Hunting Certificates & Servers

@erbbysam

DEFCON 27 PACKET HACKING VILLAGE

whoami

@erbbysam

Software Engineer

DC23, DC24 black badge (Badge Challenge, Co9)

The opinions expressed here are my own.

Nothing presented here gives you permission to exploit any host online.
Always seek explicit permission.

Part 1 -- Scanning The Internet

Monitoring the Internet… for Black Badges

We noticed @1o57 would use the same TLDs in the DEFCON badge challenge between years…

Before (and after) DEFCON 24, we created monitoring for .codes and a few other TLDs for changes. We searched for:

- Common strings we know @1o57 uses
- Domains hosted on certain hosting providers
- Relevant whois records

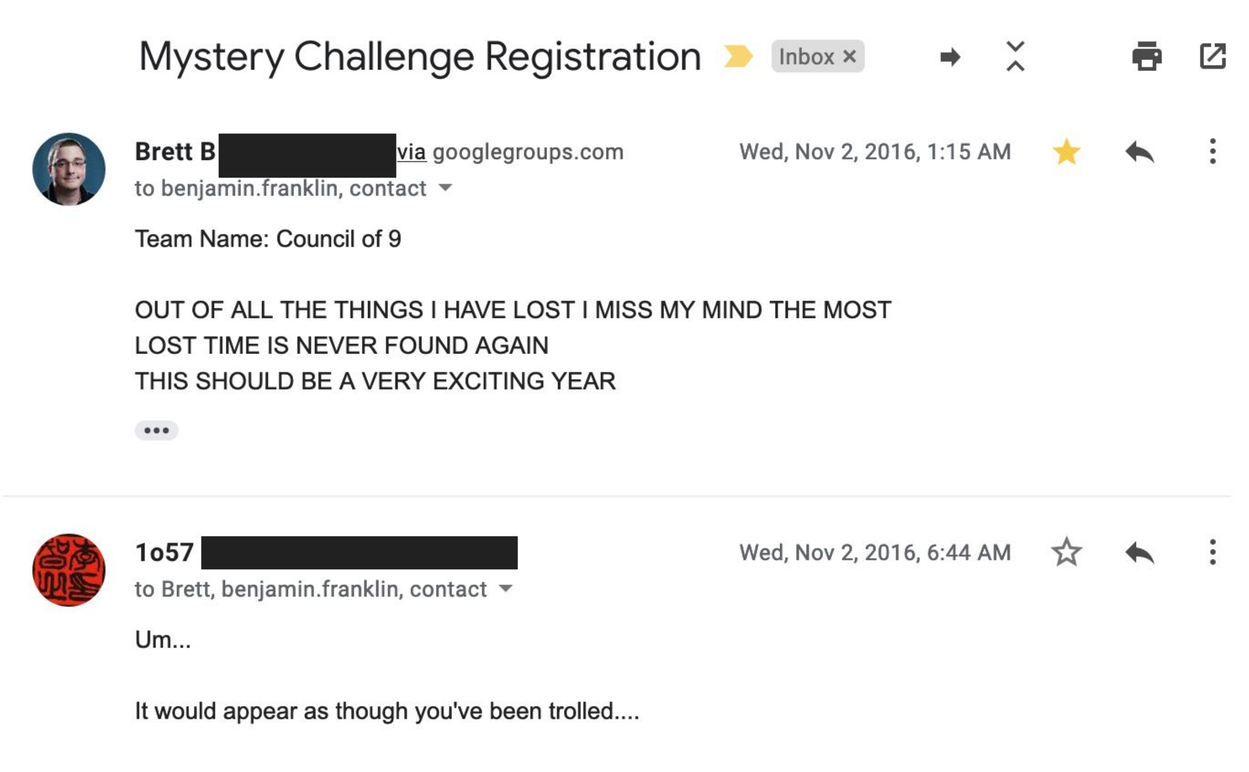
Monitoring the Internet… for Black Badges

Our scanners worked!

https://gray.codes/

Monitoring the Internet… for Black Badges

Our scanners worked…… https://gray.codes/



Mystery Challenge Registration

Brett B [redacted] via googlegroups.com
to benjamin.franklin, contact
Wed, Nov 2, 2016, 1:15 AM

Team Name: Council of 9

OUT OF ALL THE THINGS I HAVE LOST I MISS MY MIND THE MOST
LOST TIME IS NEVER FOUND AGAIN
THIS SHOULD BE A VERY EXCITING YEAR

1o57 [redacted]
to Brett, benjamin.franklin, contact
Wed, Nov 2, 2016, 6:44 AM

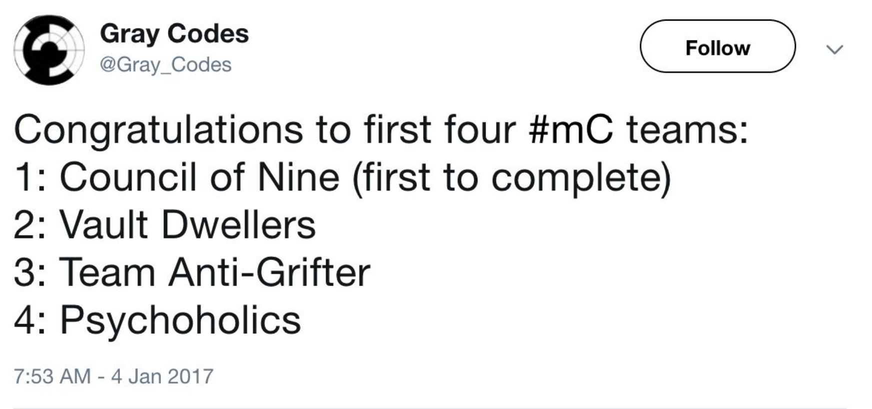
Um...

