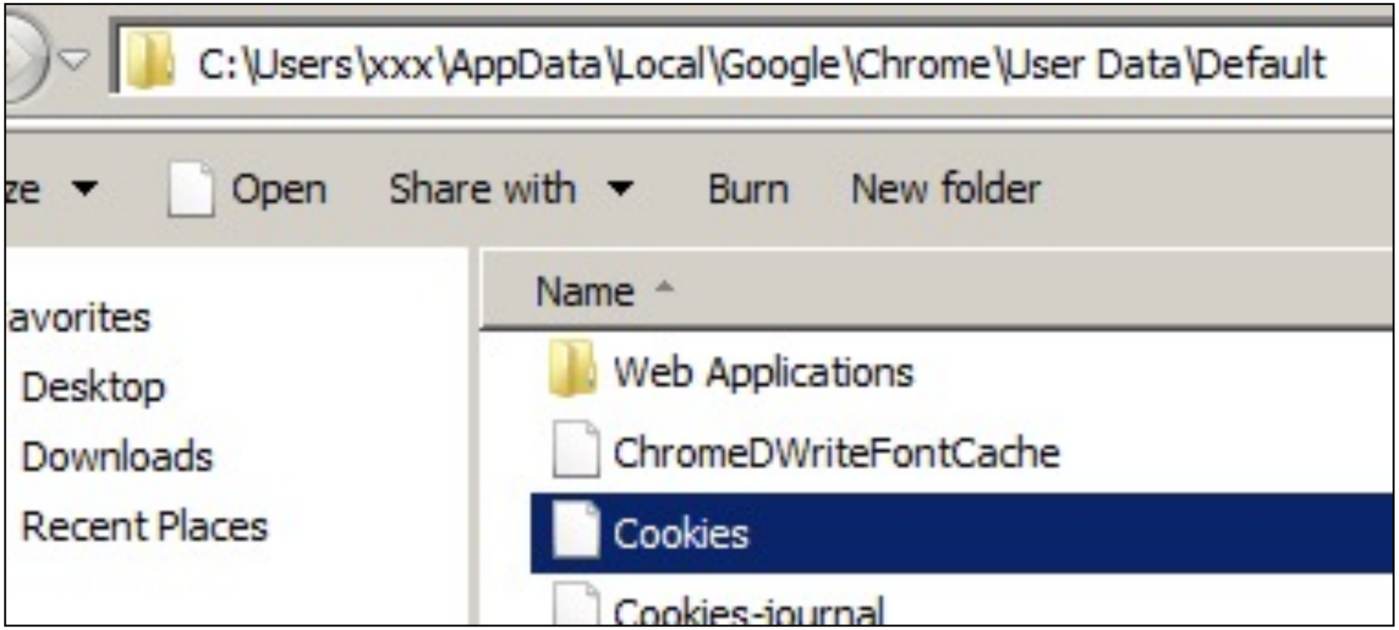
Domain: google.com.au

Certificate Type: ecdsa_sign

Created: Friday, July 31, 2015

Chrome Cookie File

- Keeps a list of cookies from all sites visited
- Can see the site name in plain text
- The user can delete these from chrome settings

