



A Hackers View of DoS Attacks

David Robinson

Code Camp Wellington
April 2023

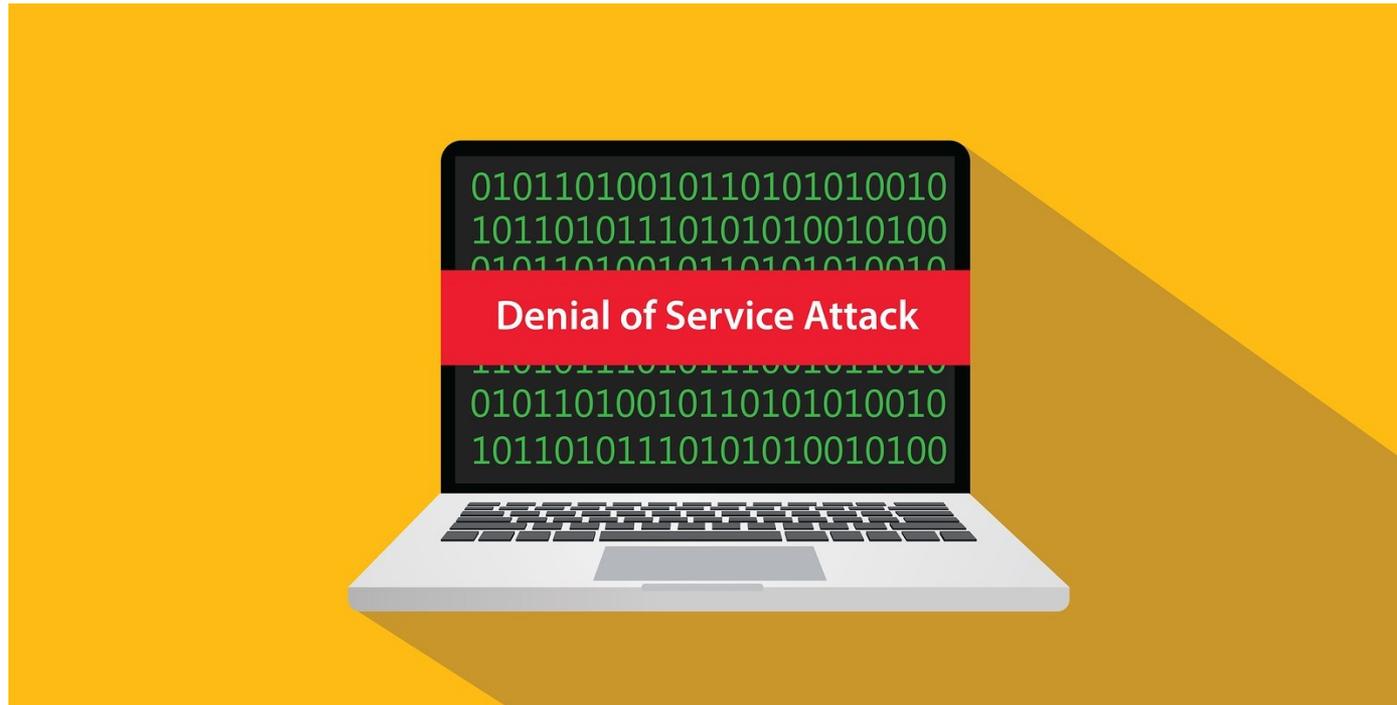
Outline

- What is a DoS attack?
- Why do people perform DoS attacks?
- What do they target?
- How to identify targets
- How to protect your systems
 - Prioritising and ordering the tasks in a plan

Terminology

- DoS – Denial of Service
 - Stop users using the system as intended
- Origin Server
 - Server running the web app
- CDN – Content Distribution Network
 - Caching, near users

What is a DoS attack?



Denial of Service

- When an attacker performs actions to make a system unusable to users
- Two main types
 - Volumetric
 - Layer 7/Protocol

Volumetric

- Send more traffic than infrastructure can handle



https://en.wikipedia.org/wiki/File:Miami_traffic_jam,_I-95_North_rush_hour.jpg

Not always inbound

- GET <https://example.com/bigimg.jpg?random>
- GET <https://example.com/bigimg.jpg?random2>
- etc

Layer 7/Protocol

- Exploit a weakness in the infrastructure or application
- Low input, High impact
- One request ties up resource which stops other requests
- Usually legit HTTP traffic, difficult to filter as it looks like a normal request

Performance Test Reports

“Yes the page is slow and has an expensive DB query, but the page is rarely used”

Most Performance Test Reports

Crash, Infinite Loops, etc

- Also examples where user input may crash application or cause infinite loops
- Zip Bombs – small zip expanding to a large file
- Billion Laughs – recursively expanding XML

```
<?xml version="1.0"?>
<!DOCTYPE lolz [
  <!ENTITY lol "lol">
  <!ELEMENT lolz (#PCDATA)>
  <!ENTITY lol1 "&lol;&lol;&lol;&lol;&lol;&lol;&lol;&lol;&lol;&lol;">
  <!ENTITY lol2 "&lol1;&lol1;&lol1;&lol1;&lol1;&lol1;&lol1;&lol1;&lol1;&lol1;">
  <!ENTITY lol3 "&lol2;&lol2;&lol2;&lol2;&lol2;&lol2;&lol2;&lol2;&lol2;&lol2;">
  <!ENTITY lol4 "&lol3;&lol3;&lol3;&lol3;&lol3;&lol3;&lol3;&lol3;&lol3;&lol3;">
  <!ENTITY lol5 "&lol4;&lol4;&lol4;&lol4;&lol4;&lol4;&lol4;&lol4;&lol4;&lol4;">
  <!ENTITY lol6 "&lol5;&lol5;&lol5;&lol5;&lol5;&lol5;&lol5;&lol5;&lol5;&lol5;">
  <!ENTITY lol7 "&lol6;&lol6;&lol6;&lol6;&lol6;&lol6;&lol6;&lol6;&lol6;&lol6;">
  <!ENTITY lol8 "&lol7;&lol7;&lol7;&lol7;&lol7;&lol7;&lol7;&lol7;&lol7;&lol7;">
  <!ENTITY lol9 "&lol8;&lol8;&lol8;&lol8;&lol8;&lol8;&lol8;&lol8;&lol8;&lol8;">
]>
<lolz>&lol9;</lolz>
```

Which one do attackers use?

- Volumetric or Layer 7
- The large attacks use a mixture of both.
- They see which is having the most impact and try to get the best value for money

DoS vs DDoS

- DoS – Denial of Service
 - May include vulnerabilities that cause applications to crash
- DDoS – Distributed Denial of Service
 - Many nodes are used to send data
 - Botnet

Why do people perform DoS attacks?