It would appear as though you've been trolled....

Monitoring the Internet… for Black Badges

Our scanners worked…................. https://gray.codes/

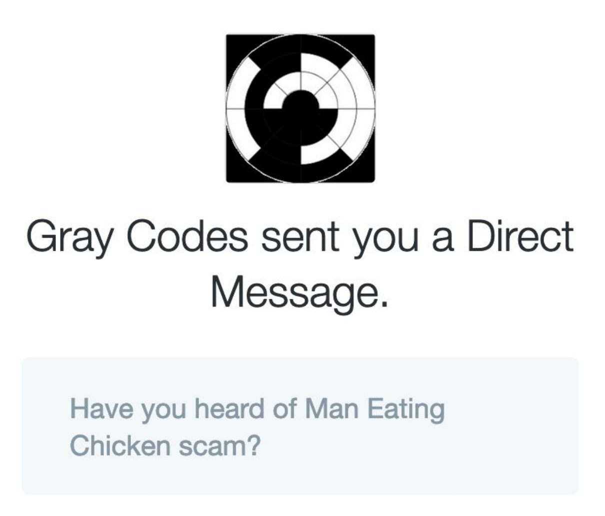
(we were all trolled)



Congratulations to first four #mC teams:
1: Council of Nine (first to complete)
2: Vault Dwellers
3: Team Anti-Grifter
4: Psychoholics

7:53 AM - 4 Jan 2017

https://twitter.com/Gray_Codes/status/816673994858524672



Gray Codes sent you a Direct Message.

Have you heard of Man Eating Chicken scam?

Monitoring the Internet…

For more than Black Badges?

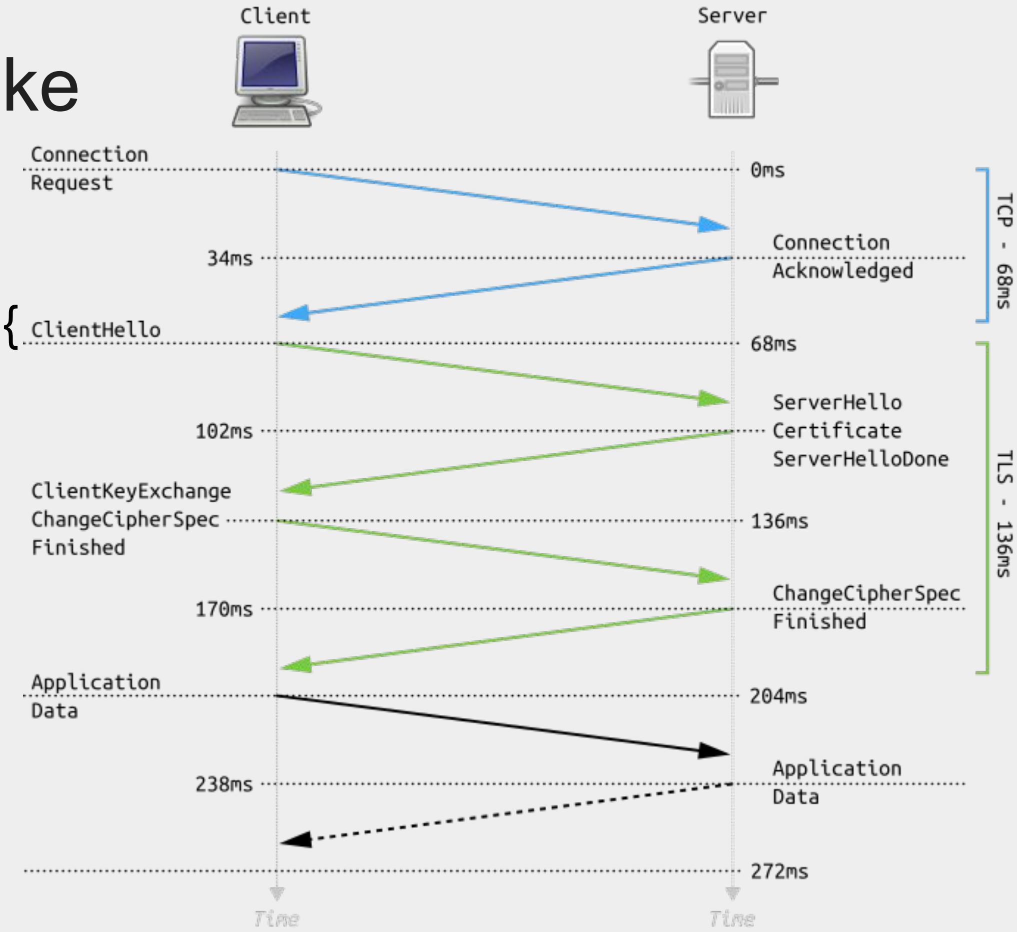
This was my first experience monitoring & searching the public internet. This made me wonder what else could be found online...

TLS Certificates

- TLS Certificates contain hostnames!

Before I talk about scanning the internet for certificates, let's talk about TLS.

