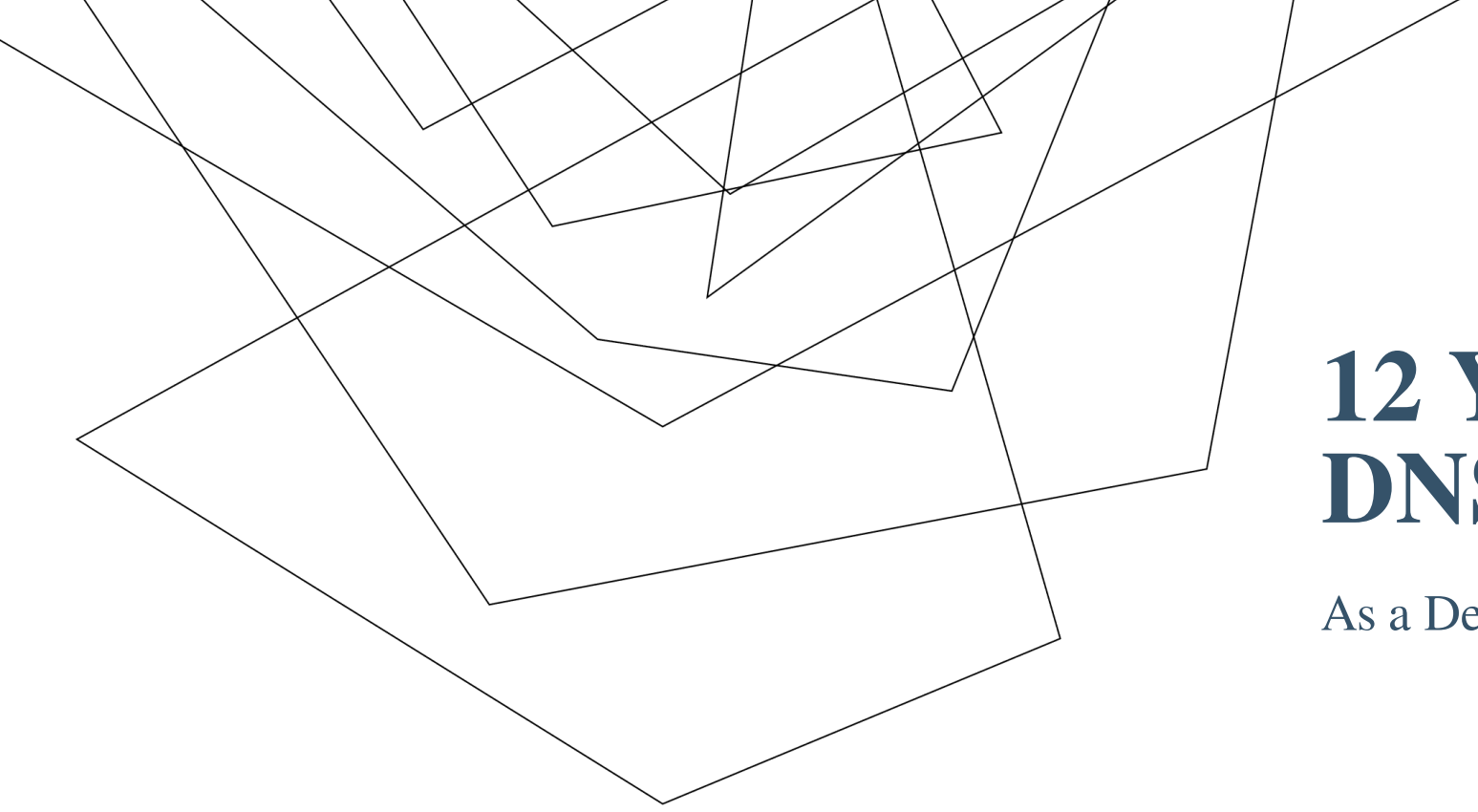


12 Years in DNS Security

As a Defender

A. S. M. **Shamim** Reza

btNOG 10

Paro

5-9 June, 2023

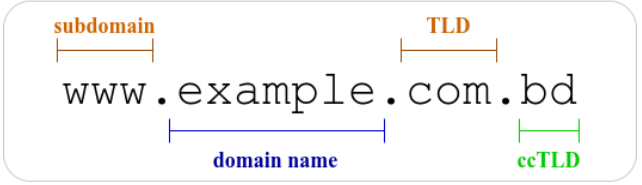
`[~]$whoami`

– 12+ years worked at *ISP*
– Chief Technology Officer, *Pipeline Inc.*
– Community Trainer, *APNIC*
– Founder, *TheTeamPhoenix*