Motives - Ransom/Blackmail

- Often indicates a business behind the attack
- They have monthly KPIs to achieve
- Requirement to deliver dividends to their share holders

Motives – Dislike Organisation

- Issue motivated groups

Motivation - Distraction

- Security team looking one way, while they launch an attack, exfill data, etc somewhere else

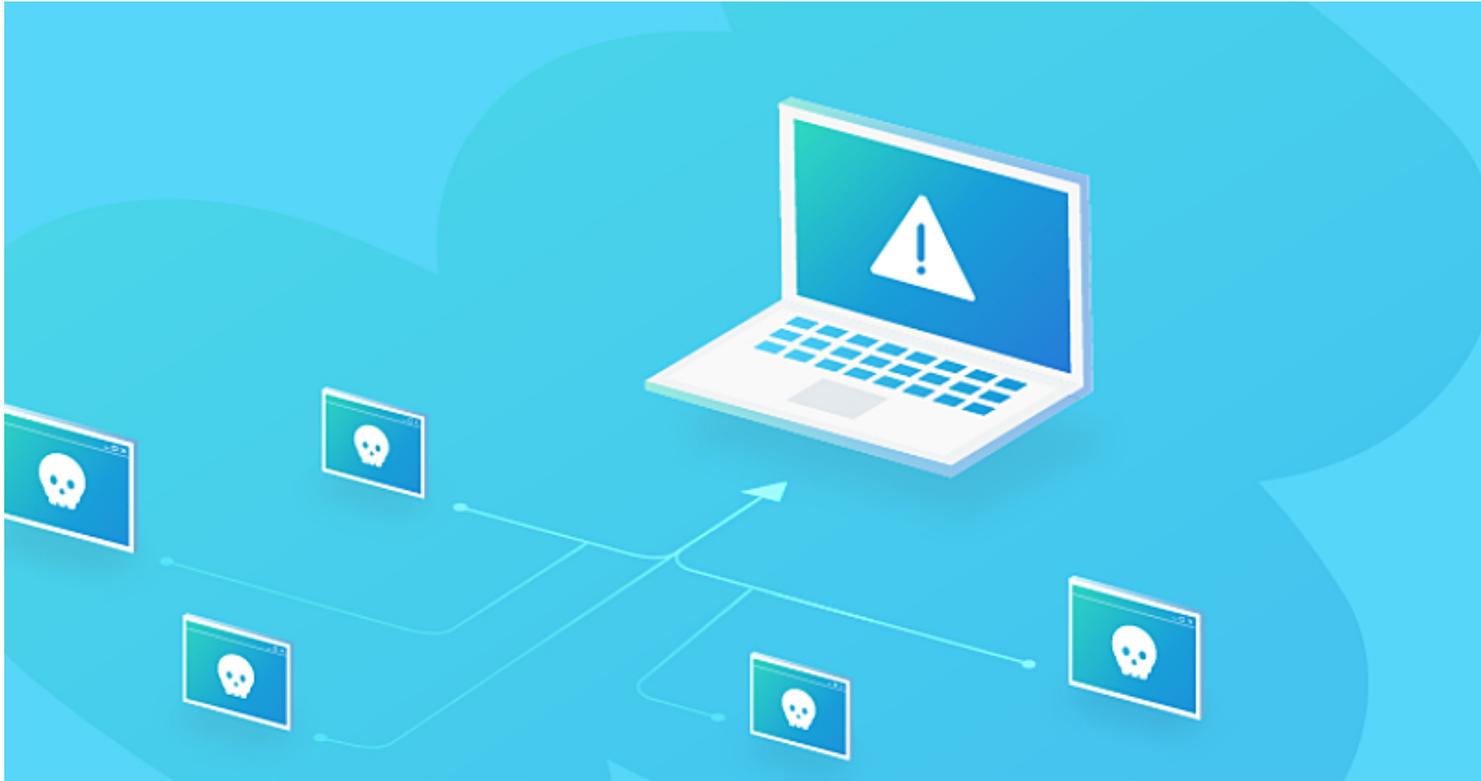
Ransomware vs DDoS Blackmail

- Different in that it is money for a threat vs money for a resolution
 - This makes it harder to extract the money
- With ransomware you can just restore from backup (maybe)

NZX – August 2020

- NZX DoS continued while it was being covered by the media.
 - The group was using it to advertise that they were competent.

How are DoS attacks performed?



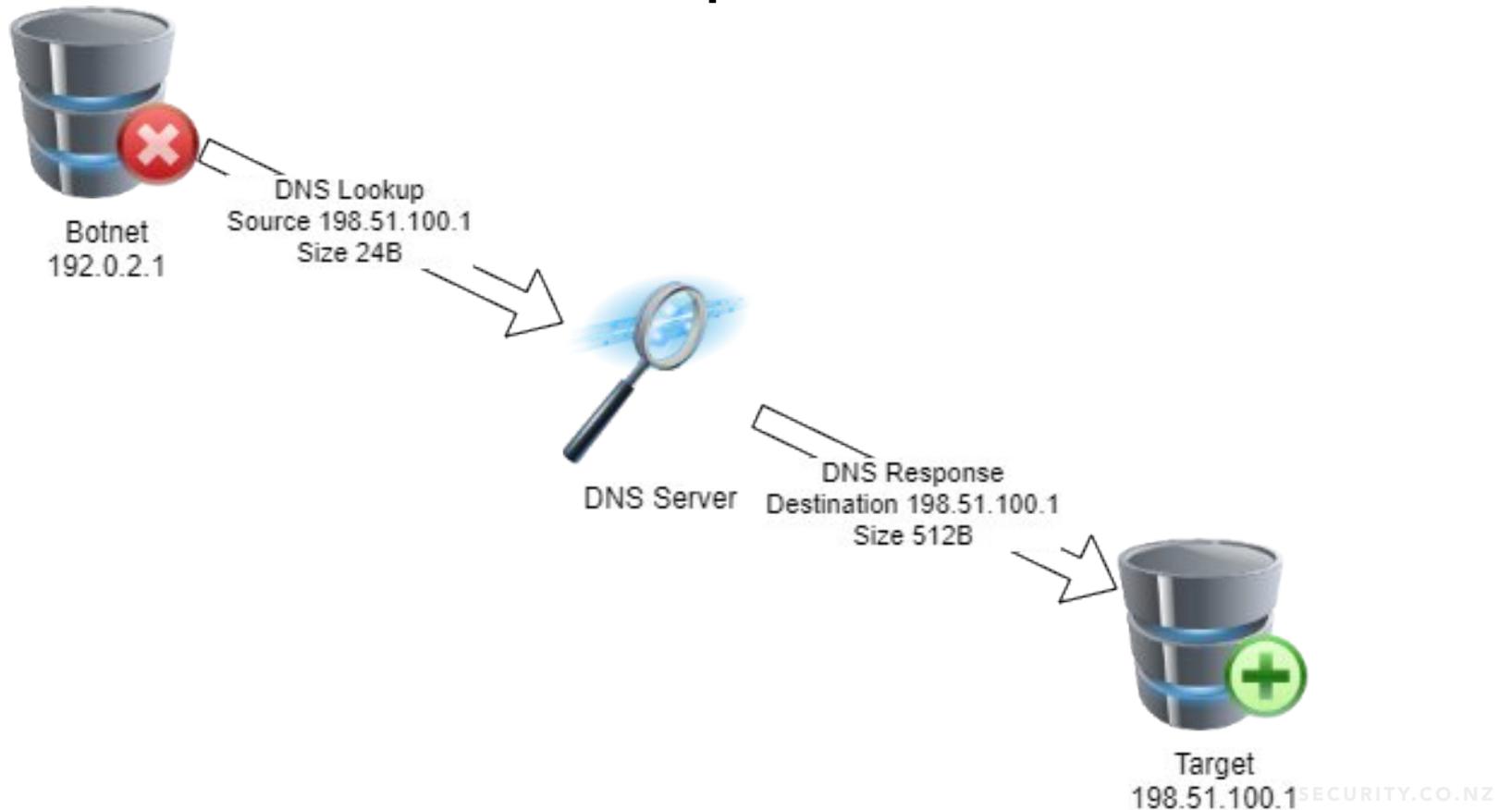
Methodology - Volumetric

- Botnet
 - Compromise a range of devices (e.g cheap ISP modem/router with default creds), get them to send a lot of traffic
- ICMP

Methodology - Volumetric

- UDP Reflective
 - E.g. DNS, NTP, SNMP
 - Spoofing of source IP address
 - Small request, large response

DNS Reflection and Amplification



Dangers of open UDP ports

- Customer who had MSSQL (UDP) open to internet
- Used in a reflective attack
- Customer received a multi-thousand dollar Azure bill
 - They were just a relay, they were not the target of the attack

How are Botnets made?