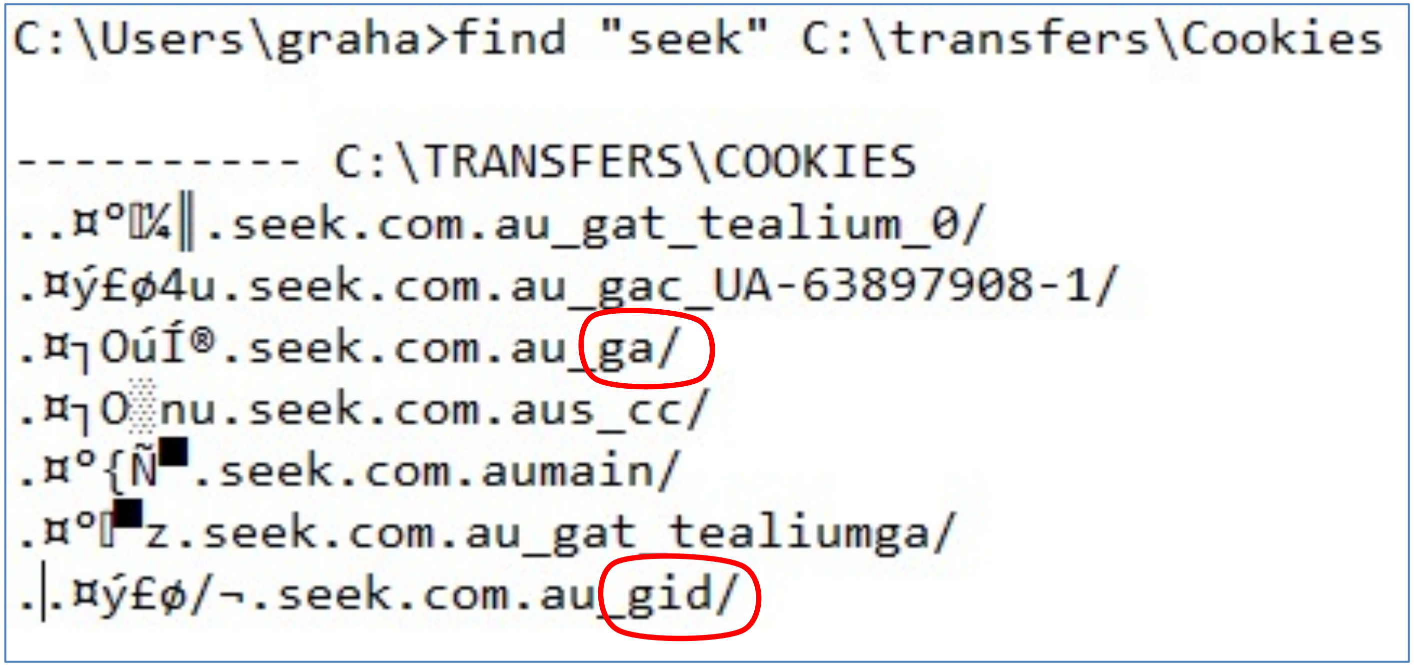


C:\Users\xxx\AppData\Local\Google\Chrome\User Data\Default

Web Applications
ChromeDWriteFontCache
Cookies
Cookies-journal

Viewing the Chrome cookie file - with find

- Copy the Cookies file to your Windows work folder
- Filter by your search term using find

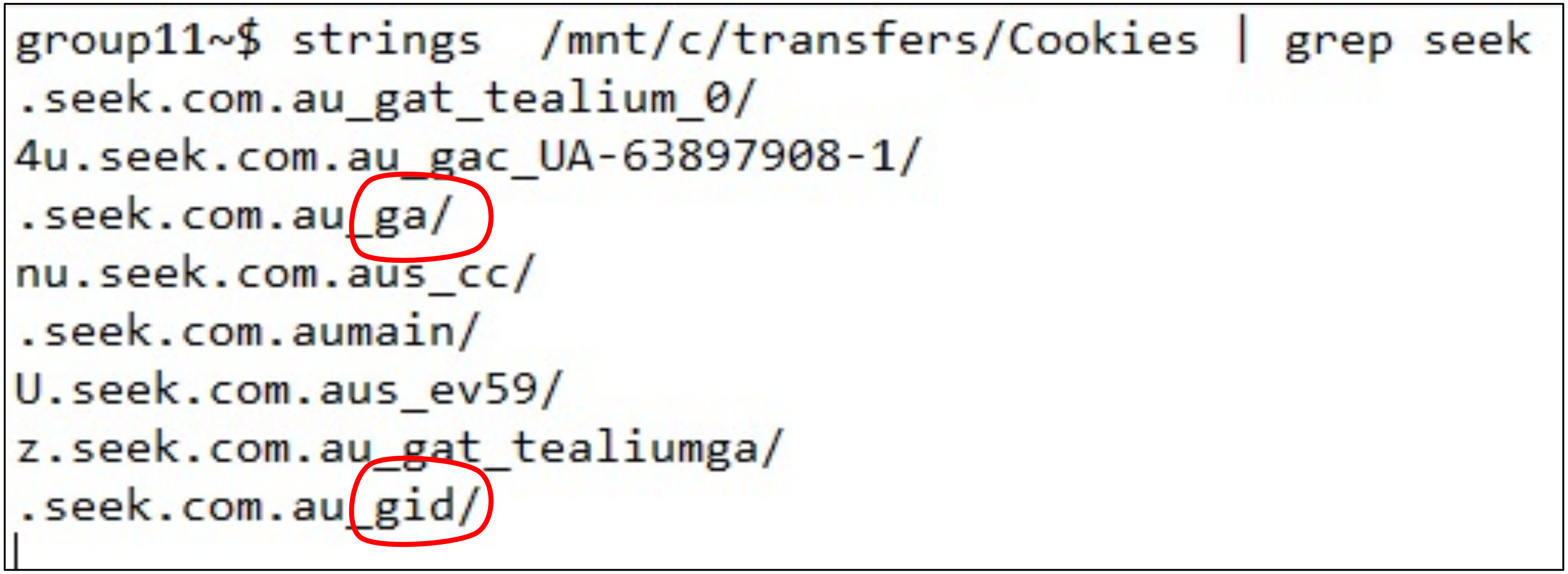


```
C:\Users\graha>find "seek" C:\transfers\Cookies

---------- C:\TRANSFERS\COOKIES
..¤°▯¼║.seek.com.au_gat_tealium_0/
.¤ý£ø4u.seek.com.au_gac_UA-63897908-1/
.¤┐OúÍ®.seek.com.au_ga/
.¤┐O░nu.seek.com.aus_cc/
.¤°{Ñ▀.seek.com.aumain/
.¤°▯▀z.seek.com.au_gat_tealiumga/
.│.¤ý£ø/¬.seek.com.au_gid/
```