@*asmshamimreza* on **Linkedin**
@*shamimrezasohag* on **Twitter**

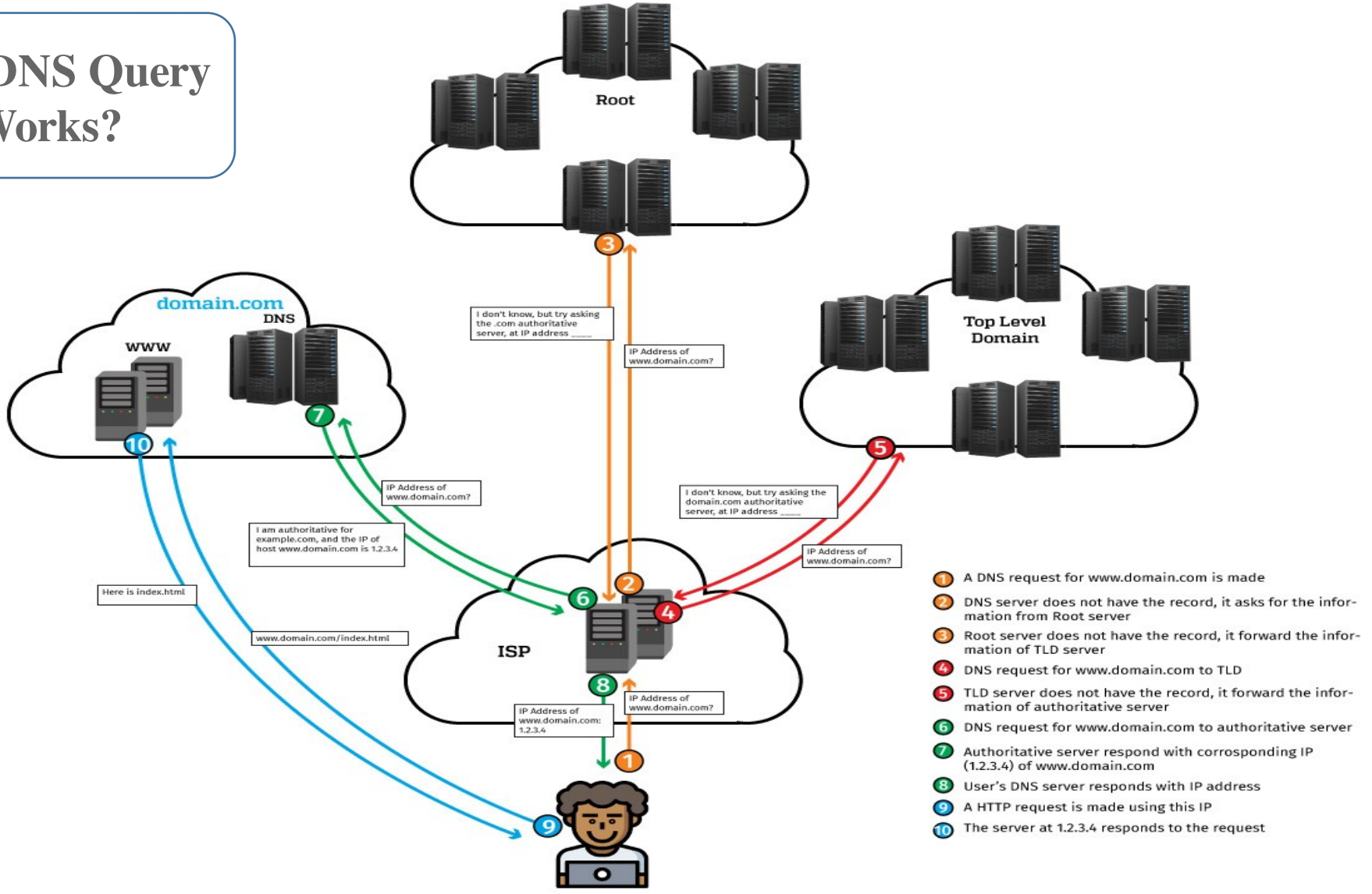
What is DNS?