TLS Handshake



Client Random
Server Name Indication(SNI) {

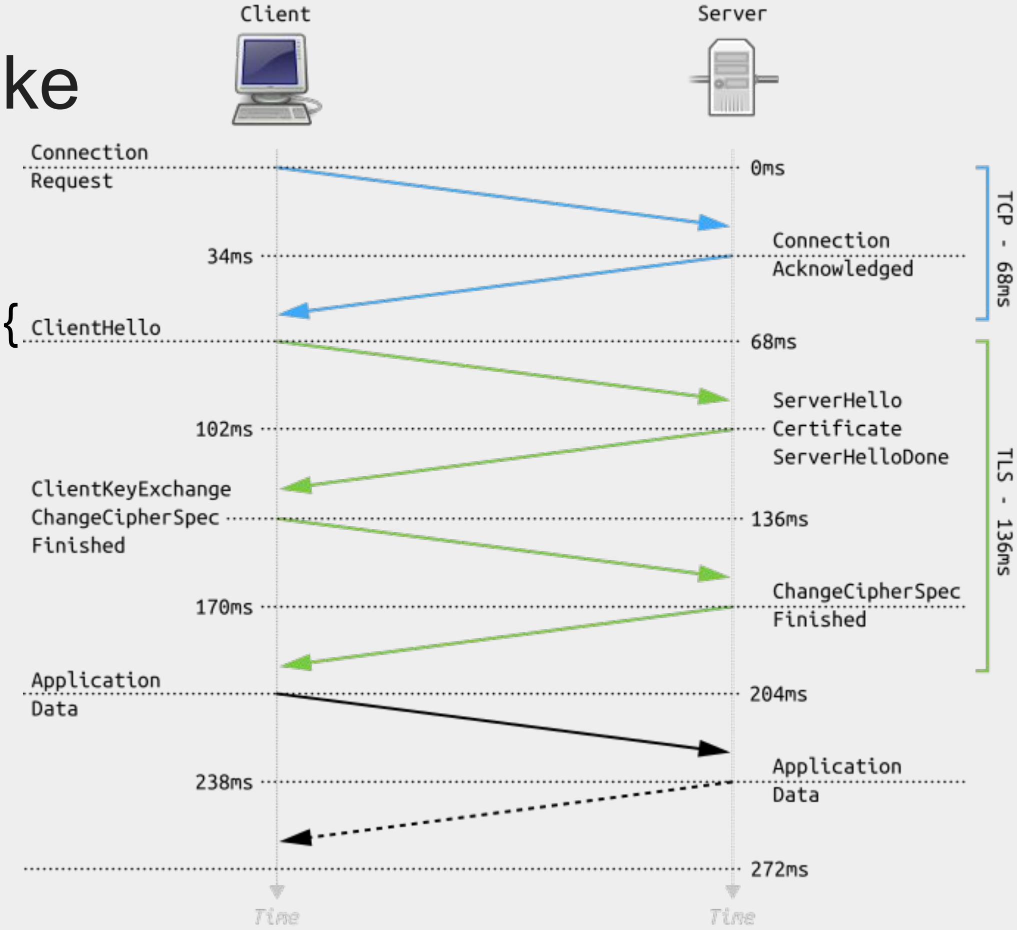
Server Random
} Certificate
Certificate Signature

Handshake leading to master secret {

} Handshake leading to master secret

Image via https://commons.wikimedia.org/wiki/File:Full_TLS_1.2_Handshake.svg

TLS Handshake



Client Random
Server Name Indication(SNI) {

Handshake leading to master secret {

I want the hostnames found here

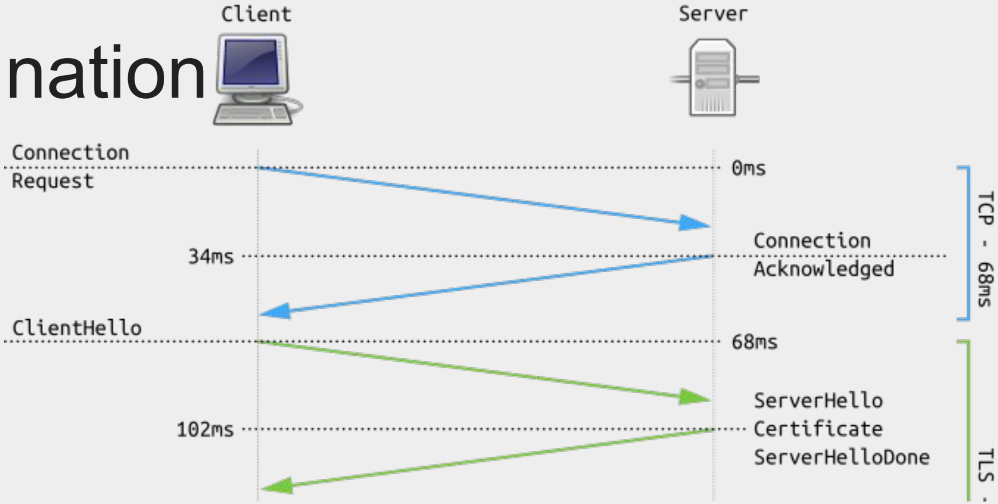
} Server Random
Certificate
Certificate Signature

} Handshake leading to master secret

Image via https://commons.wikimedia.org/wiki/File:Full_TLS_1.2_Handshake.svg

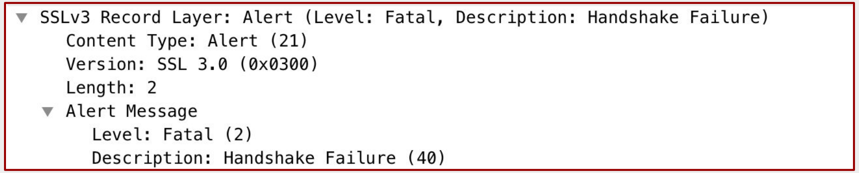
Early TLS Termination

Client Random
Server Name Indication(SNI) {



I want the hostnames found here

} Server Random
Certificate
Certificate Signature



```
▼ SSLv3 Record Layer: Alert (Level: Fatal, Description: Handshake Failure)
    Content Type: Alert (21)
    Version: SSL 3.0 (0x0300)
    Length: 2
  ▼ Alert Message
      Level: Fatal (2)
      Description: Handshake Failure (40)
```