Viewing the Chrome cookie file – with grep

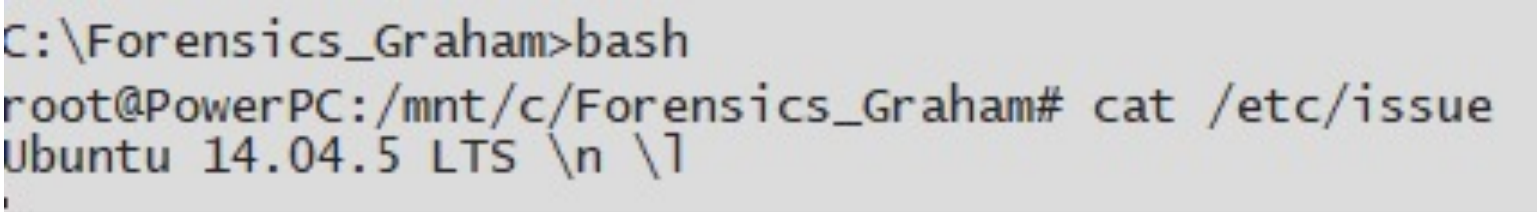
- Copy the Cookies file to your Linux work folder
- Pull out the ascii using strings
- Filter by your search term using grep



```
group11~$ strings  /mnt/c/transfers/Cookies | grep seek
.seek.com.au_gat_tealium_0/
4u.seek.com.au_gac_UA-63897908-1/
.seek.com.au_ga/
nu.seek.com.aus_cc/
.seek.com.aumain/
U.seek.com.aus_ev59/
z.seek.com.au_gat_tealiumga/
.seek.com.au_gid/
```

Windows Subsystem for Linux (WSL)

- Runs Linux on Windows 10
- Runs Linux commands in a bash shell
- Can run bash, Python, MySQl, Apache, sshd



```
C:\Forensics_Graham>bash
root@PowerPC:/mnt/c/Forensics_Graham# cat /etc/issue
Ubuntu 14.04.5 LTS \n \l
```