> “I designed the DNS so that the name-space could be anything you wanted it to be.”
>
> – Dr. Paul Mockapetris



DNS	Domain Name System
Inventor	Dr. Paul Mockapetris
Year	1983
RFC	882 & 883
Port 53 TCP/**UDP**	
Place	University of Southern California’s Information Sciences Institute

How DNS Query Works?



Attacker likes DNS

≡ WIRED

LILY HAY NEWMAN SECURITY SEP 16, 2022 5:35 PM

The Uber Hack's Devastation Is Just Starting to Reveal Itself

An alleged teen hacker claims to have gained deep access to the company's systems, but the full picture of the breach is still coming into focus.

91.3%

of malware uses DNS in attacks

68%

of Organization don't monitor DNS

Cyber Attacks on DNS

Attacks that Target DNS Server
DDoS
Recursive Query Attacks
Cache Poisoning Attacks
Buffer overflow
Port Scan

Attacks using DNS Server
Reflection Attack
DNS Tunneling
DGA
Command & Control

Stat on 53 port – Bangladesh

Listening IPs

64,576

Recursion: enabled

51,257

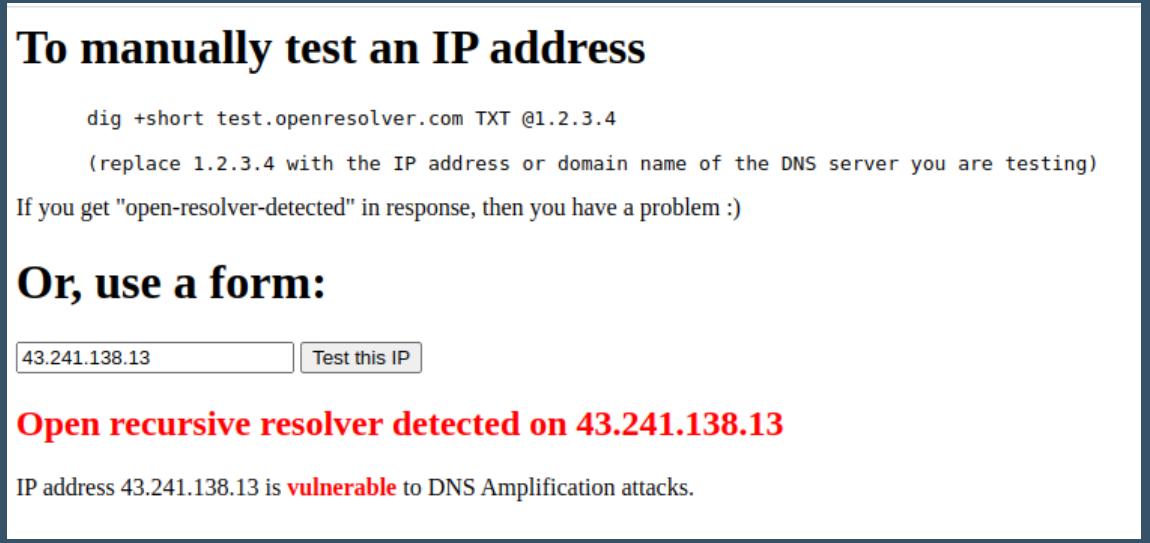
Stat on 53 port – Bhutan

Listening IPs

179

Recursion: enabled

71



To manually test an IP address

```
dig +short test.openresolver.com TXT @1.2.3.4
```

(replace 1.2.3.4 with the IP address or domain name of the DNS server you are testing)