Image via https://commons.wikimedia.org/wiki/File:Full_TLS_1.2_Handshake.svg

X509 Certificate SAN Example (google.com)

```
        X509v3 extensions:
        X509v3 Extended Key Usage:
                TLS Web Server Authentication
        X509v3 Subject Alternative Name:
                DNS:*.google.com, DNS:*.android.com, DNS:*.appengine.google.com, DNS:*.cloud.google.com,
DNS:*.crowdsource.google.com, DNS:*.g.co, DNS:*.gcp.gvt2.com, DNS:*.gcpcdn.gvt1.com, DNS:*.ggpht.cn,
DNS:*.google-analytics.com, DNS:*.google.ca, DNS:*.google.cl, DNS:*.google.co.in, DNS:*.google.co.jp,
DNS:*.google.co.uk, DNS:*.google.com.ar, DNS:*.google.com.au, DNS:*.google.com.br,
DNS:*.google.com.co, DNS:*.google.com.mx, DNS:*.google.com.tr, DNS:*.google.com.vn, DNS:*.google.de,
DNS:*.google.es, DNS:*.google.fr, DNS:*.google.hu, DNS:*.google.it, DNS:*.google.nl, DNS:*.google.pl,
DNS:*.google.pt, DNS:*.googleadapis.com, DNS:*.googleapis.cn, DNS:*.googlecnapps.cn,
DNS:*.googlecommerce.com, DNS:*.googlevideo.com, DNS:*.gstatic.cn, DNS:*.gstatic.com,
DNS:*.gstaticcnapps.cn, DNS:*.gvt1.com, DNS:*.gvt2.com, DNS:*.metric.gstatic.com, DNS:*.urchin.com,
DNS:*.url.google.com, DNS:*.youtube-nocookie.com, DNS:*.youtube.com, DNS:*.youtubeeducation.com,
DNS:*.youtubekids.com, DNS:*.yt.be, DNS:*.ytimg.com, DNS:android.clients.google.com, DNS:android.com,
DNS:developer.android.google.cn, DNS:developers.android.google.cn, DNS:g.co, DNS:ggpht.cn, DNS:goo.gl,
DNS:google-analytics.com, DNS:google.com, DNS:googlecnapps.cn, DNS:googlecommerce.com,
DNS:source.android.google.cn, DNS:urchin.com, DNS:www.goo.gl, DNS:youtu.be, DNS:youtube.com,
DNS:youtubeeducation.com, DNS:youtubekids.com, DNS:yt.be
```

TLS Scanning the Internet

For each ipv4 host:

- Masscan port 443 -- https://github.com/robertdavidgraham/masscan
- Send a TLS Client Hello, disconnect after the Server Certificate is observed

Used golang, modified the golang TLS stack to terminate at the correct time & return a parsed x509 structure.

```
pseudocode.sh:
./masscan -p443 0.0.0.0/0 -oL masscan_output --excludefile exclude.conf
./golang_scanner masscan_output > scanning_results
```

Am I finding every host on port 443?

This Scanner	**51,996,236**
2015 Paper[0]	42,676,912
Shodan	58,188,083
Shodan, ipv4 limited “net:0.0.0.0/0”	42,881,125

[0] TLS in the wild: an Internet-wide analysis of TLS-based protocols for electronic communication
Ralph Holz, Johanna Amann, Olivier Mehani, Matthias Wachs, Mohamed Ali Kaafar
https://arxiv.org/pdf/1511.00341.pdf

Am I finding every certificate?

SNI

Servers can use the Server Name Indication (SNI) in the TLS Client Hello to differentiate clients, returning different certificates.

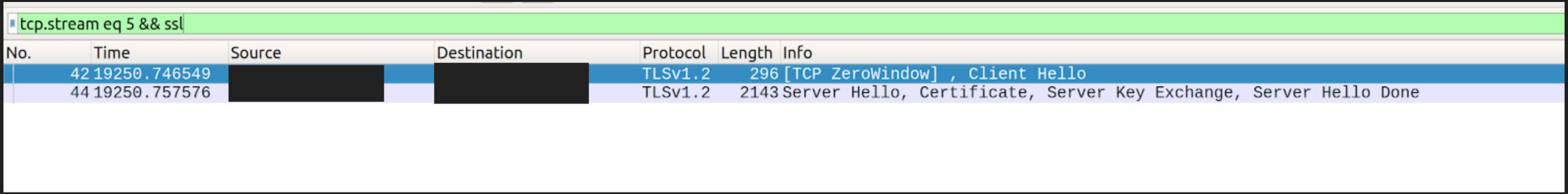
Commonly used by CDN’s. Will not be found here.

x509 Formatting Issues

Golang’s x509 parser can be “too strict” when parsing malformed certificates.

