
# A Hackers View of DoS Attacks

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BSides Canberra
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# #whoami


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- ZX Security – Hacker
- Run Kākācon
  - 18 November 2023
- Kawaiicon Shadow Crüe

# 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

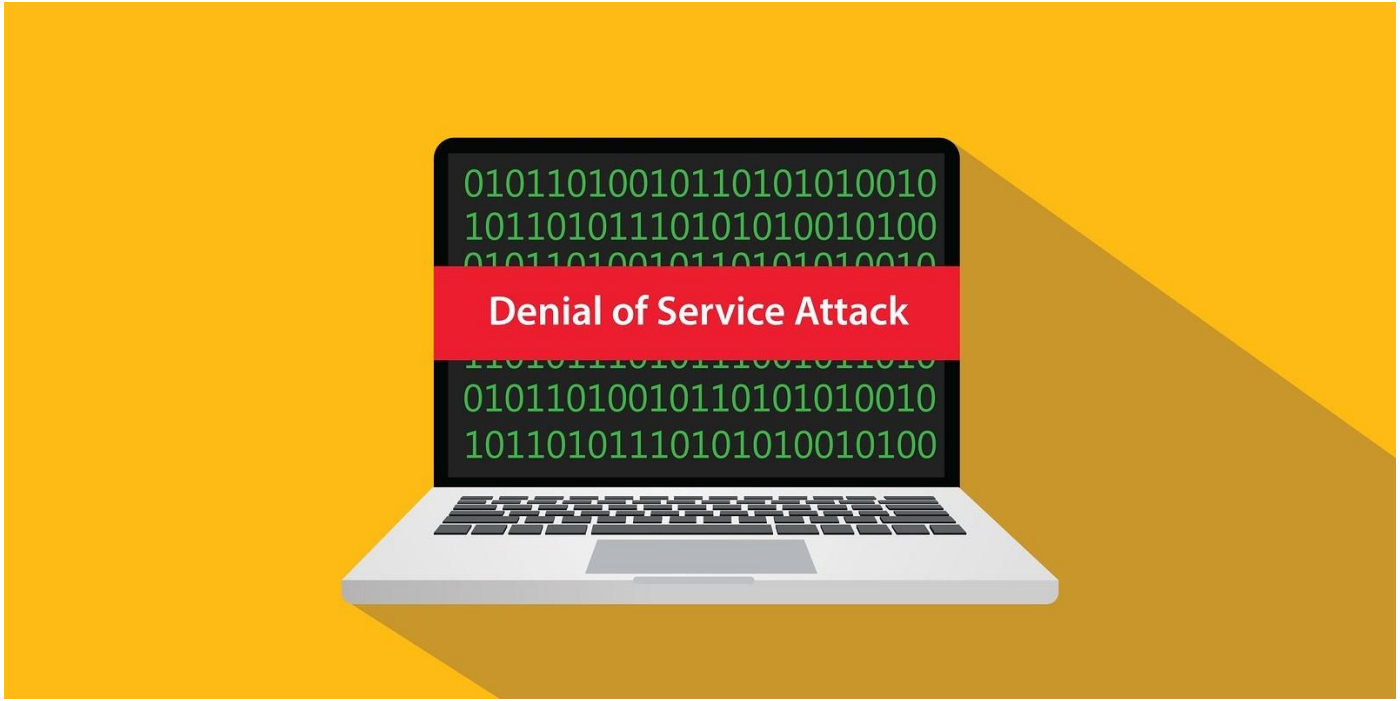
# Terminology

- 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

# 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

# What is a DoS attack?



# Denial of Service

- When an attackers 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

- Even with a CDN we flooded the outbound pipe

# 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>
```

https://en.wikipedia.org/wiki/Billion_laughs_attack

# 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

# 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

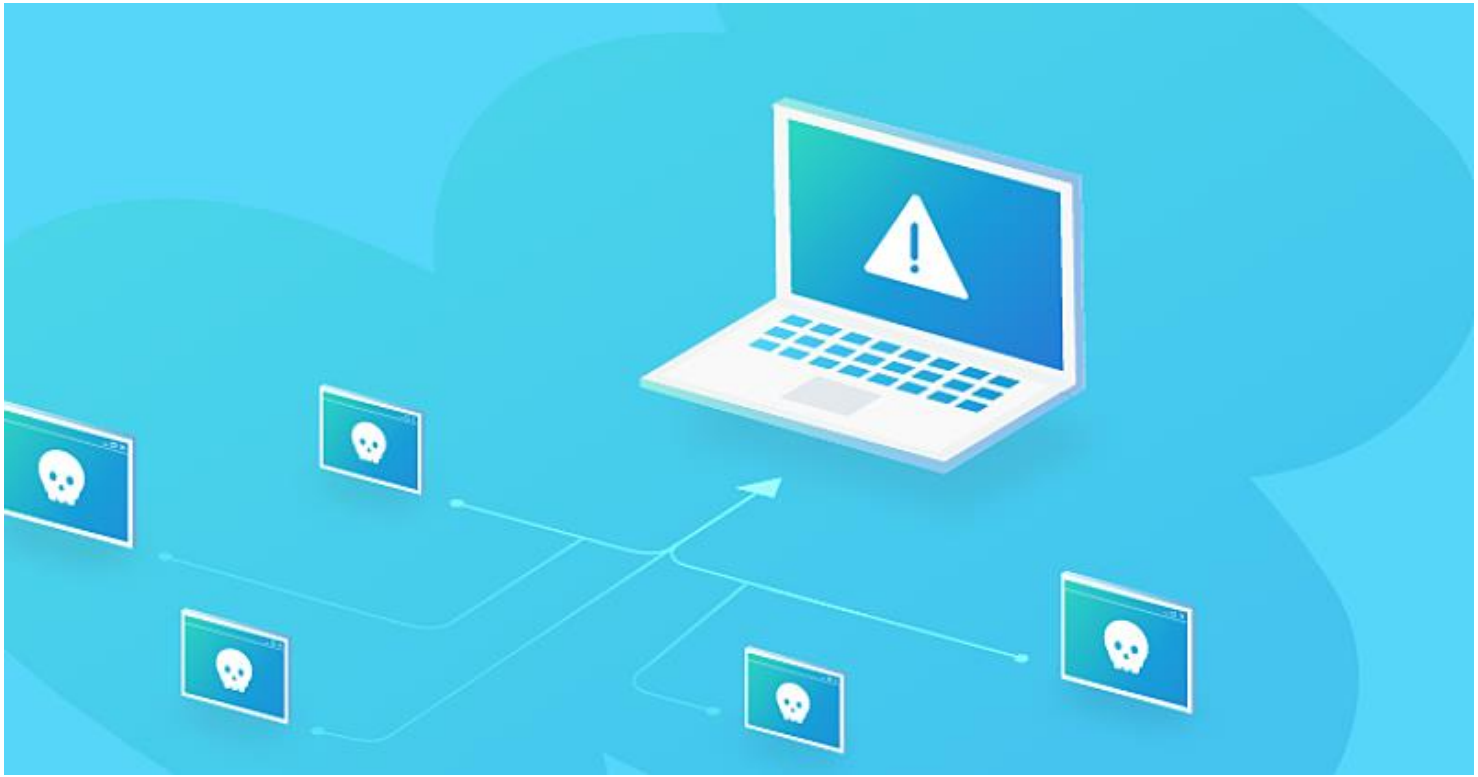