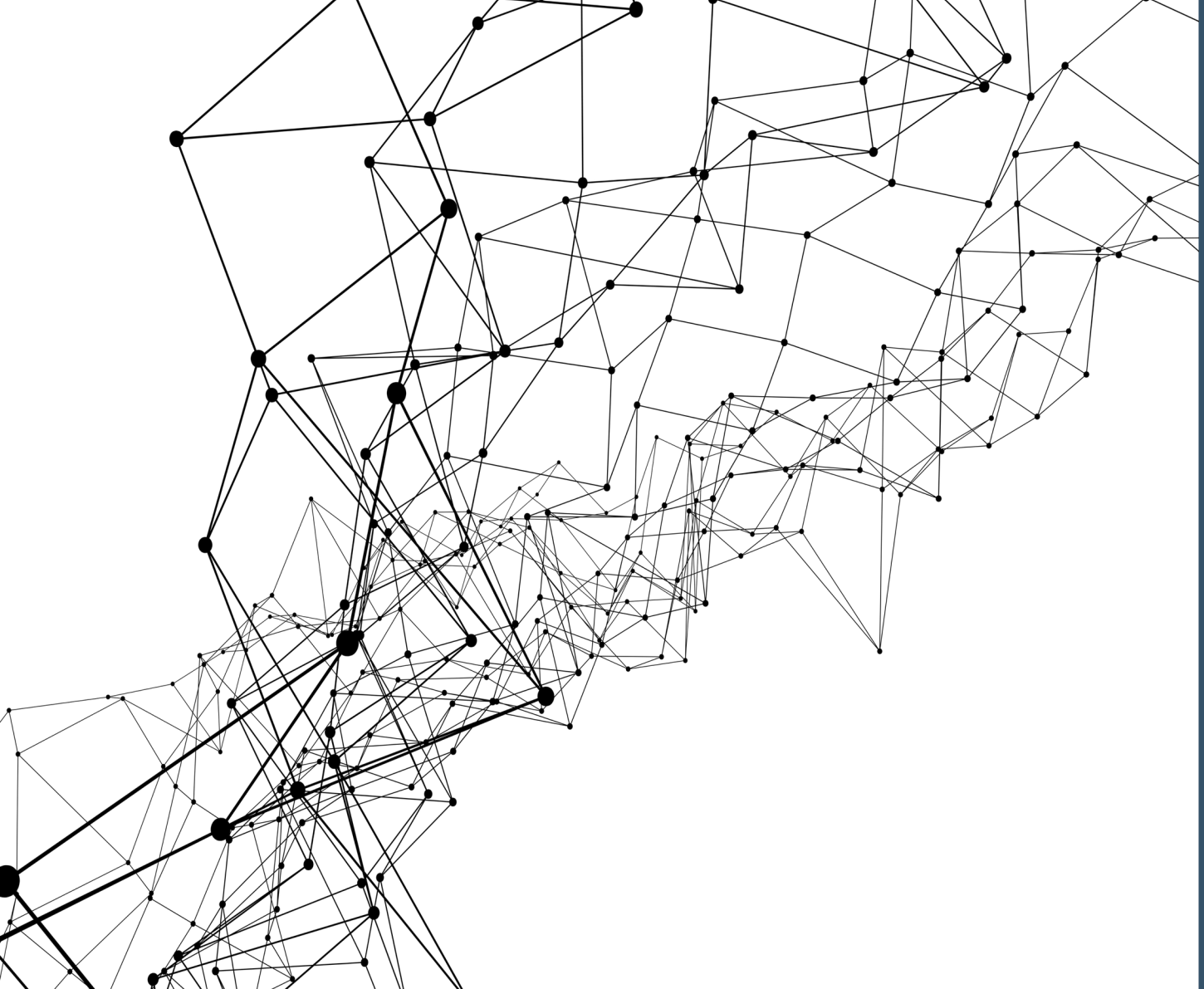
If you get "open-resolver-detected" in response, then you have a problem :)

Or, use a form:

43.241.138.13 Test this IP

Open recursive resolver detected on 43.241.138.13

IP address 43.241.138.13 is **vulnerable** to DNS Amplification attacks.



Lets talk about the Journey

Observing DDoS

Findings	Mitigation Technique?
Authoritative & Recursive service at the same system	Separated them into different Hosts
Service was running with Same OS and Bind service	Migrated with BIND+CentOS & Unbound+FreeBSD
Recursive resolver was Central	Deployed IP Anycast for Recursive DNS in multiple region.

Initial goal was to increase service availability

Observing DDoS – additional steps

– OS installation was practice with Minimal ISO.

– Allowed only required service port.

– Practiced IP ACL on remote access at Host based firewall.

– Imposed IP ACL on DNS service configuration.

– Disabled service version exposer.

– Automatic update on OS Kernel, packages and patches.

– BIND configured with CHROOT.