RouterOS v6.1 *2013-06-12*

You have connected to a router. Administrative access only. If this device is not in your possession, please contact your local network administrator.

WebFig Login:

Login:

Password:

 Winbox  Telnet  Graphs  License  Help

© mikrotik

DrayTek

Vigor2760 Series

Login

Username

Password

Login

Delight

Copyright © 2013 DrayTek Corp. All Rights Reserved.



Hewlett Packard
Enterprise

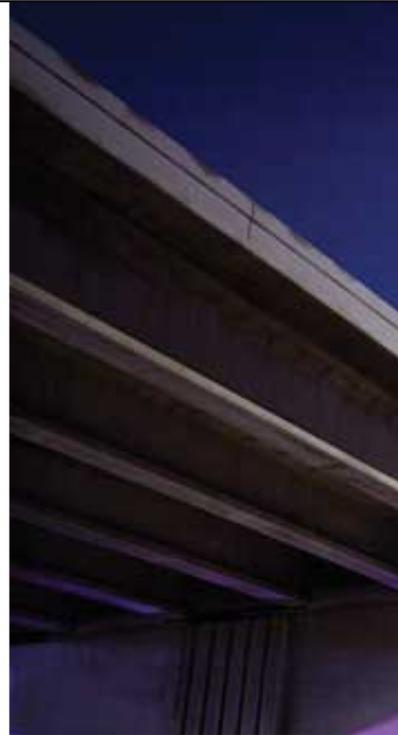
Integrated Lights-Out 3

HP ProLiant

2016-10-24

Firmware Version 1.88

© 2016 Hewlett-Packard Development Company, L.P.



Local user name:

Password:

Log In



ZEG Virtual Appliance

This ZEG virtual machine (Zero Effort Groupware) is intended to provide a complete testing environment of SOGo, the Open Source messaging and calendaring software.

The appliance is based on packaged with the following preconfigured components:

- [SOG](#)
- [OpenChange/Samba4](#) (Outlook compatibility)
- [PostgreSQL](#) (database server)
- [OpenLDAP](#) (LDAP directory)
- [Cyrus](#) (IMAP server)
- [Postfix](#) (SMTP server)

How To Login To Web Interface

The SOGo login page is accessible from this URL:

[https://\[redacted\]nz:8443/SOG](https://[redacted]nz:8443/SOG)

There are some predefined accounts which you can use to login:

username	password	email
sogo1	sogo	sogo1@example.com
sogo2	sogo	sogo2@example.com
sogo3	sogo	sogo3@example.com

Please configure the password >>

- General
- Address Book
- Fax
- Copy
- Print
- Scan
- Administrator
- Network

► Status

- Auto Refresh Interval
- Maintenance Information
- Lists/Reports
- Find Device
- Contact & Location
- Sleep Time
- Mode Timer
- Sound Volume
- Date&Time
- Panel
- Replace Toner

Status

Device Status

Sleep

Automatic Refresh

Off On

Toner Level



BK

Web Language

Auto ▾

How do I purchase a vDos plan?

Purchasing a booter plan is easy and only takes a few minutes, we accept the following payment methods, based on your billing country/region and the currency in which you want to pay to make it an easy, secure and a quick shopping experience for you.

Bitcoin, we believe in the huge potential of this new digital currency.



Pricing Lists

Select the best package based on your usage needs and size of business.

Bronze	Silver	Gold	VIP
\$19.99 /monthly	\$29.99 /monthly	\$39.99 /monthly	\$199.99 /monthly

Methodology – Layer 7 Denial of Service

- Firstly need to find a vulnerability in the application or network
- Can be achieved using a botnet, but the number of hosts can be much smaller
- During an engagement we took down a server for US\$0.12/h on AWS
 - They were paying for DoS prevention

What would an attacker target?



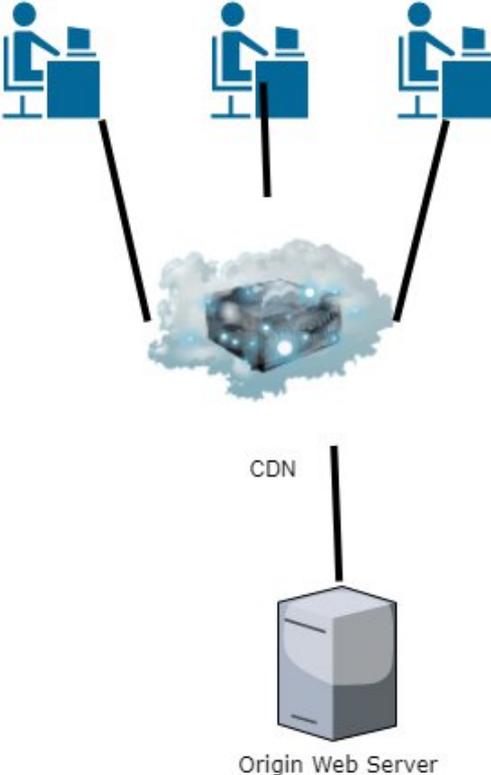
Attacker's Goal

- The attacker's goal depends on what they want to target
- With **blackmail**, they most probably want to disrupt business operations
- If they want to impact **public relations**, something publicly facing is good
- If the motive is **distraction**, most probably a little bit everywhere.

Target Selection – Attacker's Mindset

- Brochureware website?
 - Why bother? Business will just continue
- They want to find targets which affect business operations

CDN Servers



Finding the Origin Server

- If there is a CDN in front of need to find the origin server
- To save money test.wwww.example.com isn't behind a CDN
- What are the chances that prod origin server and test server are behind the same firewall?
 - Or the same host???
 - And using same DB???

Scan the internet

- At ZX Security we use Flaming Penguin, which is similar to Shodan (and metl's low hanging kiwi fruit)
 - Scanning the NZ IP space
 - Identify what is there
 - Take screenshots of web sites, etc
- Would be fair to assume that an attacker would be doing something similar

Identify Branch Offices/Retail Sites

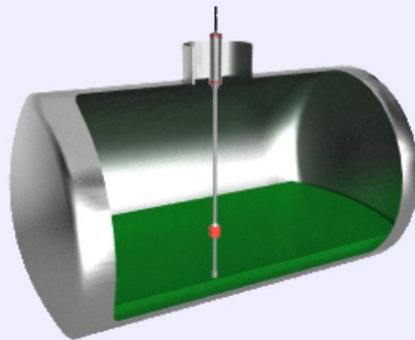


MAGLINK LX - Web Console Configuration


ProGauge

English

Select



Tank Status

System [FMS](#) [Setup](#)

[Download History](#) [Auto Refresh](#)

[Status](#) [Alarms](#) [Control](#) [Compliance](#) [Reports](#) [Data Logging](#)