# Motivation - Distraction

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

# 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?



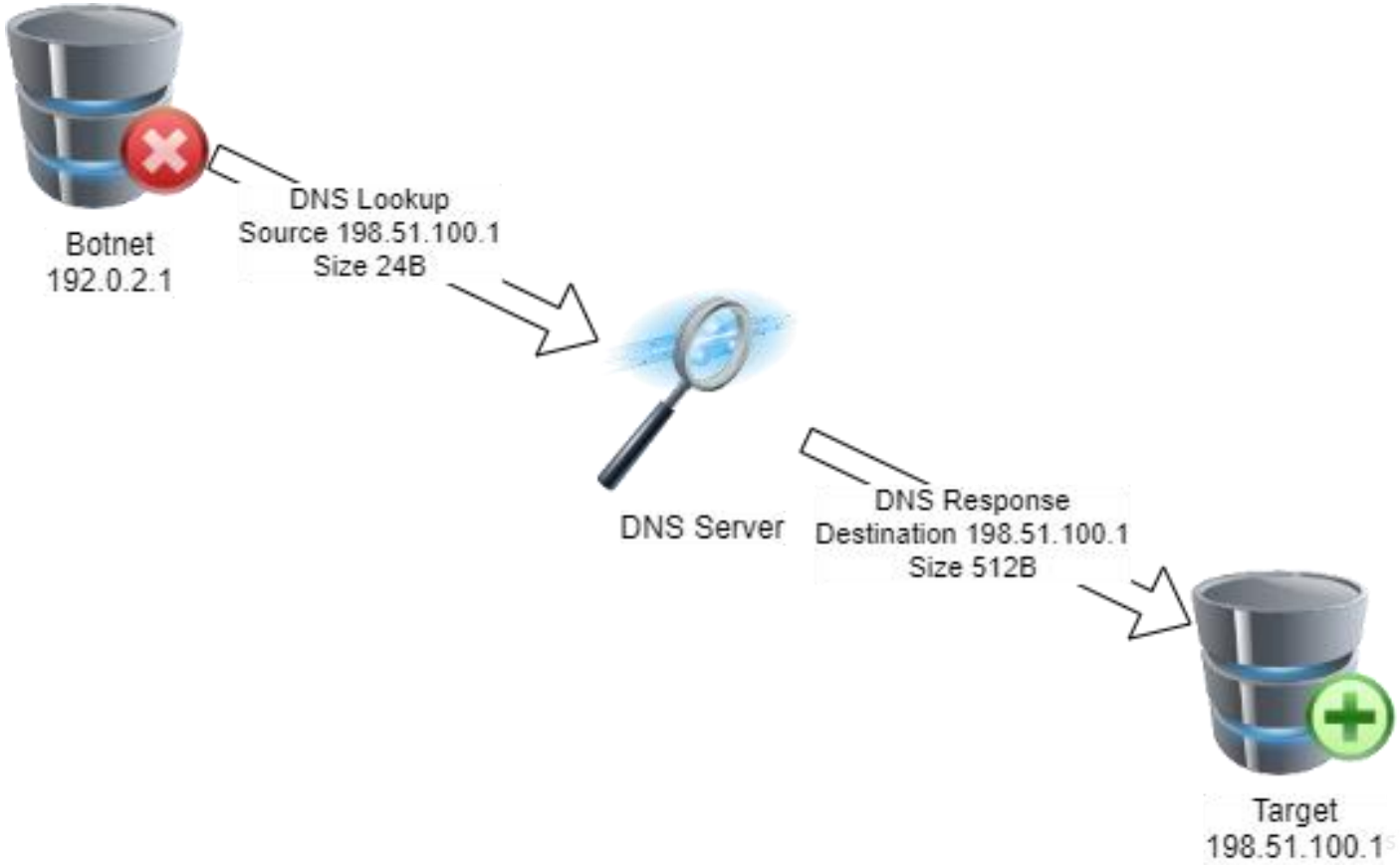
# Methodology - Volumetric

- 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

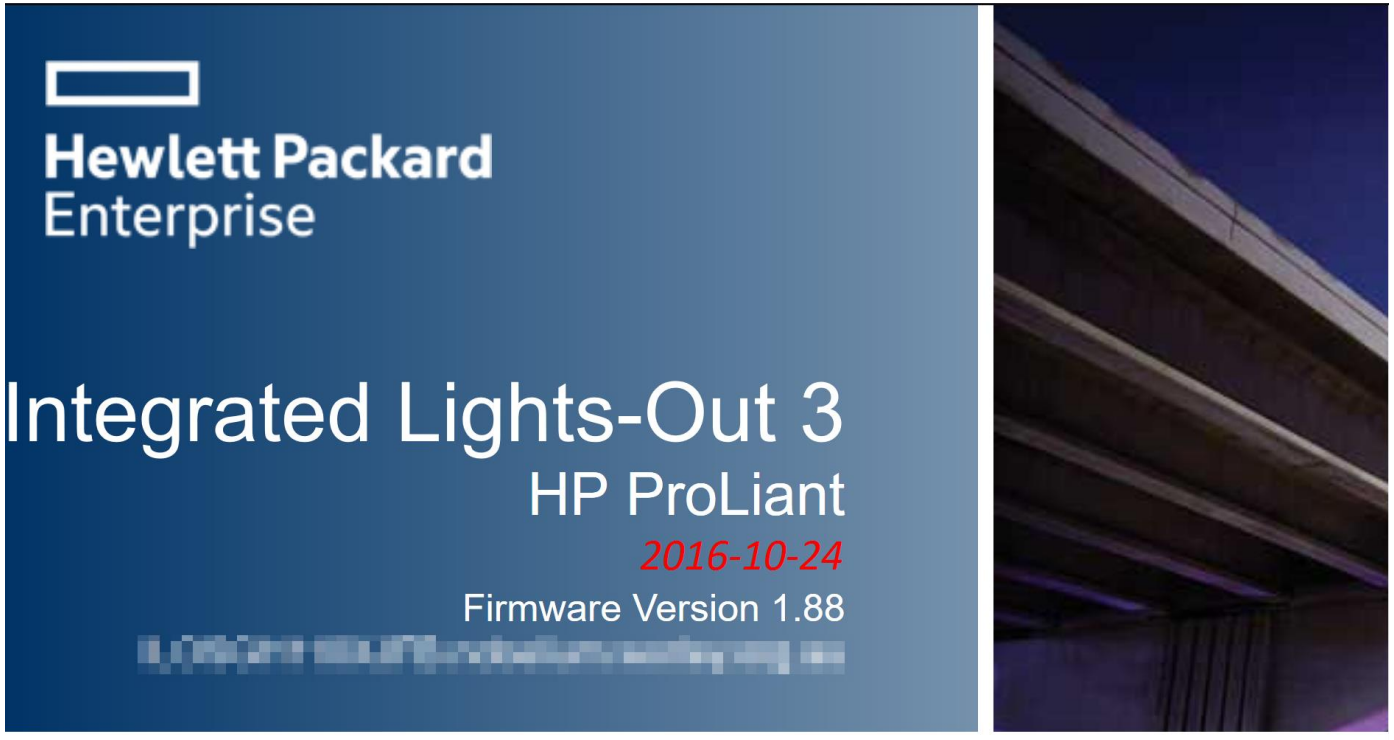


# Dangers of open UDP ports

- 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?


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
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:

- SOGo
- OpenChange/Samba4 (Outlook compatibility)
- PostgreSQL (database server)
- OpenLDAP (LDAP directory)
- Cyrus (IMAP server)
- Postfix (SMTP server)

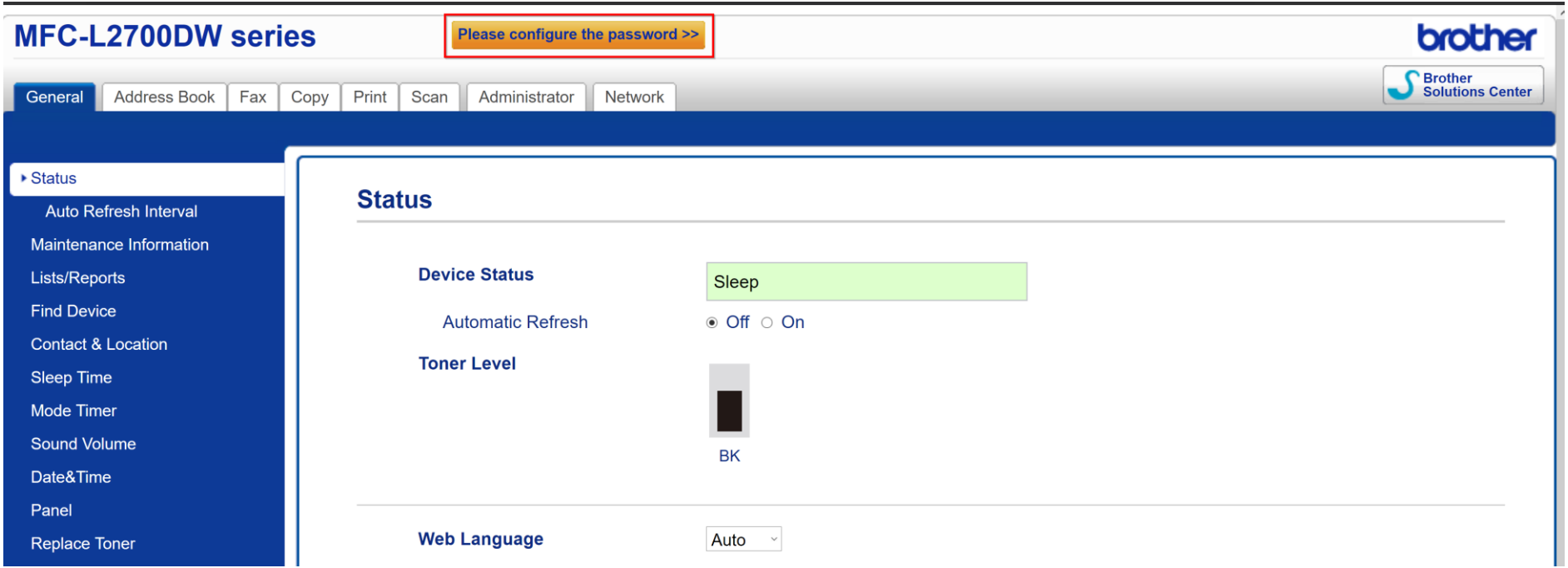
## How To Login To Web Interface

The SOGo login page is accessible from this URL:

https://[redacted]nz:8443/SOGo

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 |



VDOS

## 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 |

https://krebsonsecurity.com/wp-content/uploads/2016/09/vdoshome.png