Looking for other Attacks? increase insights

- **Started log storing**
- CLI based analytic
- BIND Stats visualization

Log File Category Definition:

```
category default { default_file; };
category general { general_file; };
category database { database_file; };
category security { security_file; };
category config { config_file; };
category resolver { resolver_file; };
category xfer-out { xfer-out_file; };
category notify { notify_file; };
category client { client_file; };
category unmatched { unmatched_file; };
category queries { queries_file; };
category network { network_file; };
category update { update_file; };
category dispatch { dispatch_file; };
category dnssec { dnssec_file; };
category lame-servers { lame-servers_file; };
```

Looking for other Attacks? increase insights

– Started log storing
– **CLI based analytic**
– BIND Stats visualization

– Used DNSTOP for automated Stats check from CLI
– DNSTOP can be used in all the Linux variants.
– In addition we have used generic utilities from the CLI to get the summary.

```
# cat query.log | cut -d " " -f 10 |
sort | uniq -c | sort -n

  23506 www.google.com
  26679 imgcdn.ptvcdn.net
  28539 outlook.office.com
  47835 dns.google
 100117 time-c.timefreq.bldrdoc.gov
 100533 time-b.timefreq.bldrdoc.gov
 101298 time-a.timefreq.bldrdoc.gov
```

```
# cat query.log | cut -d " " -f 10 | cut
-d "." -f "2-3" | sort | uniq -c | sort
-n

  31836 office.com
  36193 ms-acdc.office
  39567 events.data
  42475 google.com
  47835 google
 301948 timefreq.bldrdoc
```

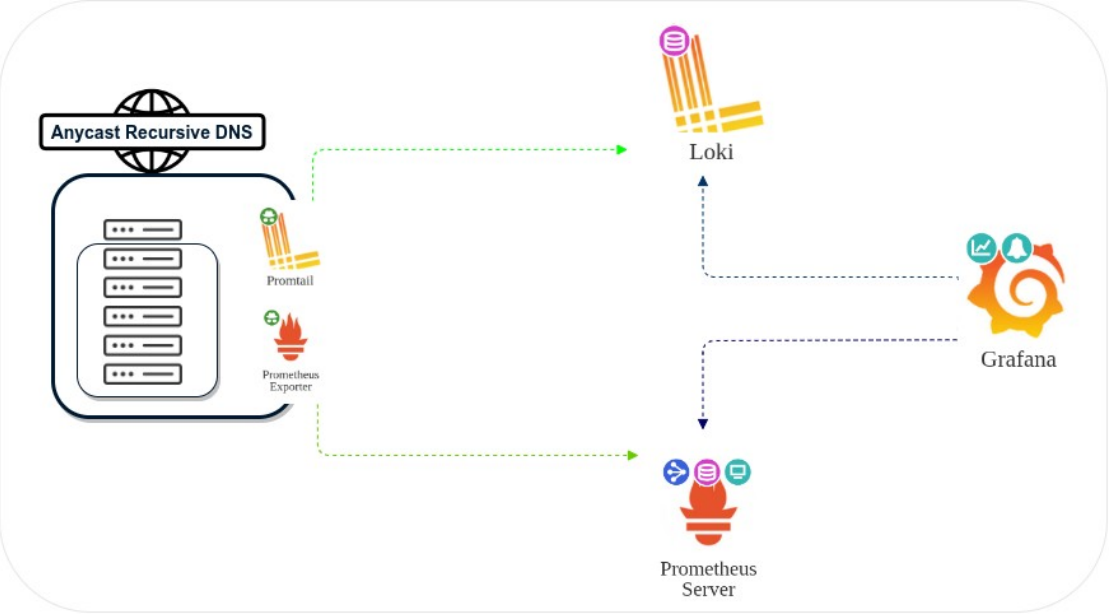
Looking for other Attacks? increase insights

– Started log storing
– CLI based analytic
– **BIND Stats visualization**

– With the CLI based check, we face few challenges as the log volume was increasing day by day.
  – time consuming
  – repetitive task for the same activity *(scripting wasnt helping)*

Deployed **Grafana** eco-system to get all the Stats + logs and then visualized.