This is best described here:
https://sslmate.com/blog/post/how_certspotter_parses_255_million_certificates

Who else is terminating TLS early?



```
tcp.stream eq 5 && ssl
```

No.	Time	Source	Destination	Protocol	Length	Info
42	19250.746549	[redacted]	[redacted]	TLSv1.2	296	[TCP ZeroWindow] , Client Hello
44	19250.757576	[redacted]	[redacted]	TLSv1.2	2143	Server Hello, Certificate, Server Key Exchange, Server Hello Done

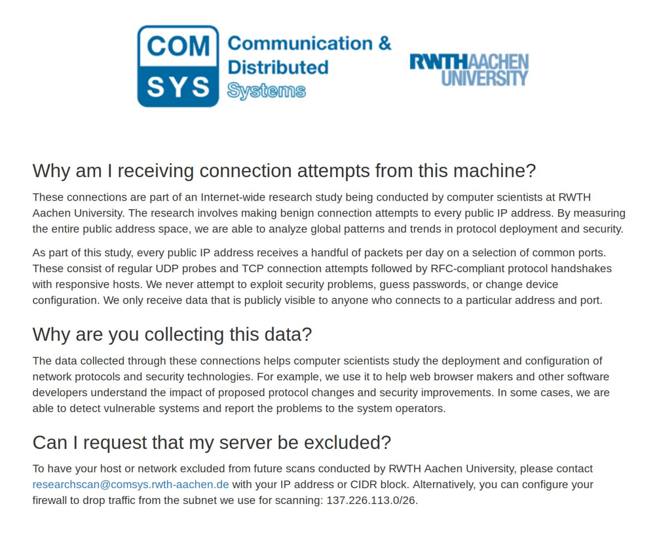
I ran a TLS server and captured traffic for a few days...

3 clients terminated after the Server Hello:

- Server hosted at hosteurope.de
- Albert-Ludwigs-Universität Freiburg, Germany
- RWTH Aachen University, Germany

This could just be due to the self-signed certificate used during testing. However, no “Certificate Unknown” TLS alert was observed!

Additionally, no SNI was sent.



Why am I receiving connection attempts from this machine?

These connections are part of an Internet-wide research study being conducted by computer scientists at RWTH Aachen University. The research involves making benign connection attempts to every public IP address. By measuring the entire public address space, we are able to analyze global patterns and trends in protocol deployment and security.

As part of this study, every public IP address receives a handful of packets per day on a selection of common ports. These consist of regular UDP probes and TCP connection attempts followed by RFC-compliant protocol handshakes with responsive hosts. We never attempt to exploit security problems, guess passwords, or change device configuration. We only receive data that is publicly visible to anyone who connects to a particular address and port.

Why are you collecting this data?

The data collected through these connections helps computer scientists study the deployment and configuration of network protocols and security technologies. For example, we use it to help web browser makers and other software developers understand the impact of proposed protocol changes and security improvements. In some cases, we are able to detect vulnerable systems and report the problems to the system operators.

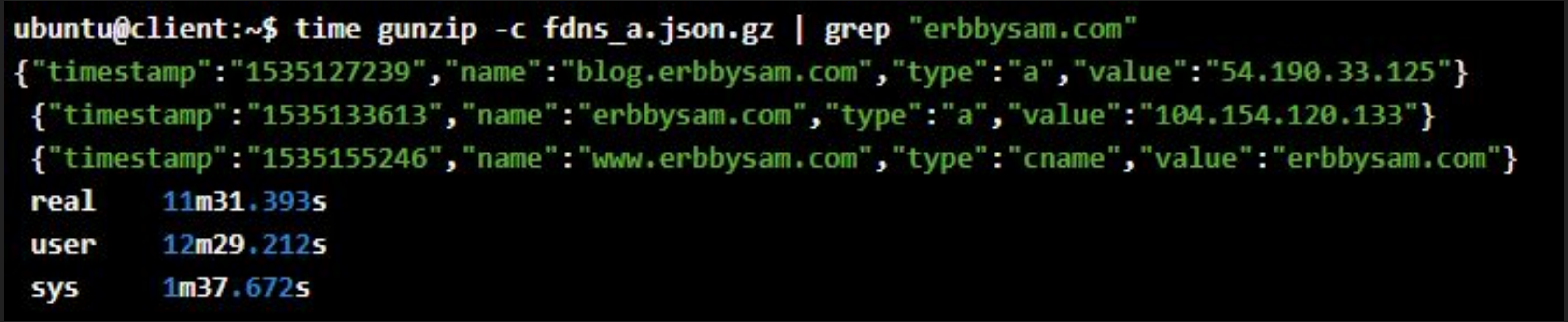
Can I request that my server be excluded?

To have your host or network excluded from future scans conducted by RWTH Aachen University, please contact researchscan@comsys.rwth-aachen.de with your IP address or CIDR block. Alternatively, you can configure your firewall to drop traffic from the subnet we use for scanning: 137.226.113.0/26.

Part 2 -- Searching DNS Data

How to search large DNS datasets

This started as a problem I had. Rapid7 datasets were 10GB of unsorted, **compressed** DNS data.



```
ubuntu@client:~$ time gunzip -c fdns_a.json.gz | grep "erbbysam.com"
{"timestamp":"1535127239","name":"blog.erbbysam.com","type":"a","value":"54.190.33.125"}
 {"timestamp":"1535133613","name":"erbbysam.com","type":"a","value":"104.154.120.133"}
 {"timestamp":"1535155246","name":"www.erbbysam.com","type":"cname","value":"erbbysam.com"}
 real    11m31.393s
 user    12m29.212s
 sys     1m37.672s
```

This obviously took a long time to search.

https://blog.erbbysam.com/index.php/2019/02/09/dnsgrep/

How to search large DNS datasets (continued)

I took advantage of the DNS tree structure to sort the data:

```
com
com.erbbysam
com.erbbysam.blog
```

To make this a bit more generic/scriptable, I reversed the DNS name, then sorted:

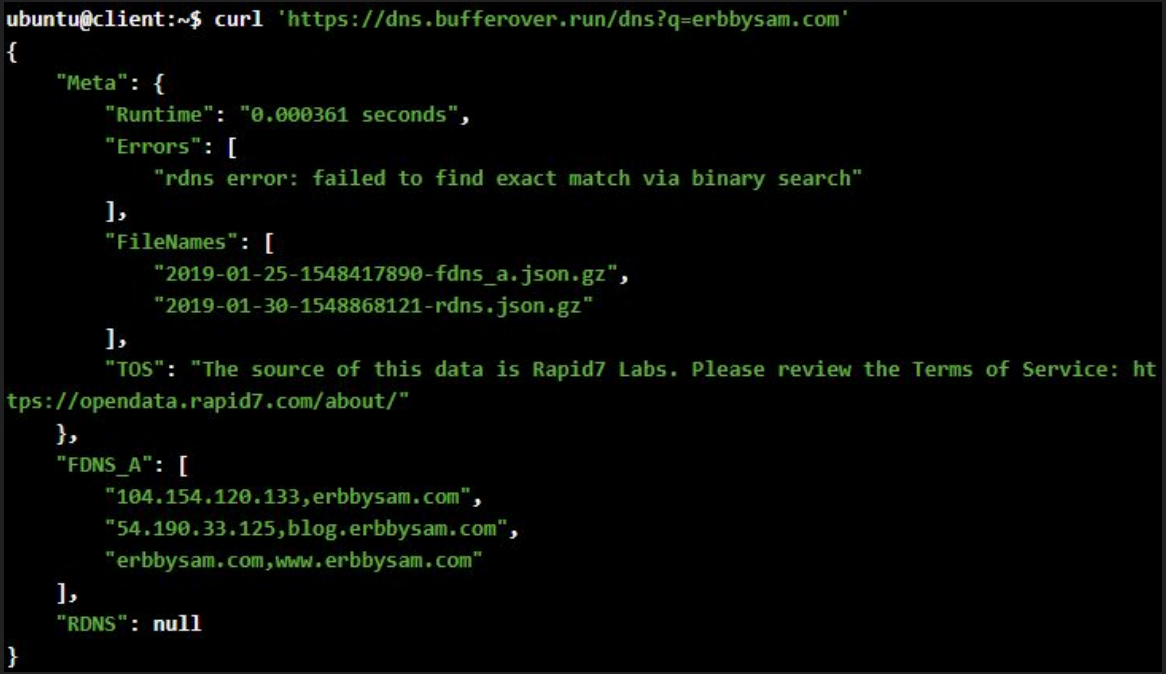
```
moc.masybbre.golb,521.33.091.4
moc.masybbre,331.021.451.40
moc.masybbre.www,moc.masybbre
```

With this sorted data, I could now binary search to quickly find the records I wanted.

https://blog.erbbysam.com/index.php/2019/02/09/dnsgrep/

How to search large DNS datasets (continued)

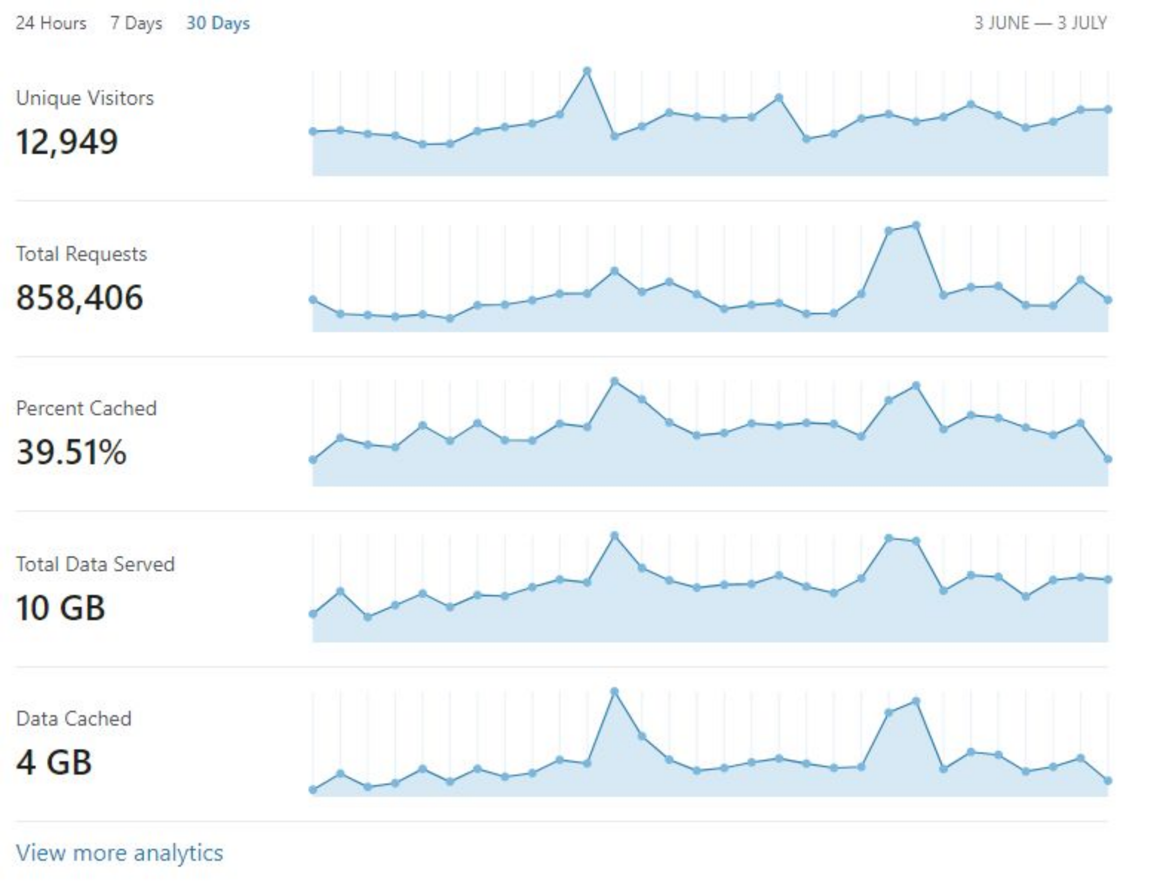
I put this online using a golang webserver:



```
ubuntu@client:~$ curl 'https://dns.bufferover.run/dns?q=erbbysam.com'
{
    "Meta": {
        "Runtime": "0.000361 seconds",
        "Errors": [
            "rdns error: failed to find exact match via binary search"
        ],
        "FileNames": [
            "2019-01-25-1548417890-fdns_a.json.gz",
            "2019-01-30-1548868121-rdns.json.gz"
        ],
        "TOS": "The source of this data is Rapid7 Labs. Please review the Terms of Service: ht
tps://opendata.rapid7.com/about/"
    },
    "FDNS_A": [
        "104.154.120.133,erbbysam.com",
        "54.190.33.125,blog.erbbysam.com",
        "erbbysam.com,www.erbbysam.com"
    ],
    "RDNS": null
}
```