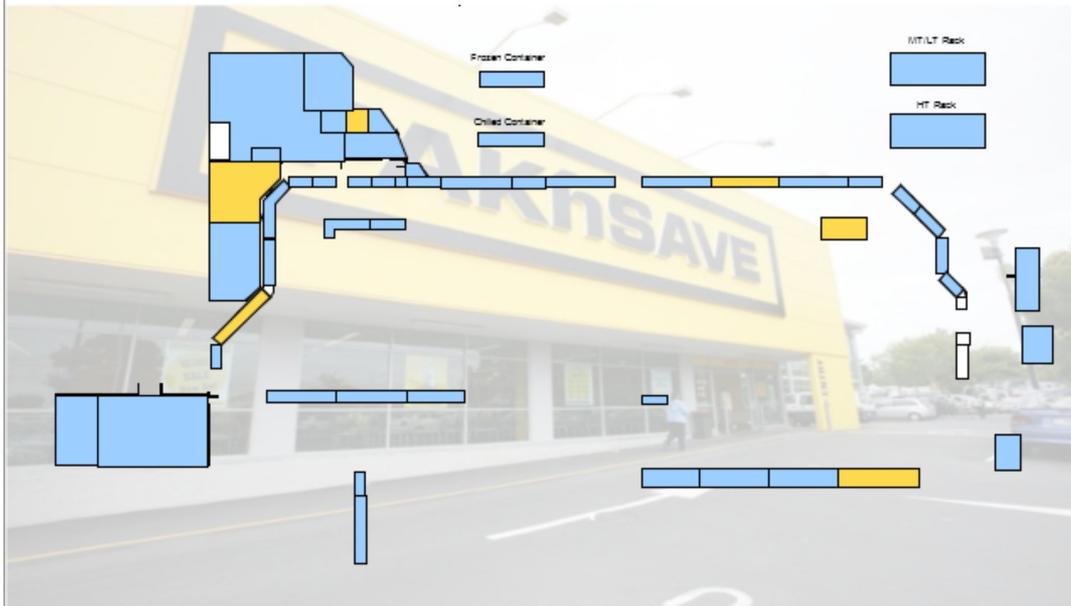
[Tanks](#) [Lines](#) [Sensors](#) [Pumps](#)

TANKS

Image	Manifold ID	Tank ID	Name	Product	Alarms	Level	Gross Volume	Net Volume	Ullage	Water Level	Temperature	Max Capacity	Capacity %
		1	95	95		1785.96	15164.75	15199.24	2695.44	.66	13.75	18800.00	80.66
		2	91	91		1988.49	39193.51	39282.40	2036.49	0.00	13.76	43400.00	90.31
		3	DSL - Ago	Product 3		1728.17	37566.41	37627.75	8146.45	26.73	13.56	48200.00	77.94
		4	100 PLUS	Product 4		1251.57	7491.71	7509.83	5984.22	20.31	13.64	14200.00	52.76
		5	Go Clear	Product 5		1027.74	4086.36	4095.97	578.58	0.00	13.69	4910.46	83.22

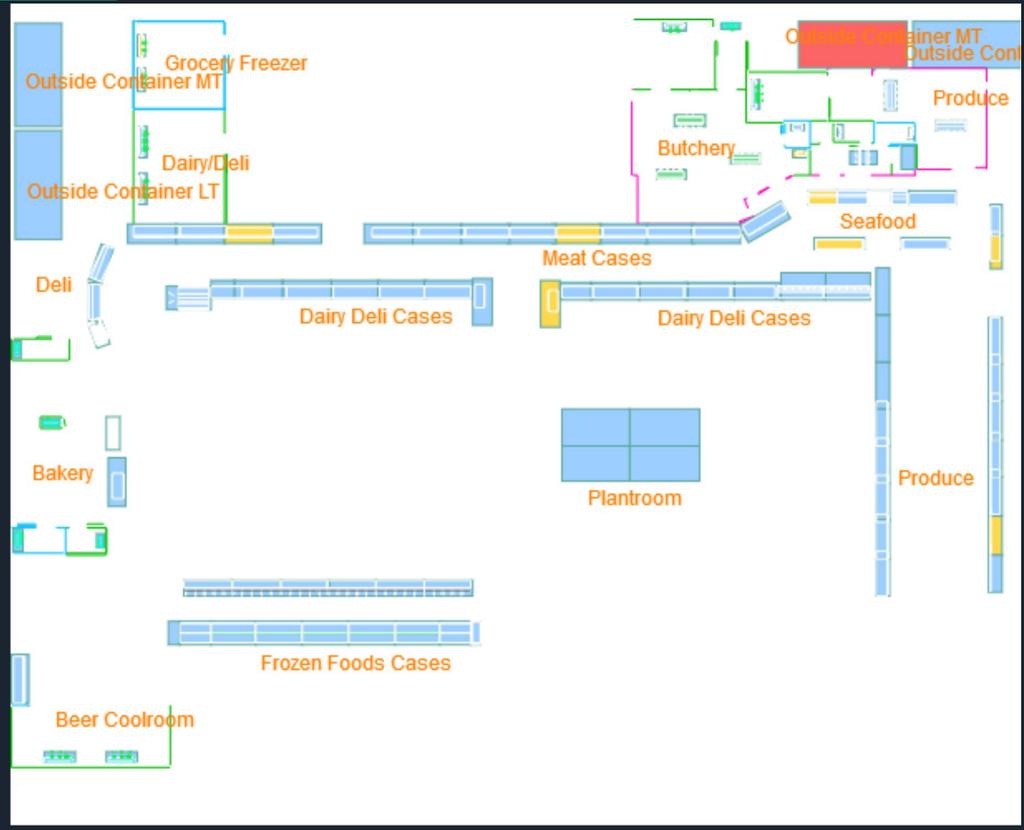


new layout





Layout



POS

- Make Line
- Cut Table
- Orders

\$0

Place Order

- Value Pizza
- Extra Value Pizza
- Traditional Pizza
- Gourmet Pizza
- Combo
- SIDES
- DELIVERY
- Shakes
- Misc
- DRINKS
- DESSERTS
- BURGER
- BURGER SIDES
- Juice
- Toppings
- Sauces

BBQ ITALIAN SAUSAGES	Beef & Onion Pizza	Cheesy Garlic Pizza	HALF & HALF	HAM & CHEESE PIZZA	Hawaiian Pizza
Margaretta Pizza	Pepperoni Pizza	Simply Cheese Pizza	Tropical Vege Pizza		

Retail sites

- Most probably use a UFB or Cellular Connection
 - Retail level connection probably does not have DDoS scrubbing or monitoring by ISP
- Point of Sale most probably uses the same connection
- What is the financial impact if a location can not make sales?

Find Retail Sites?

- Could an attacker identify these assets easily?

Remote Access





 Council
SCADA VPN

Login

[Forgot Password](#)

Company Name  Webmail

User name:

Password:

 sign in



Remote Access Endpoints

- Disrupts people working from home
- Makes remote support difficult
- Consider other services which traverse the same firewall
 - They don't have to take out a server
 - They could take out the firewall in front of the target

Certificate Transparency

- All HTTPS certificates are now added to the Certificate Transparency Log
- We can use this to find hosts and look them up in DNS
- Becomes interesting if the target is not behind a CDN
- Useful for identifying Origin Servers

Criteria

Type: Identity Match: ILIKE Search: 'google.com'

crt.sh ID	Logged At ↑	Not Before	Not After	Common Name	Matching Identities
3144337544	2020-07-26	2011-07-10	2013-07-09	*.google.com	admin@google.com *.google.com
2381394777	2020-01-27	2011-07-13	2012-07-13	*.mail.google.com	*.docs.google.com *.mail.google.com *.plus.google.com *.sites.google.com *.talkgadget.google.com
2380986199	2020-01-26	2011-02-16	2012-02-16	*.mail.google.com	*.docs.google.com *.mail.google.com *.sites.google.com *.talkgadget.google.com
2380850988	2020-01-26	2012-02-29	2013-02-28	onex.wifi.google.com	onex.wifi.google.com
2380841885	2020-01-26	2011-07-13	2012-07-13	accounts.google.com	accounts.google.com
2380681291	2020-01-26	2013-11-22	2013-11-24	hosted-id.google.com	hosted-id.google.com
2380579544	2020-01-26	2011-05-11	2012-05-11	accounts.google.com	accounts.google.com
2379825238	2020-01-26	2011-05-11	2012-05-11	adwords.google.com	adwords.google.com adwords.google.com.ar adwords.google.com.au