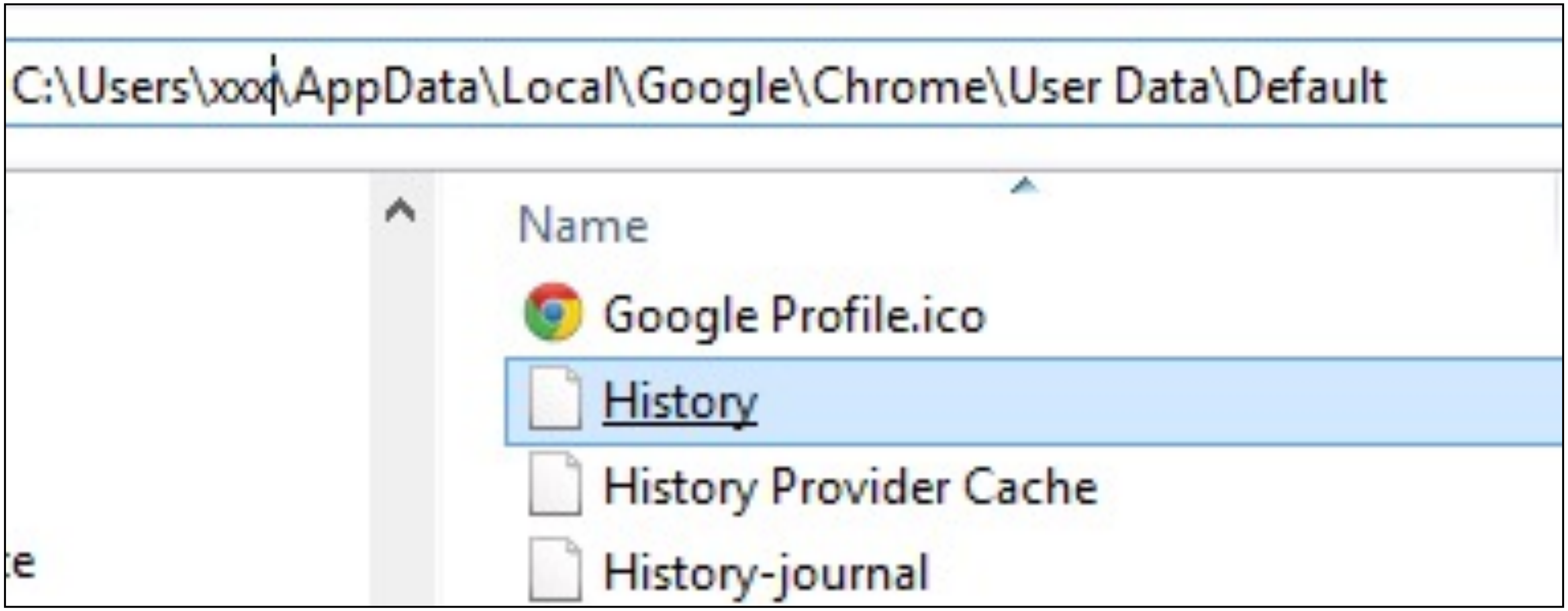
- Can install a Distro (Ubuntu for example)
- See Windows 10 Subsystem for Linux in Readings

Objectives

- To use Web Browsers for Forensics
- To use web tracking for Forensics
- To locate and examine cookie files
- To locate and examine web browser history
- To locate and examine temporary internet files

Web History Files

- The browser stores the history of visited pages
- This is usually large (MB) so cannot read directly.
- The browser has methods of deleting web history