# 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?

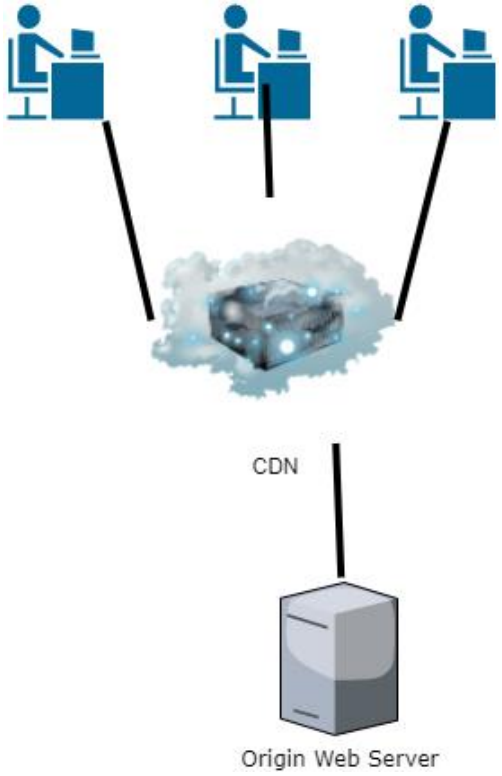
# Attacker’s Goal

- 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.www.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

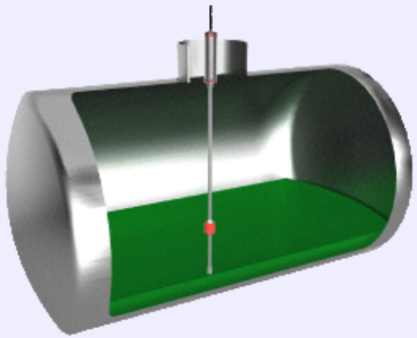
# Identifv Branch Offices/Retail Sites

# MAGLINK LX - Web Console Configuration

TOKHEIM ProGauge

English

Select



[redacted] **Truckstop - Guest access level** L mm °C | Personal Preferences

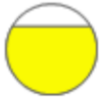
[redacted] **Tank Status** [redacted]

System FMS Setup Download History Auto Refresh

Status Alarms Control Compliance Reports Data Logging [redacted]

Tanks Lines Sensors Pumps

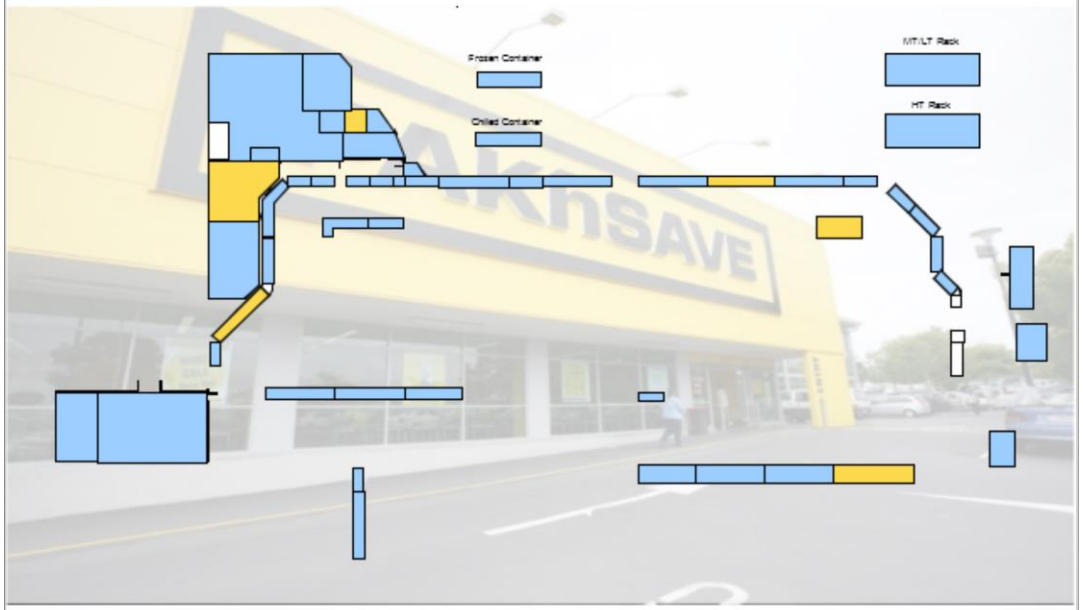
**TANKS**

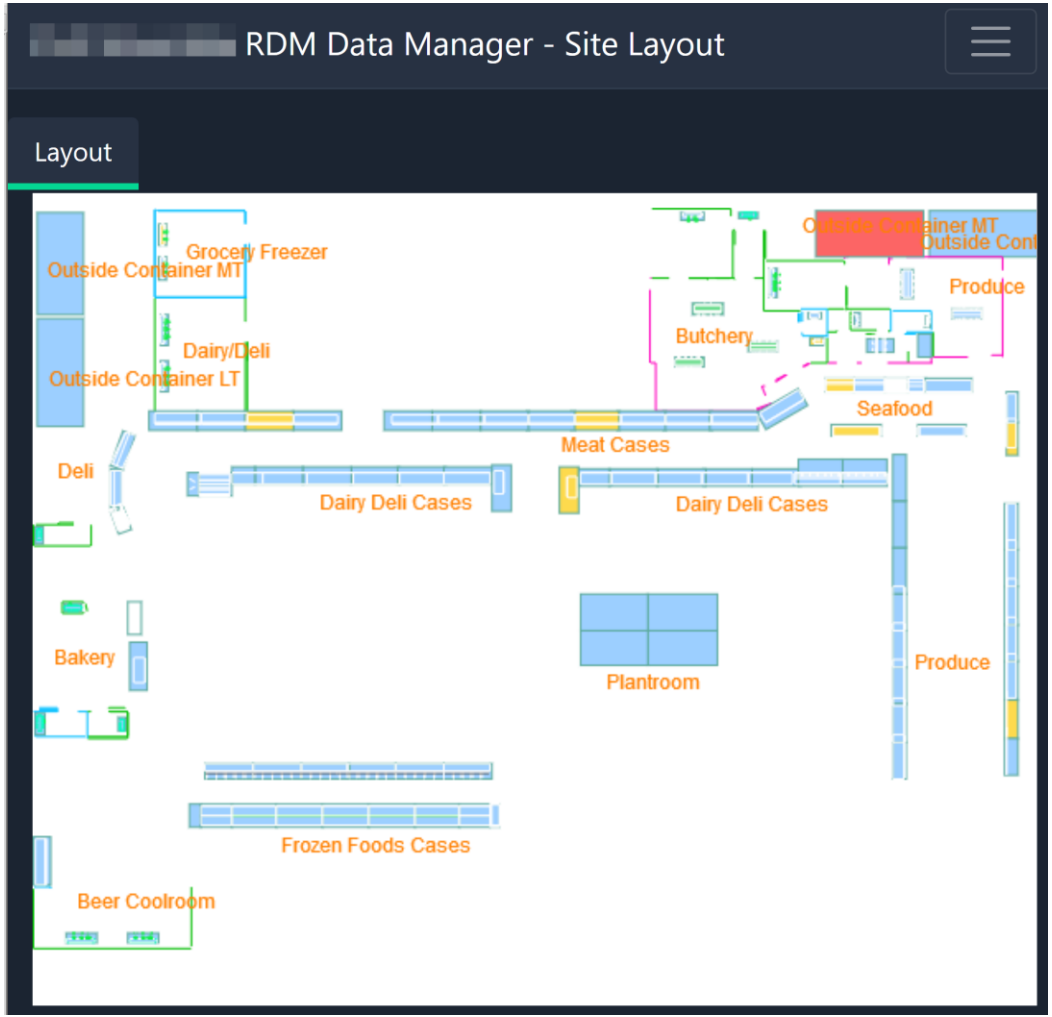
| Image | Manifold ID | Tank ID | Name | Product | Alarms | Level | Gross Volume | Net Volume | Ullage | Water Level | Temperature | Max Capacity | Capacity % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | | 1 | 95 | 95 | | 1785.96 | 15164.75 | 15199.24 | 2695.44 | .66 | 13.75 | 18800.00 | 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 |

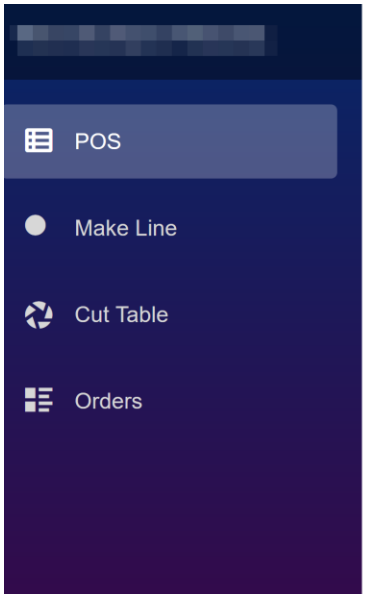
[redacted] - Site Layout

Resource Data Management

new layout








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 | | |

$0

Place Order

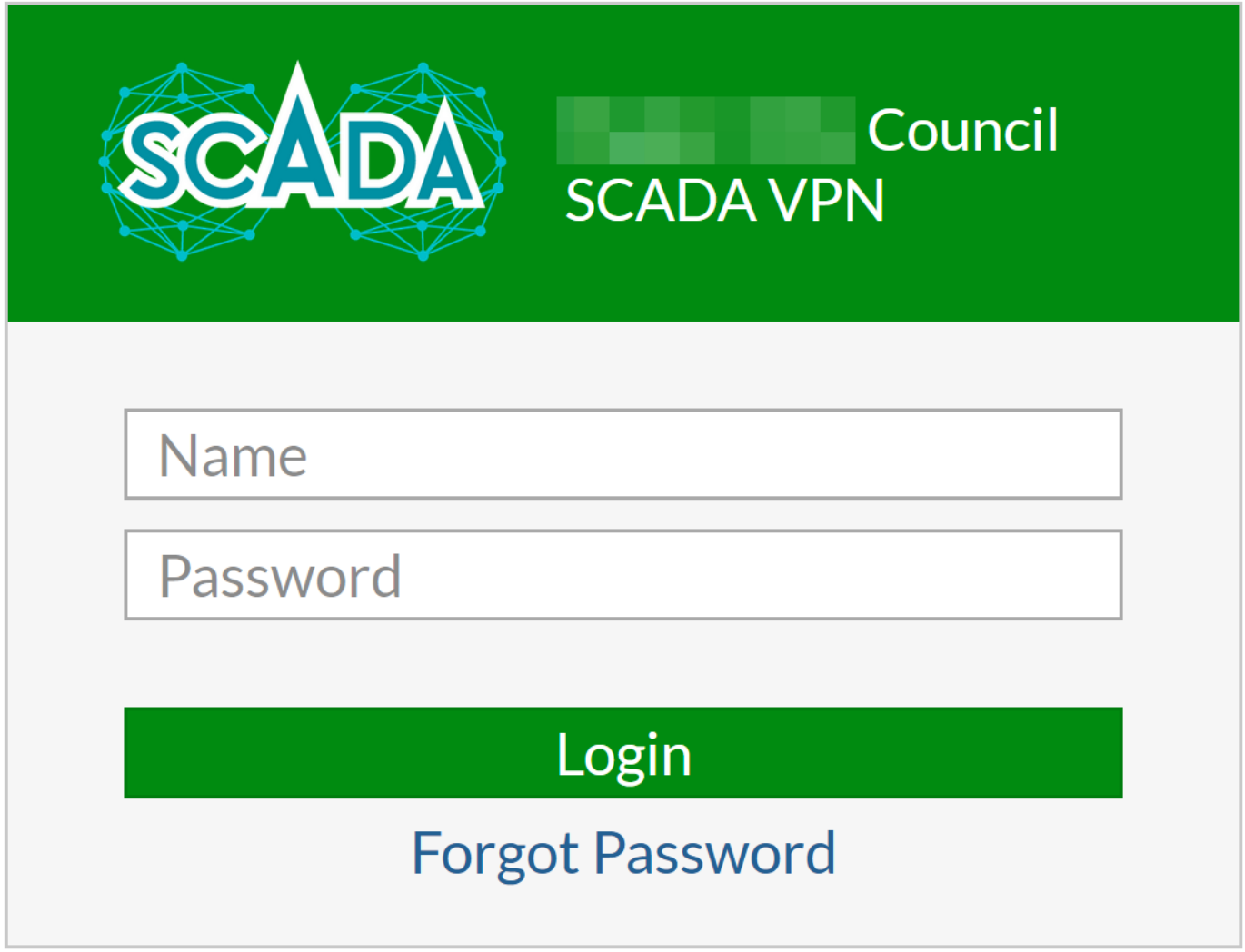
# Retail sites

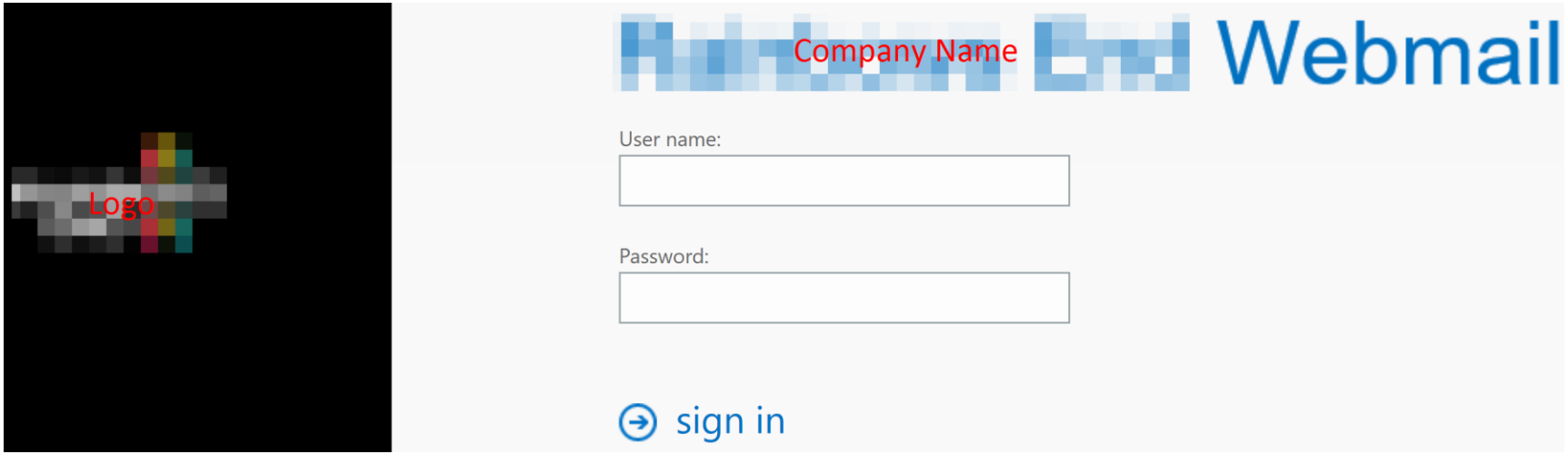
- Most probably use a UFB or Cellular Connection
  - Retail level connection probably does not have DDoS scrubbing or monitoring by ISP
- Point of Sale most probably uses the same connection
- What is the financial impact if a location can not make sales?

# Find Retail Sites?

- Could an attacker identify these assets easily?

# Remote Access




Logo
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 are 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<br>*.google.com |