Spider Site

- Find the slow pages
- Useful for sites that are on a CDN
 - Slow pages may indicate that the page can't be cached and is going to the origin server

Spidering weak sites

- While penetration testing sites we have taken them down, by accident
 - From our laptop
 - With as little as 10 threads
 - Using tools, like Dirbuster, Burp
 - Using the search dialogue box on the site

Email headers

- Email headers reveal IP addresses and domain names
 - Particularly server generated ones like signups and password resets

```
Received: from ns2.██████████.net (ns2.██████████.net. [██████████])  
    by mx.google.com with ESMTP id ██████████  
    for <██████████>;  
    Fri, 04 Jan 2019 14:03:35 -0800 (PST)  
Received-SPF: pass (google.com: best guess record for domain of apache@ns2.██████████.net designates 1██████████ as permitted  
sender) client-ip=1██████████;  
Authentication-Results: mx.google.com;  
    dkim=neutral (body hash did not verify) header.i=@██████████.com header.s=default header.b=██████████;  
    spf=pass (google.com: best guess record for domain of apache@ns2.██████████.net designates 1██████████ as permitted  
sender) smtp.mailfrom=apache@ns2.██████████.net  
Received: by ns2.██████████.net (Postfix, from userid 48) id ██████████; Fri,  
    4 Jan 2019 22:03:24 +0000 (UTC)
```

Historical DNS

- Search historic DNS records
- Client has changed their DNS to point to a CDN, but the historic DNS records store the origin

IP history results for google.com.

=====

IP Address	Location	IP Address Owner	Last seen on this IP
64.233.165.139	United States	Unknown	2021-01-14
64.233.165.138	United States	Unknown	2021-01-14
64.233.165.113	United States	Unknown	2021-01-14
64.233.165.102	United States	Unknown	2021-01-14
64.233.165.101	United States	Unknown	2021-01-14
64.233.165.100	United States	Unknown	2021-01-14

Regulatory Requirements

- Is the business subject to regulatory requirements?
- For example with the NZX:
 - Web site was attacked
 - The trading platform was fine
 - They had to halt the market as the web site attack meant that regulatorily requirements documents were not accessible to market participants

Collateral Damage

- What other organisations share the same internet connections/firewalls/web servers
 - Can an attack on them affect you?
- Attacks could affect International and Domestic Links

Collateral Damage - Story

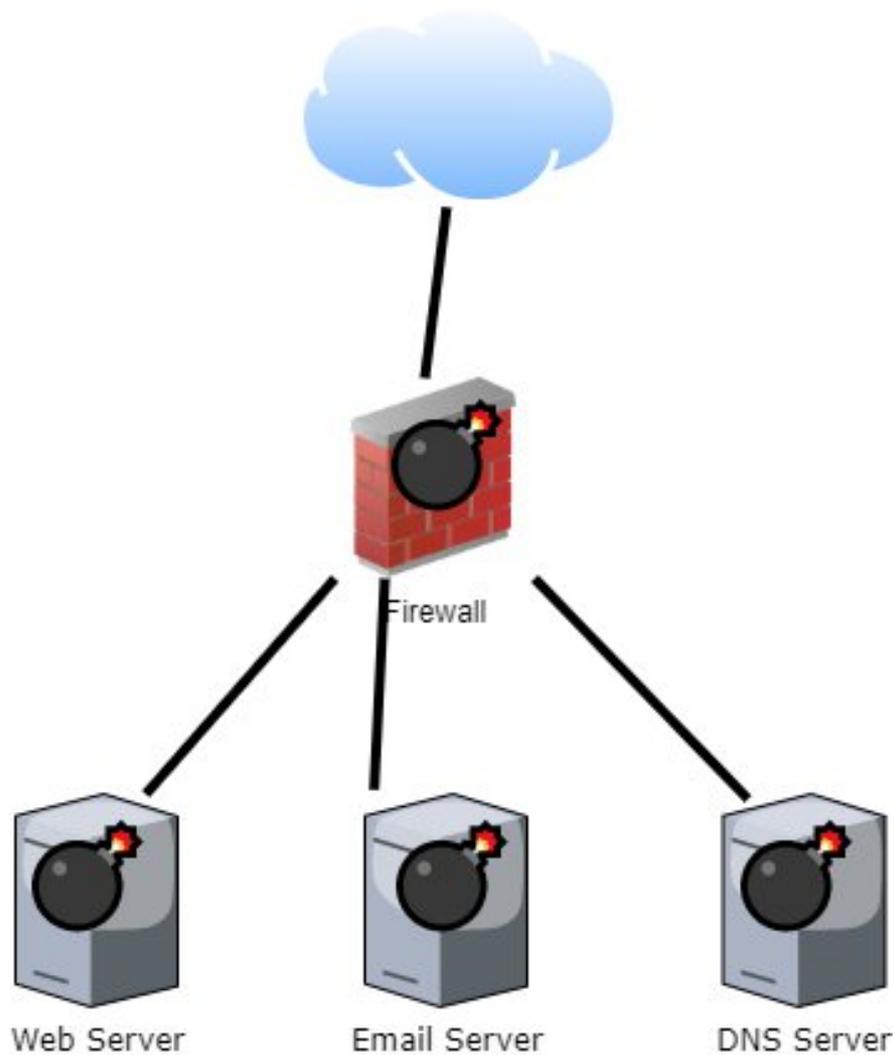
- Customer Site
 - Had CDN
- Used an MSP for hosting
- Shared link IX to DC

How to protect your systems



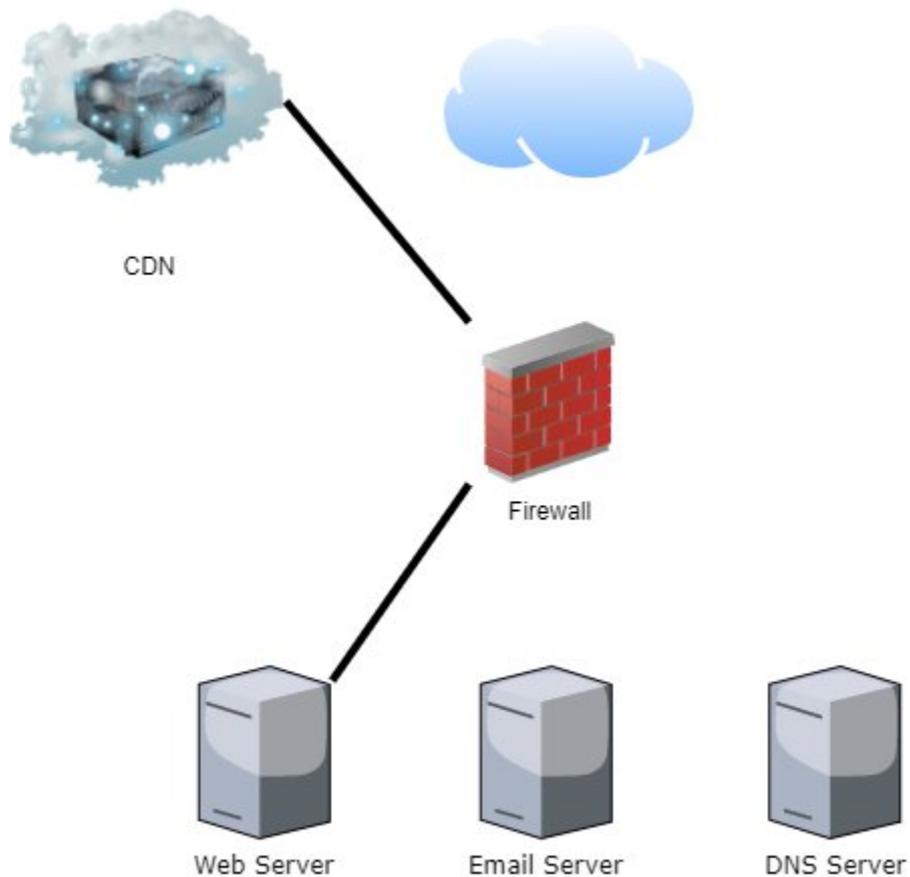
What systems do you have?