C:\Users\xxx\AppData\Local\Google\Chrome\User Data\Default

Name

Google Profile.ico

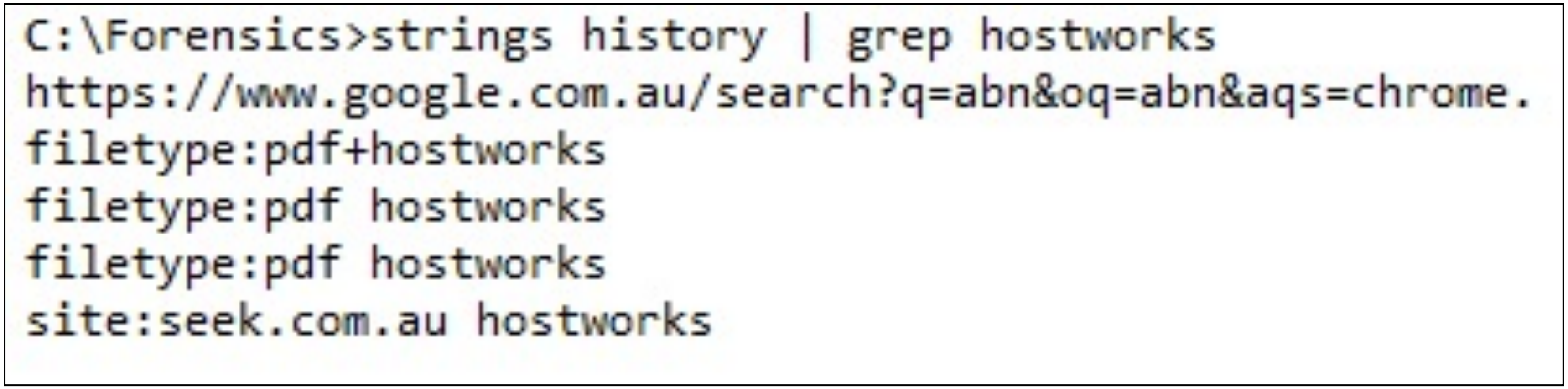
History

History Provider Cache

History-journal

Viewing the Chrome web history file

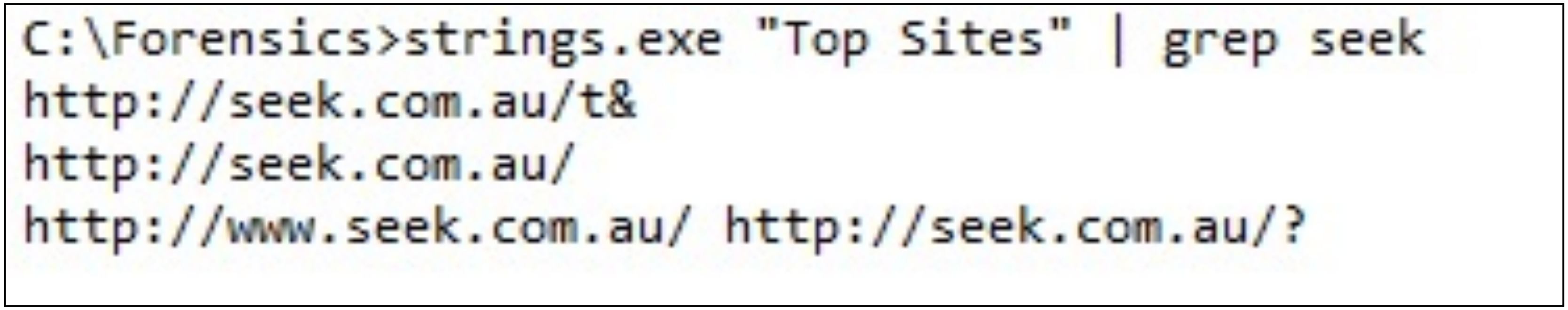
- Copy the history file to your work folder
- Pull out the ascii using strings
- Filter by your search term using grep



```
C:\Forensics>strings history | grep hostworks
https://www.google.com.au/search?q=abn&oq=abn&aqs=chrome.
filetype:pdf+hostworks
filetype:pdf hostworks
filetype:pdf hostworks
site:seek.com.au hostworks
```

Chrome top sites

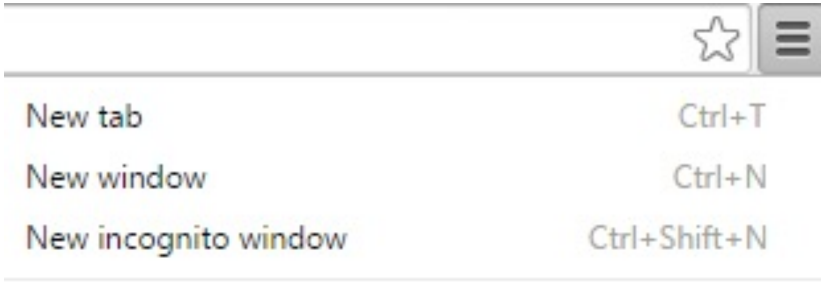
- Records the most visited sites
- Can indicate a suspect’s interest

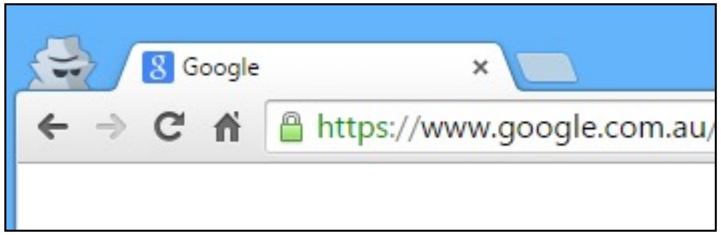


```
C:\Forensics>strings.exe "Top Sites" | grep seek
http://seek.com.au/t&
http://seek.com.au/
http://www.seek.com.au/ http://seek.com.au/?
```

Hiding Web History

- Unfortunately for forensics, there are easy ways for users to minimise the evidence
- In chrome this is called incognito browsing





Going incognito doesn’t hide your browsing from your employer, your internet service provider, or the websites you visit.