| 2381394777 | 2020-01-27 | 2011-07-13 | 2012-07-13 | *.mail.google.com | *.docs.google.com<br>*.mail.google.com<br>*.plus.google.com<br>*.sites.google.com<br>*.talkgadget.google.com |
| 2380986199 | 2020-01-26 | 2011-02-16 | 2012-02-16 | *.mail.google.com | *.docs.google.com<br>*.mail.google.com<br>*.sites.google.com<br>*.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<br>adwords.google.com.ar<br>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.[redacted].net (ns2.[redacted].net. [1[redacted]])
        by mx.google.com with ESMTP id [redacted]
        for <[redacted]>;
        Fri, 04 Jan 2019 14:03:35 -0800 (PST)
Received-SPF: pass (google.com: best guess record for domain of apache@ns2.[redacted].net designates 1[redacted] as permitted
sender) client-ip=1[redacted];
Authentication-Results: mx.google.com;
       dkim=neutral (body hash did not verify) header.i=@[redacted].com header.s=default header.b=[redacted];
       spf=pass (google.com: best guess record for domain of apache@ns2.[redacted].net designates 1[redacted] as permitted
sender) smtp.mailfrom=apache@ns2.[redacted].net
Received: by ns2.[redacted].net (Postfix, from userid 48) id [redacted]; 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 server

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

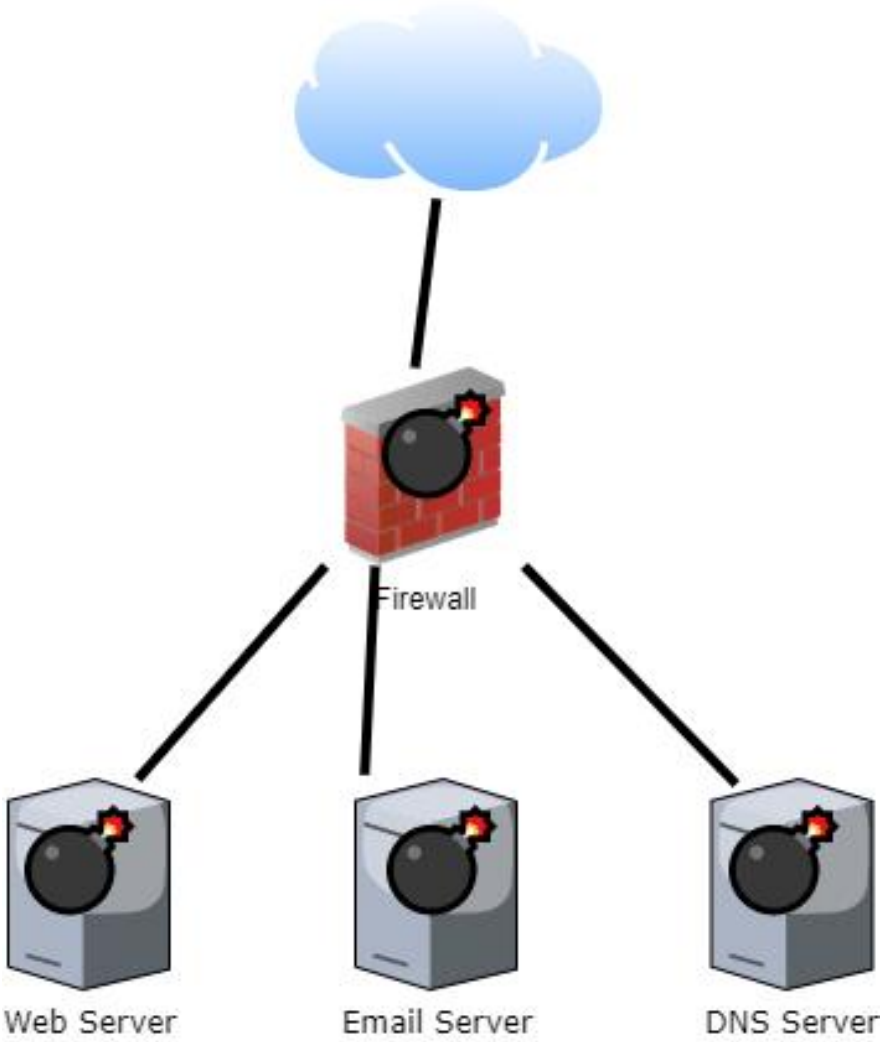
# Collateral Damage - Story

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

# How to protect your systems

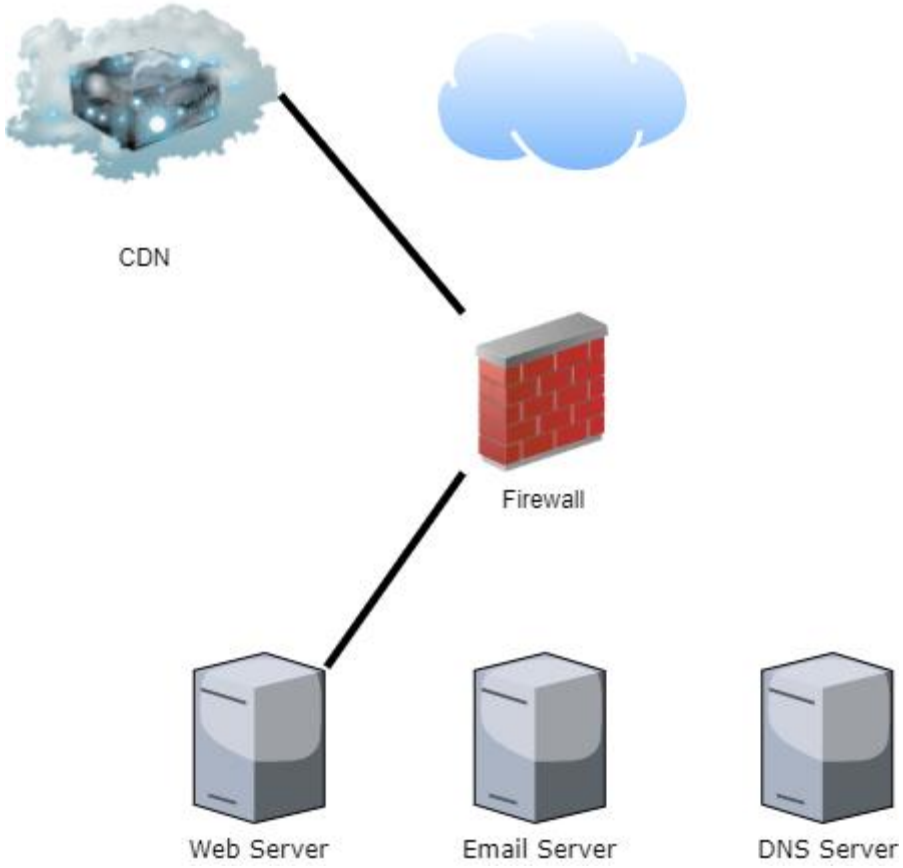
# What systems do you have?

- 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

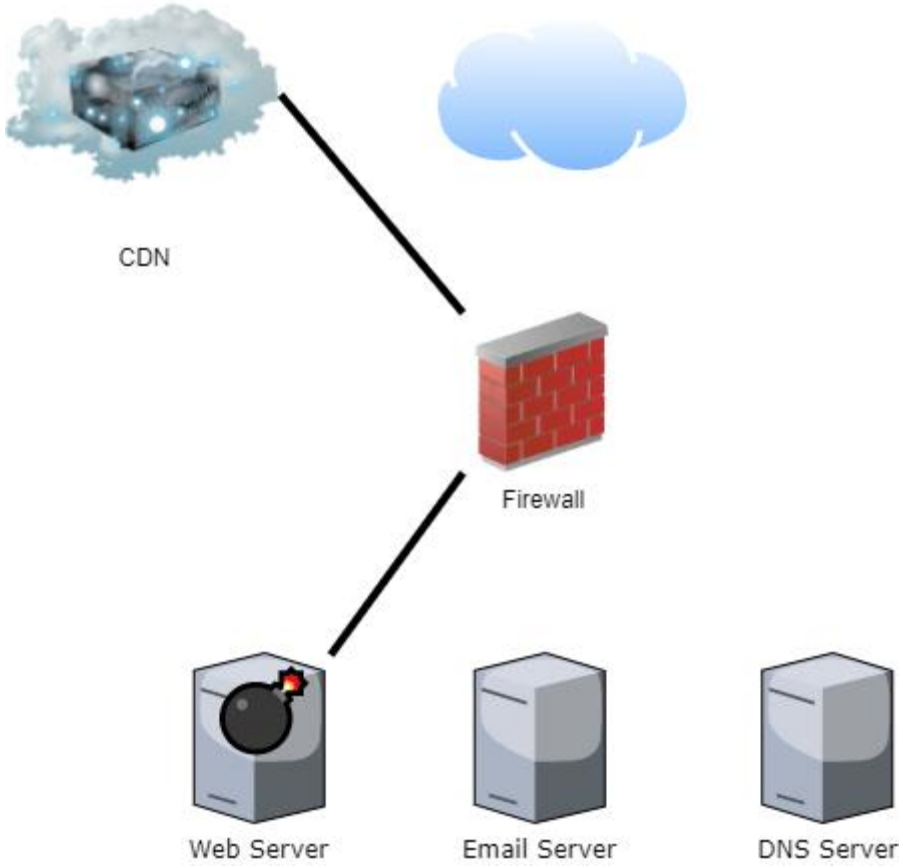
```
$ curl -o /dev/null -w %{time_total} -s https://example.com/1.html
0.299s
$ curl -X PURGE https://example.com/1.html
{ "status": "ok", "id": "10422-1600263910-3" }
$ curl -o /dev/null -w %{time_total} -s https://example.com/1.html
1.163
$ curl -o /dev/null -w %{time_total} -s https://example.com/1.html
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