- If you have Shadow IT the attacker most probably has a better than you
- Can't defend what you don't know about
- Even systems you don't know about can cause issues to other systems or reputational damage



Web Content

- Use a CDN
- Problem Solved?



CDN Considerations

- Is the content CDNable?
 - Big images mentioned before
- How is dynamic and user sessions going to be handled?

Does the CDN have the right tick boxes?

- Do Origin Servers only allow requests from CDN?
- Who can purge/expire documents cached in the CDN?

CDN Purge

```
$ curl -o /dev/null -w %{time_total} -s  
https://example.com/1.html  
0.299s
```

CDN Purge

```
$ curl -o /dev/null -w %{time_total} -s  
https://example.com/1.html
```

```
0.299s
```

```
$ curl -X PURGE https://example.com/1.html  
{ "status": "ok", "id": "10422-1600263910-3" }
```

CDN Purge

```
$ curl -o /dev/null -w %{time_total} -s  
https://example.com/1.html
```

0.299s

```
$ curl -X PURGE https://example.com/1.html  
{ "status": "ok", "id": "10422-1600263910-3" }
```

```
$ curl -o /dev/null -w %{time_total} -s  
https://example.com/1.html
```

1.163

CDN Purge

```
$ curl -o /dev/null -w %{time_total} -s https://example.com/1.html
```

```
0.299s
```

```
$ curl -X PURGE https://example.com/1.html
```

```
{ "status": "ok", "id": "10422-1600263910-3" }
```

```
$ curl -o /dev/null -w %{time_total} -s https://example.com/1.html
```

```
1.163
```

```
$ curl -o /dev/null -w %{time_total} -s https://example.com/1.html
```

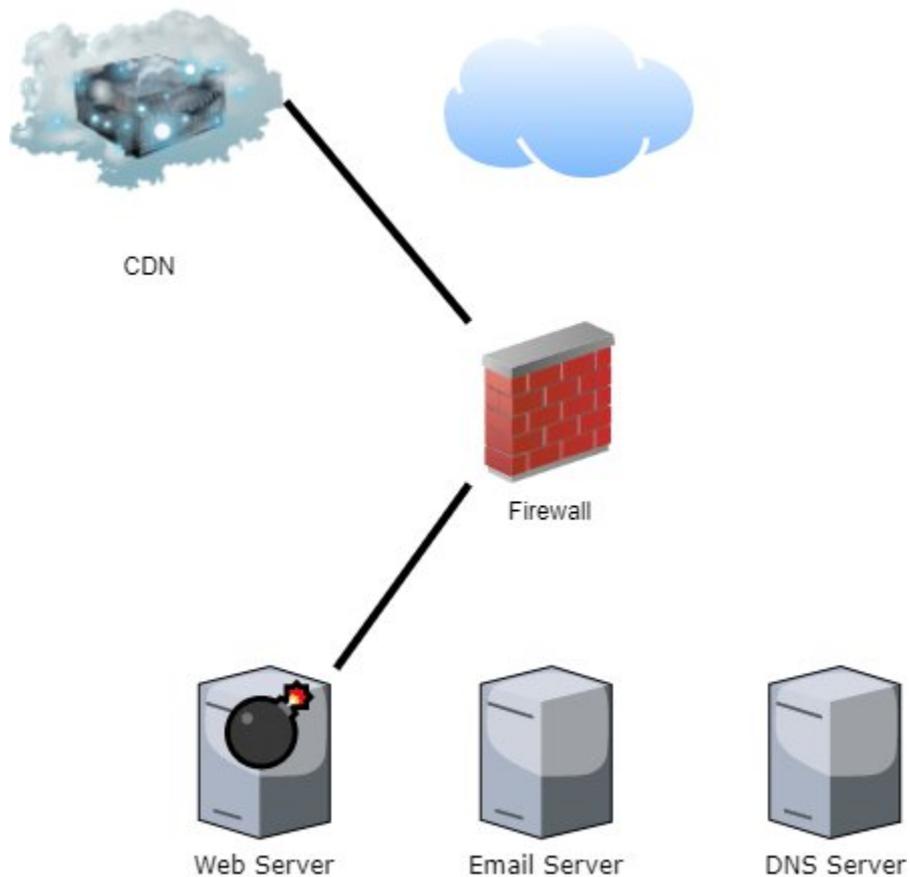
```
0.268
```

Can people still find the Origin Servers?

- Are your Origin Servers still on the same IP addresses?
 - Can you look up the IP address in DNS history
- Maybe you are using a domain name like `origin.www.example.com`