`Focused was to get all the insights on NXDOMAIN.`



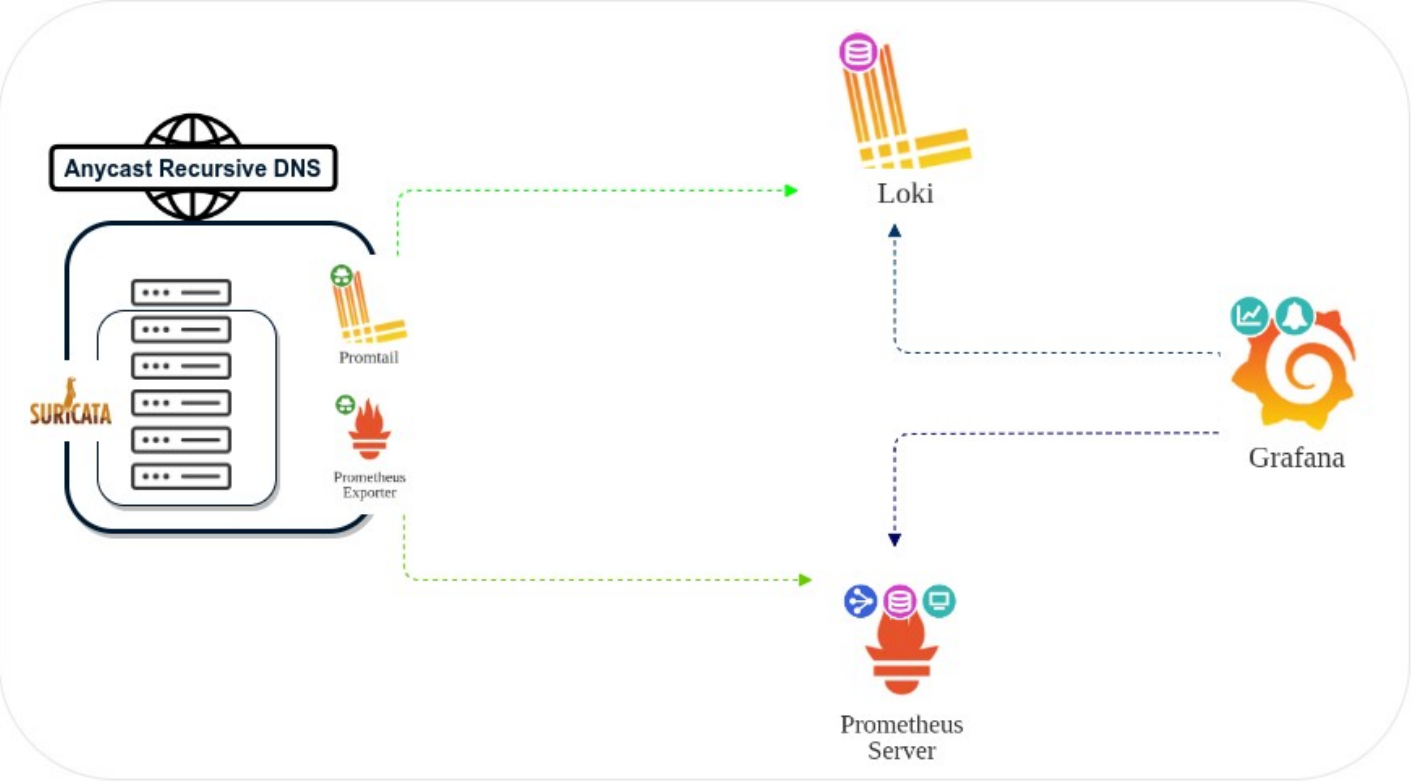
Looking beyond NXDOMAIN!