https://blog.erbbysam.com/index.php/2019/02/09/dnsgrep/
https://github.com/erbbysam/DNSGrep

https://dns.bufferover.run/dns?q=



Unique Visitors
12,949

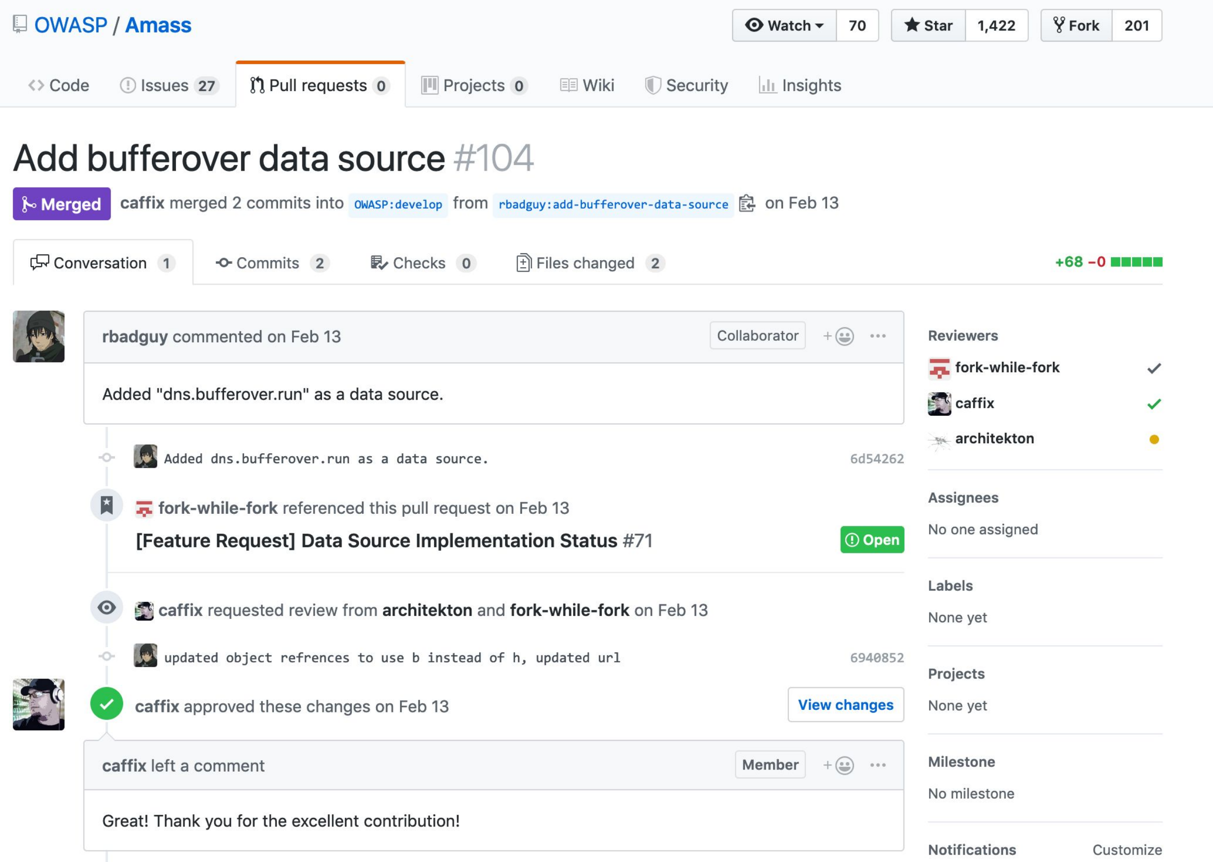
Total Requests
858,406

Percent Cached
39.51%

Total Data Served
10 GB

Data Cached
4 GB

https://dns.bufferover.run/dns?q=



Add bufferover data source #104

Merged caffix merged 2 commits into OWASP:develop from rbadguy:add-bufferover-data-source on Feb 13

rbadguy commented on Feb 13 Collaborator

Added "dns.bufferover.run" as a data source.

```
Added dns.bufferover.run as a data source.                6d54262
```

fork-while-fork referenced this pull request on Feb 13

[Feature Request] Data Source Implementation Status #71 Open

caffix requested review from architekton and fork-while-fork on Feb 13

```
updated object refrences to use b instead of h, updated url                6940852
```

caffix approved these changes on Feb 13 View changes

caffix left a comment Member

Great! Thank you for the excellent contribution!