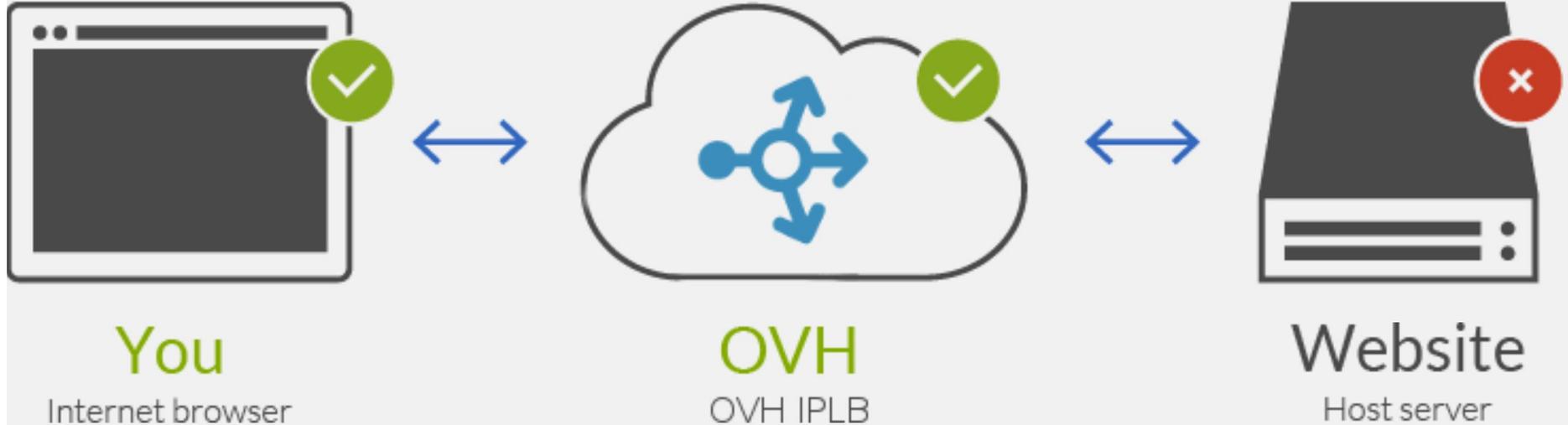
Send traffic to Origin Servers

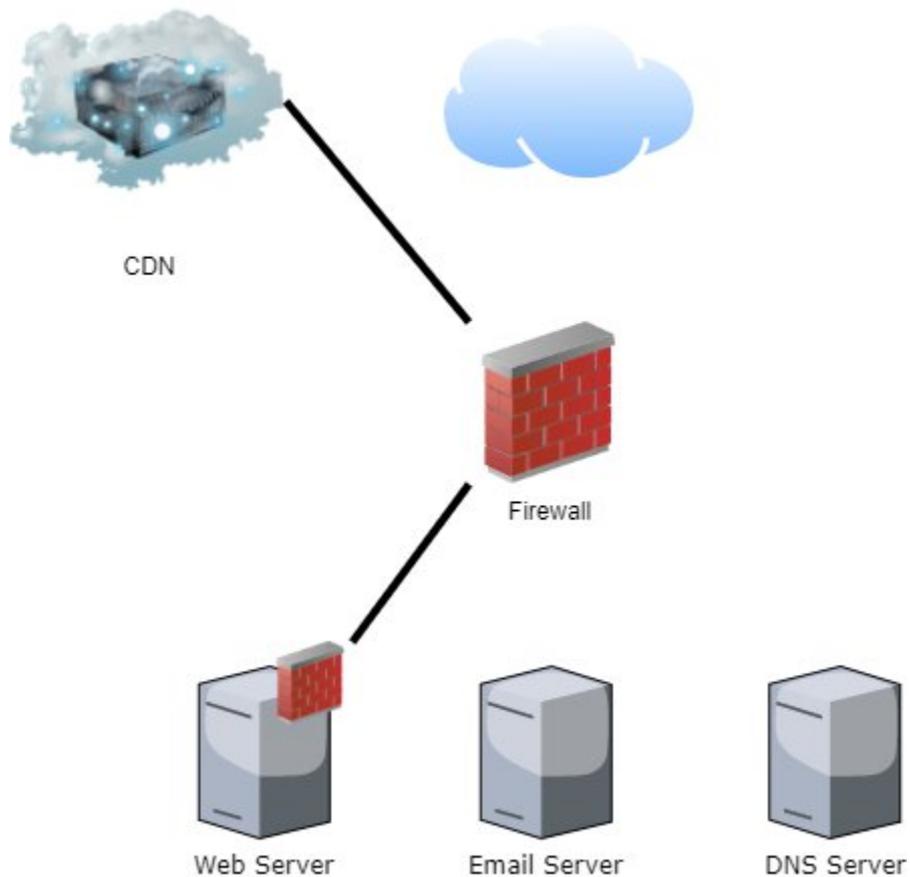
- Can you send traffic to those IP addresses
 - Even if the Firewall denies the packets, it still consumes some CPU resources (hopefully it can handle it)



Error 503: Backend unavailable

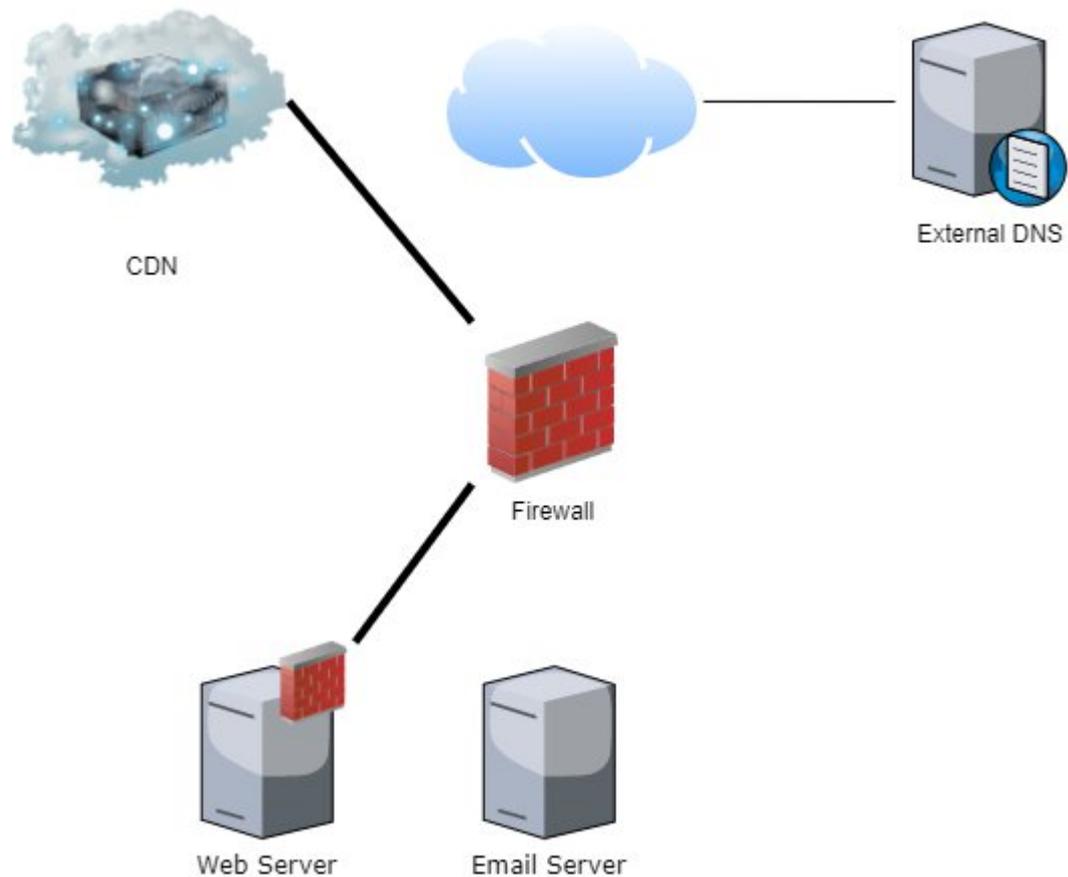
This type of error usually results of an unavailability of servers behind IP Load Balancing.





DNS/Domain Registration

- A lot of mitigations require DNS updates to move critical systems
- Ensure public DNS is scalable to DDoS attacks
 - Use a DNS provider who has Points of Presence world wide, including NZ
 - Allows for changes quickly (subject to DNS TTL)

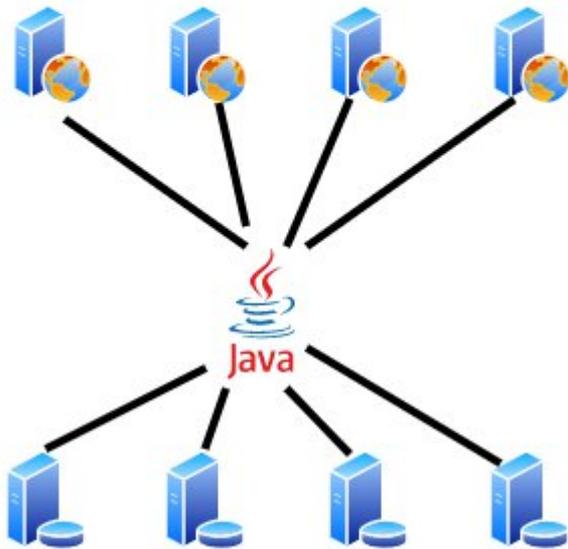


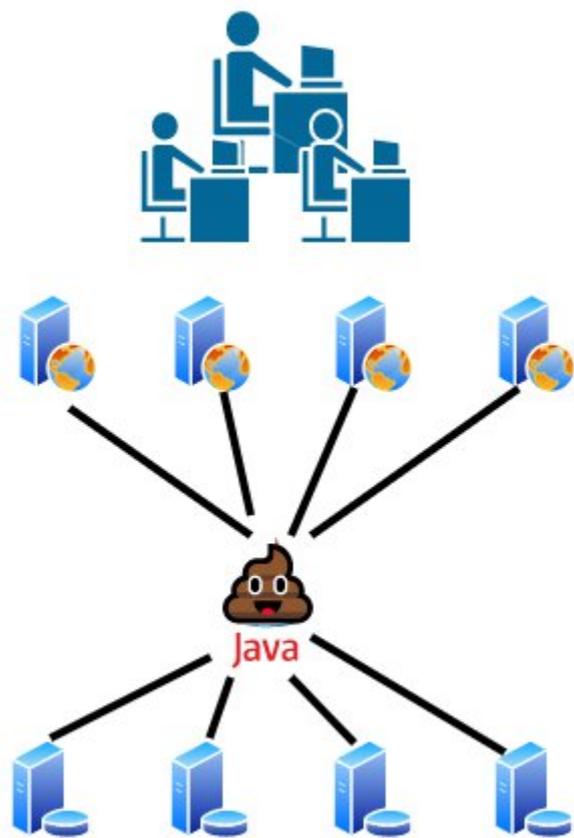
DNS/Domain Registration

- Consolidate all the domain registration and DNS in one place
 - Know how to access it
 - Don't fail because one person is on leave