– Observed overall pattern of NXDOMAIN across the DNS infra

– Few zones crosses the threshold on a specific time in max of cases

– Log shows C&C communication in a few cases, decided to dig deep for NXDOMAIN

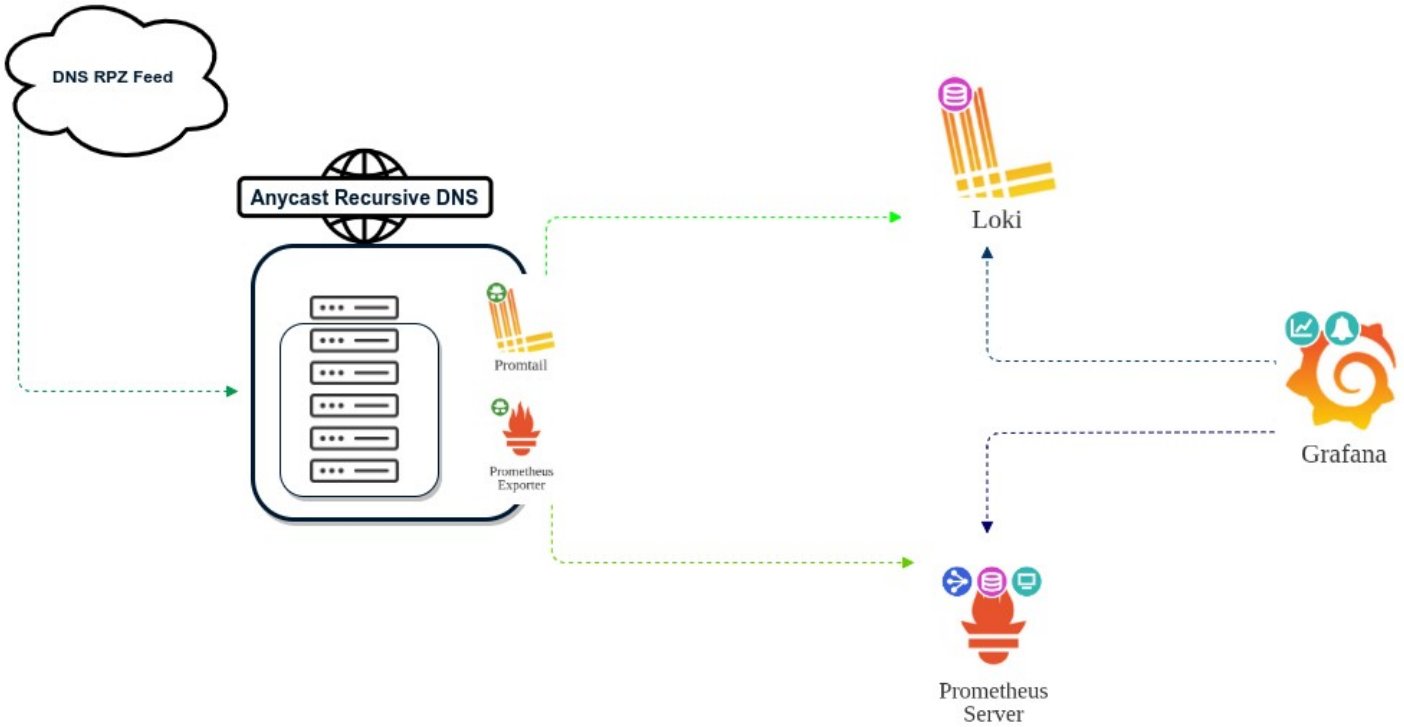
– Installed ***Suricata NIDS*** in the DNS Infra and start monitoring the activity



Including active Defense!

– The outcome of the analysis, after incorporating Suricata, was enormous.

– To overcome the issue, plan to deploy ***DNS RPZ***



"One should always look for a possible alternative, and provide against it. It is the first rule of criminal investigation."

Sherlock Holmes, the adventure of black peter

What Next? Network Traffic – *NetFlow with NFSen*

Roaming around in NetFlow

– Searched for IPs listening on 53 port to mitigate **OpenResolver**
– Setup threshold on traffic on 53 port both for TCP & UDP
– Looking for a specific region that uses the 53 port heavily.
– Looking for IPs that are sending 40<= bytes of PKT.