Reviewers
fork-while-fork ✓
caffix ✓
architekton ●

Assignees
No one assigned

Labels
None yet

Projects
None yet

Milestone
No milestone

Notifications Customize

https://github.com/OWASP/Amass/pull/104

Part 3 -- Putting Everything Together

Putting This Together

- Built an efficient TLS scanner that runs once a week
- Built an efficient way to query DNS datasets

Created https://tls.bufferover.run/dns?q=.defcon.org

```
# curl 'https://tls.bufferover.run/dns?q=.defcon.org' 2>/dev/null | jq .Results
[
  "162.222.171.214,DEF CON Communications Inc.,p2ps0.defcon.org",
  "162.222.171.214,DEF CON Communications Inc.,p2ps1.defcon.org",
  "162.222.171.214,DEF CON Communications Inc.,p2ps2.defcon.org",
  "162.222.171.214,DEF CON Communications Inc.,p2ps3.defcon.org",
  ...
```

Comparing tls.bufferover.run/dns?q=

shodan.io

- Should contain similar results
- Not free

Certificate Transparency monitors (such as crt.sh)

- Only contains publicly trusted certificates
- Does not identify servers which use a given certificate

Rapid7 TLS dataset (https://opendata.rapid7.com/sonar.ssl/)

- I ♥ Rapid7 datasets, but I wish they were easier to use
- This contains only the “new” certificates they encounter on their scans

Many others -- OWASP amass source is a good resource https://github.com/OWASP/Amass/issues/71

demo

Hack yourself first!

(credit troyhunt.com)

demo

Hack yourself first!

(credit troyhunt.com)

Hack your military first!

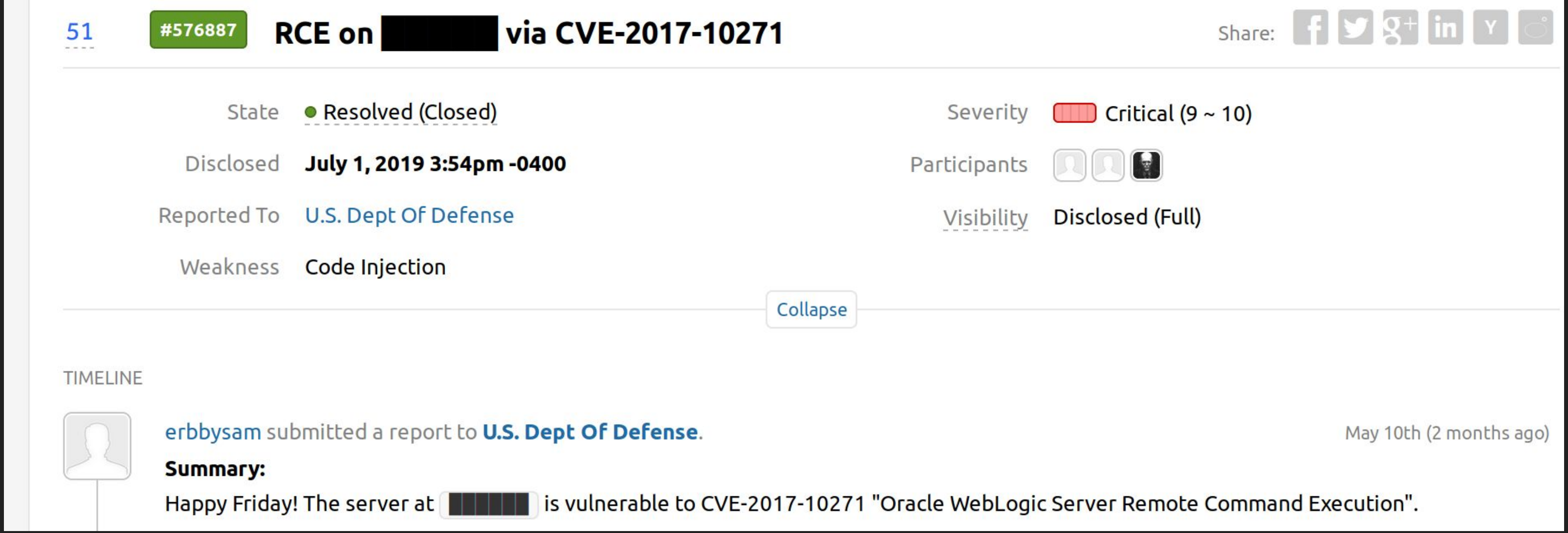
https://tls.bufferover.run/dns?q=.mil returns ~473,000 results!

Report what you find → https://hackerone.com/deptofdefense

demo

Hack your military first!

https://tls.bufferover.run/dns?q=.mil returns ~473,000 results!



51 #576887 **RCE on [redacted] via CVE-2017-10271**

State ● Resolved (Closed)

Disclosed **July 1, 2019 3:54pm -0400**

Reported To U.S. Dept Of Defense

Weakness Code Injection

Severity 🟥 Critical (9 ~ 10)

Participants

Visibility Disclosed (Full)

TIMELINE

erbbysam submitted a report to **U.S. Dept Of Defense**. May 10th (2 months ago)

Summary:

Happy Friday! The server at [redacted] is vulnerable to CVE-2017-10271 "Oracle WebLogic Server Remote Command Execution".

Questions?

Contact: @erbbysam

Thank you for inspiration/ideas:
https://twitter.com/bbuerhaus
https://twitter.com/smiegles
https://twitter.com/tomnomnom
https://twitter.com/hacker_

Try this out today:

https://tls.bufferover.run/dns?q=.defcon.org