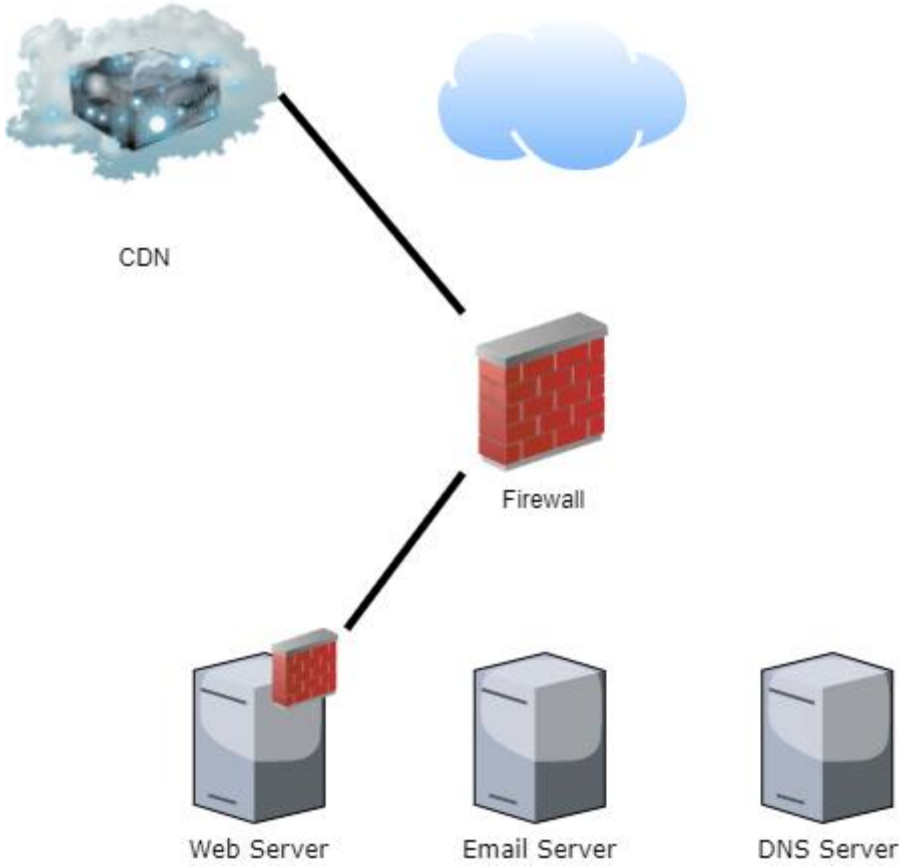
# Send traffic to Origin Servers

- Can you send traffic to those IP addresses
  - Even if the Firewall denys 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.

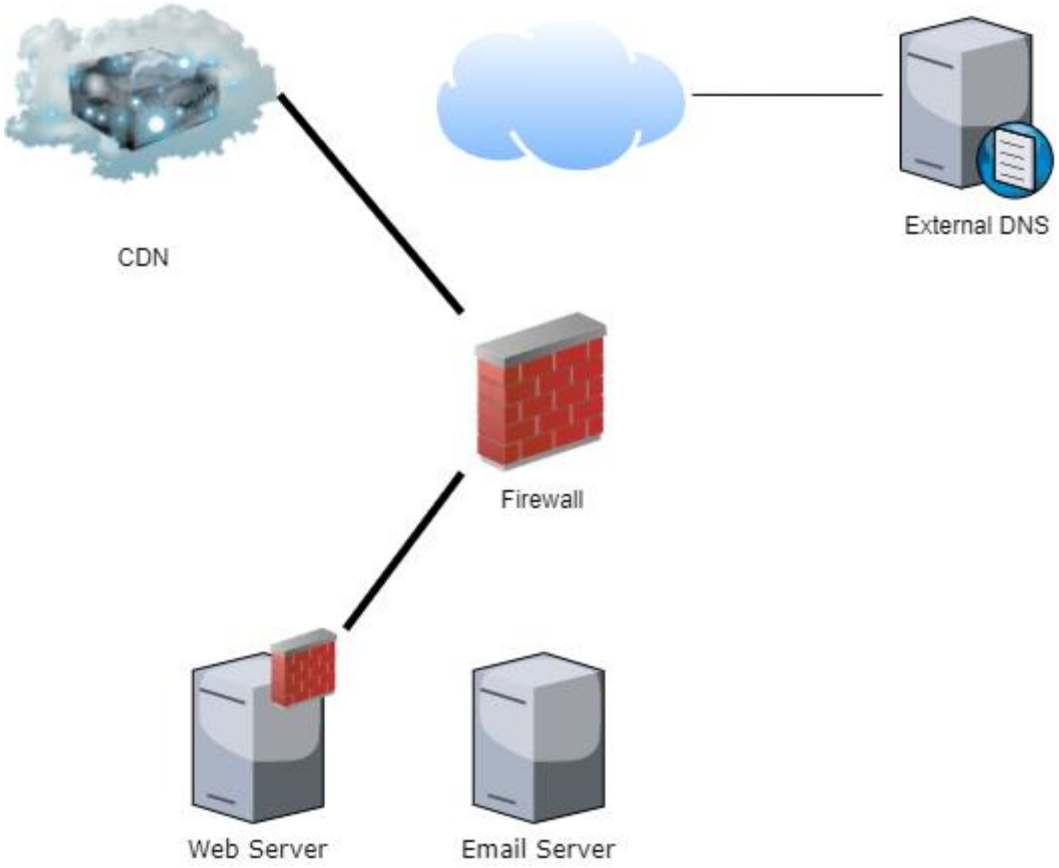


# DNS/Domain Registration

- 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 DoS

- Who would win?
- A laptop running a DNS Sub Domain Bruteforce
- Vs
- A Top Level Domain