What Next? Network Traffic – *NetFlow with NFSen*

Date first seen	Duration	Proto	Src IP Addr:Port		Dst IP Addr:Port	Flags	Tos	Packets	Bytes	pps	bps	Bpp	Flows
2022-08-20 11:57:20.410	7.040	UDP	10.160.252.254:55427	->	192.168.0.254:10032	.....	0	4	280	0	318	70	1
2022-08-20 11:57:20.430	7.040	UDP	10.160.252.254:55429	->	192.168.0.254:10032	.....	0	4	280	0	318	70	1
2022-08-20 11:57:21.500	7.050	UDP	10.160.252.254:51601	->	192.168.0.254:99032	.....	0	4	276	0	313	69	1
2022-08-20 11:57:21.500	7.050	UDP	10.160.252.254:56961	->	192.168.0.254:19032	.....	0	4	276	0	313	69	1
2022-07-10 22:52:31.540	158.330	UDP	10.175.8.138:53	->	192.168.0.254:19032	.....	0	111	7509	0	379	67	1
2022-07-10 22:52:26.570	199.400	UDP	10.175.8.78:53	->	192.168.0.254:20031	.....	0	90	6123	0	245	68	1
2022-07-10 22:54:01.770	147.120	UDP	10.175.21.234:53	->	192.168.0.254:60245	.....	0	104	7526	0	409	72	1
2022-07-10 22:54:25.950	133.830	UDP	10.175.24.160:53	->	192.168.0.254:8206	.....	0	117	8018	0	479	68	1
2022-07-10 22:52:24.280	280.700	UDP	10.175.22.226:53	->	192.168.0.254:94036	.....	0	117	8836	0	251	75	1
2022-09-08 19:06:41.210	0.000	UDP	10.160.252.188:61902	->	192.168.0.254:12023	.....	0	1	45	0	0	45	1
2022-09-08 21:08:20.570	0.000	UDP	10.160.252.212:40960	->	192.168.0.254:10046	.....	0	1	45	0	0	45	1
2022-08-26 21:44:18.720	0.000	UDP	142.93.132.42:55433	->	192.16.204.217:12067	.....	72	1	28	0	0	28	1
2022-08-26 21:45:11.320	0.000	UDP	142.93.132.42:55433	->	192.16.204.217:11057	.....	72	1	40	0	0	40	1
2022-08-26 21:47:33.480	0.000	TCP	88.6.232.5:42671	->	192.16.204.219:53	....S.	40	1	40	0	0	40	1
2022-08-26 22:18:58.290	0.000	TCP	88.6.232.5:52561	->	192.16.204.213:53	....S.	40	1	40	0	0	40	1
2022-09-12 19:54:04.130	52.830	TCP	10.160.68.26:53	->	192.168.0.254:55024	.AP...	0	319	349200	6	52879	1094	1
2022-09-12 20:04:27.090	1426.890	TCP	10.160.68.26:53	->	192.168.0.254:10035	.AP...	0	245007	349.3 M	171	2.0 M	1425	1
2022-08-20 12:07:59.650	0.000	UDP	10.160.252.254:62415	->	192.168.0.254:10014	.....	0	2	202	0	0	101	1
2022-08-20 12:07:59.650	0.000	UDP	10.160.252.254:64165	->	192.168.0.254:10053	.....	0	2	202	0	0	101	1
2022-08-20 12:07:59.660	0.000	UDP	10.160.252.254:63760	->	192.168.0.254:10123	.....	0	2	116	0	0	58	1
2022-08-20 12:07:59.660	0.000	UDP	10.160.252.254:49521	->	192.168.0.254:10135	.....	0	2	198	0	0	99	1
2022-08-20 12:07:59.660	0.000	UDP	10.160.252.254:61534	->	192.168.0.254:10145	.....	0	2	198	0	0	99	1
2022-08-20 12:07:59.670	0.000	UDP	10.160.252.254:50694	->	192.168.0.254:10068	.....	0	2	192	0	0	96	1
2022-08-20 12:07:59.670	0.000	UDP	10.160.252.254:50557	->	192.168.0.254:10037	.....	0	2	192	0	0	96	1
2022-09-01 00:38:35.710	5.000	UDP	10.160.252.205:21343	->	192.168.0.254:100379	.....	0	4	1256	0	2009	314	1
2022-09-01 00:38:40.660	5.010	UDP	10.160.252.205:2500	->	192.168.0.254:10790	.....	0	4	976	0	1558	244	1
2022-09-01 00:38:45.710	7.960	UDP	10.160.252.205:29718	->	192.168.0.254:10357	.....	0	4	1256	0	1262	314	1
2022-09-01 00:38:50.670	6.440	UDP	10.160.252.205:5733	->	192.168.0.254:23032	.....	0	4	960	0	1192	240	1
2022-10-02 00:09:22.800	0.000	UDP	10.111.186.85:42531	->	192.168.0.254:53	.....	192	1	160	0	0	160	1
2022-10-02 00:09:22.800	0.000	UDP	10.111.186.85:49651	->	192.168.0.254:53	.....	192	1	160	0	0	160	1
2022-10-02 00:09:22.800	0.000	UDP	10.111.186.85:35340	->	192.168.0.254:53	.....	192	1	160	0	0	160	1

***Manipulated sample data

What Next? Network Traffic – *span traffic with Zeek*

Roaming around with Zeek

– Using existing script to find DNS activity
– Finding subdomains with random TLD and longer names.
– Finding subdomains with upper/lower/numbers
– DNS beaconing

What Next?

– With high-end Threat freed, 85%-93% of Cyber attack can be stopped with DNS RPZ.
– Adversaries are evolving their attack tactics.

Incorporate ML/NLP to detect DGA in DNS Query log.

THANK YOU