Application Design/Architecture

- Design and Architect the applications/networks to best make use of caching and DDoS mitigations technologies
- Anything not cacheable should be behind a login, CAPTCHA, or other rate limiting techniques
 - Test your CAPTCHA
- Implement multi-tier architecture and make sure you don't have layer-7 bottlenecks





Layer 7

- Conduct a detailed performance test against your web sites/infrastructure
- Understand the performance bottlenecks
- It's hard for a WAF to block traffic to endpoints affected by performance issues as the requests will look legitimate.

404 Pages

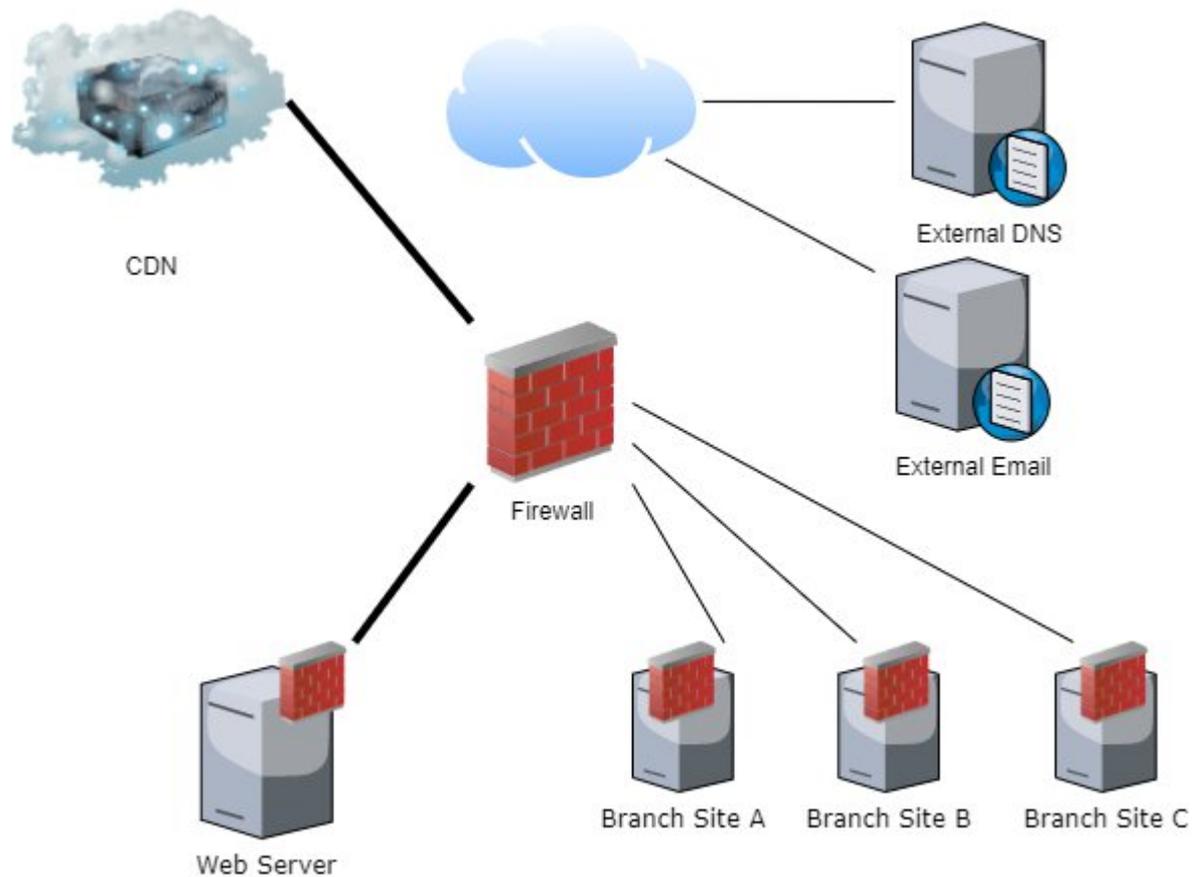
- 404 pages should not be a problem right???

How to know what is a 404?

- The CDN will cache all the pages which have been requested
- Do 404s have to go to the origin server and hit the database?
- There are infinite(ish) possible 404 pages

404 Make CDN Aware

- Make the CDN aware of the valid pages, so the CDN can return the 404 itself
 - Even if it is the first time that URL has ever been requested



Monitor all the things

- Monitor and collect statistics on your system
 - Know what **normal** looks like

**LOOKING AT TRAFFIC
LOGS FOR THE FIRST TIME**



IS THIS A DDOS ATTACK

Monitoring

- Monitor the servers / websites
 - NAGIOS, Pingdom, etc
- Do external monitoring from inside & outside of NZ

Disk space monitoring, what's that?

- We recently caused a firewall to fail spectacularly when its disk filled up with logs during a routine port scan.
- This resulted in an outage
 - The client complained
 - We logged it as a high-risk finding

Test/Simulation

- Does the end to end system work how you expect it to work?
- Does you service provider have the correct phone numbers?

Wrap up

- What systems could cripple your business (or your customers) if affected, focus on those
- Hopefully you now have an idea about what:
 - Your threats are
 - A start of a plan to defend them
- This can be a little overwhelming

Do things in a sensible order

- There is a Maturity Model for that:
- <https://zxsecurity.co.nz/maturity-models/dos-preparation-maturity-model/>

Denial-of-Service (DoS) Attack Preparation Maturity Model



A denial-of-service attack is a cyberattack specifically designed to shut down a computer or network, making it inaccessible to its users.



LEVEL 1 Lack of Awareness

The base starting level for an organisation. You are not likely to have a full picture of your IT asset base or have a process for dealing with a DoS attack in place.

LEVEL 2 Understand your Ecosystem

You understand your systems and the impact to the organisation if a DoS attack were to occur.

- You will have:
- an IT asset inventory
 - documentation for key systems
 - a patching process
 - communication with external service providers

LEVEL 3 Planning

You plan what the organisation will do if there was a DoS attack.

- This includes a:
- Documented communications plan if an attack were to happen.
 - Plan for how the organisation is going to respond to a DoS attack.
 - Plan for how the organisation is going to defend its assets.

LEVEL 4 Defending the Assets

You ensure all your systems (web, remote access, APIs, email, etc.) have DoS protections in place.

- This includes:
- implement DoS mitigations and origin server protection
 - conducting performance and load testing of systems
 - DoS protection for non-web services, e.g. VPN, Email
 - All domains are managed through a single registrar

LEVEL 5 Proactive Monitoring and Simulation

You are on the front foot regarding DoS attacks by running through DoS attack simulations and increasing your situational awareness.

Systems are monitored and architected to best use caching technologies offered by your Content Delivery Network or similar.



Roughly distils down to

1. Figure out what you have to defend/what attackers are going to attack
2. Plan how you are going about defending your assets
3. Put the defences in place
4. Start monitoring and doing simulations

Thanks

- You for coming
- Thank for Code Camp Crew for accepting my talk
- ZX Team for bouncing ideas off & giving me content