Recovering hidden Web History

- A good forensic investigation can recover hidden evidence
- One likely place is volatile memory
  - process history
  - system history
- Another is disk
  - temporary files (including cached files)
  - swap files
- Yet another is the local dns server cache
- We will visit these later

Objectives

- To use Web Browsers for Forensics
- To use web tracking for Forensics
- To locate and examine cookie files
- To locate and examine web browser history
- To locate and examine temporary internet files

Temporary Internet Files

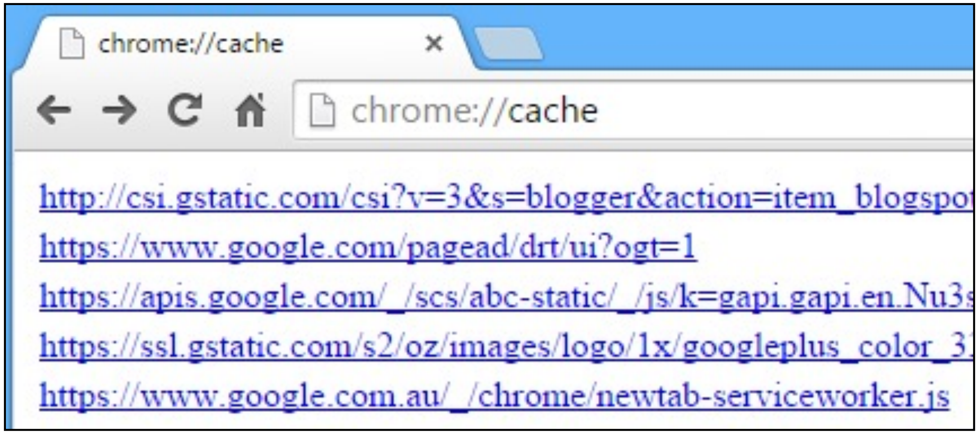
- http allows Web Browsers to cache recently visited pages
- When a viewer revisits a webpage, http checks the date on the cached page and decides whether to show the cached copy or refresh the page from the server.
- Caching cuts down on web traffic and speeds the rendering of the webpage
- Cached pages are a mine of forensic information

Layout Engines

- The temporary file location is chosen by the web page layout engine
- The Layout Engine for IE is called Trident
- The Layout Engine for Firefox is Gecko
- The Layout Engine for Google Chrome is Blink
  - Blink is a fork of the WebCore part of WebKit
- The Layout Engine for Edge was EdgeHtml
- Current Edge uses Chromium with the BLink engine
- en.wikipedia.org/wiki/Temporary_Internet_Files
- en.wikipedia.org/wiki/Trident_(layout_engine)

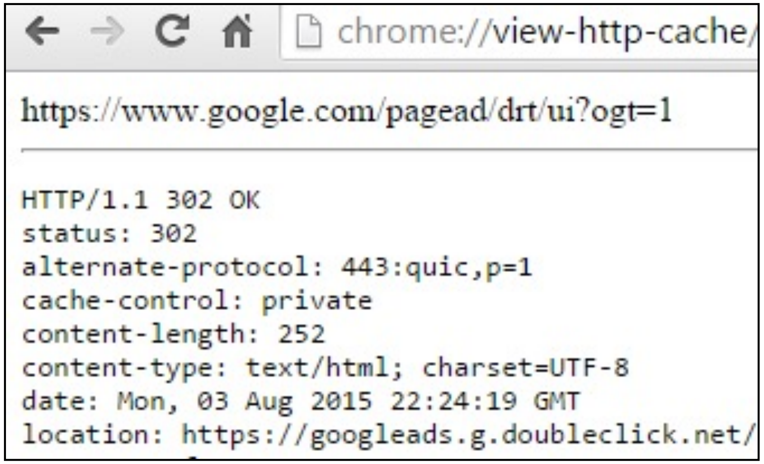
Chrome Cache files

- These use data files, so no luck with strings
- Can use the chrome decoder



chrome://cache

http://csi.gstatic.com/csi?v=3&s=blogger&action=item_blogspo
https://www.google.com/pagead/drt/ui?ogt=1
https://apis.google.com/_/scs/abc-static/_/js/k=gapi.gapi.en.Nu3s
https://ssl.gstatic.com/s2/oz/images/logo/1x/googleplus_color_3
https://www.google.com.au/_/chrome/newtab-serviceworker.js



chrome://view-http-cache/

https://www.google.com/pagead/drt/ui?ogt=1

```
HTTP/1.1 302 OK
status: 302
alternate-protocol: 443:quic,p=1
cache-control: private
content-length: 252
content-type: text/html; charset=UTF-8
date: Mon, 03 Aug 2015 22:24:19 GMT
location: https://googleads.g.doubleclick.net/
```

  - Function removed since Chrome 66
- Can also use a Chrome Browser Forensics program

Next week is Wireshark week

- You need to download and install Wireshark on your laptop for the Week 4 Lab.
- Check it works as expected.
- If you need a refresher, please do the Wireshark warmup Lab in Readings before the Week 4 Lab.

Fin