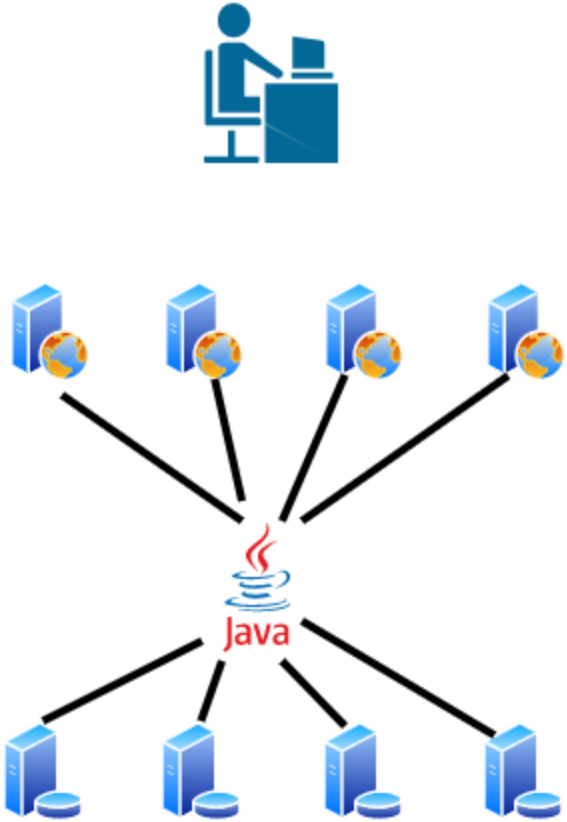


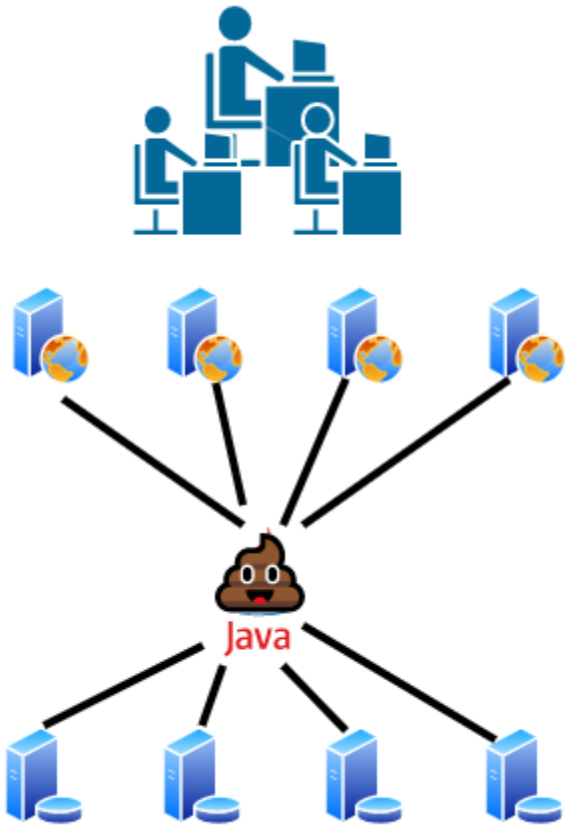
# DNS/Domain Registration

- 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


Java


Java

# 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.

# Sounds Hard

- Can an app actually be done?
- Recent Job
- New infrastruture so no DNS history etc

# Design

- CDN with a WAF
- Then Load Balancing Tier
- Auto Scaling
- i.e. Cloud Native

# Flows

- Non Cacheable
  - Had CAPTCHA at CDN
    - E.g. login form
  - Then authed JWT checked at edge

# Testing

- Full performance testing
- Tested scaling
- Monitoring all worked as expected knew what was going in application

# DoS Test

- All good

# Other applications dimensions to consider

# 404 Pages

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

# How to know what is a 404?

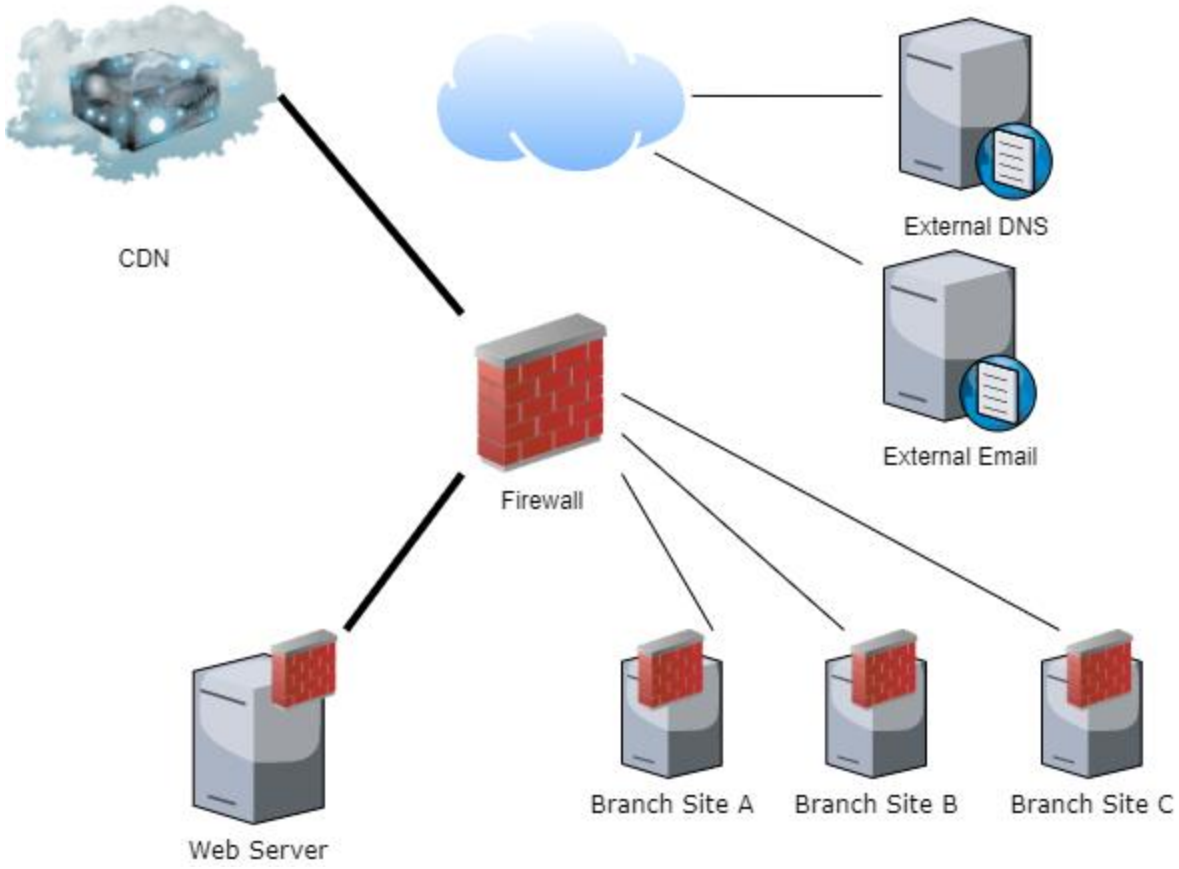
- The CDN will cache all the pages which have been requested
- Do 404s have to go to the origin server and hit the database?
- There are infinite(ish) possible 404 pages

# 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

# Branch Sites

- Restrict access to branch site firewalls
  - Geo fencing to NZ IP addresses (ok)
  - Only allow access from the head office/site-to-site VPN (better)



# 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
imgflip.com

# 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.**

1

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

2

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.

3

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

4

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.

5

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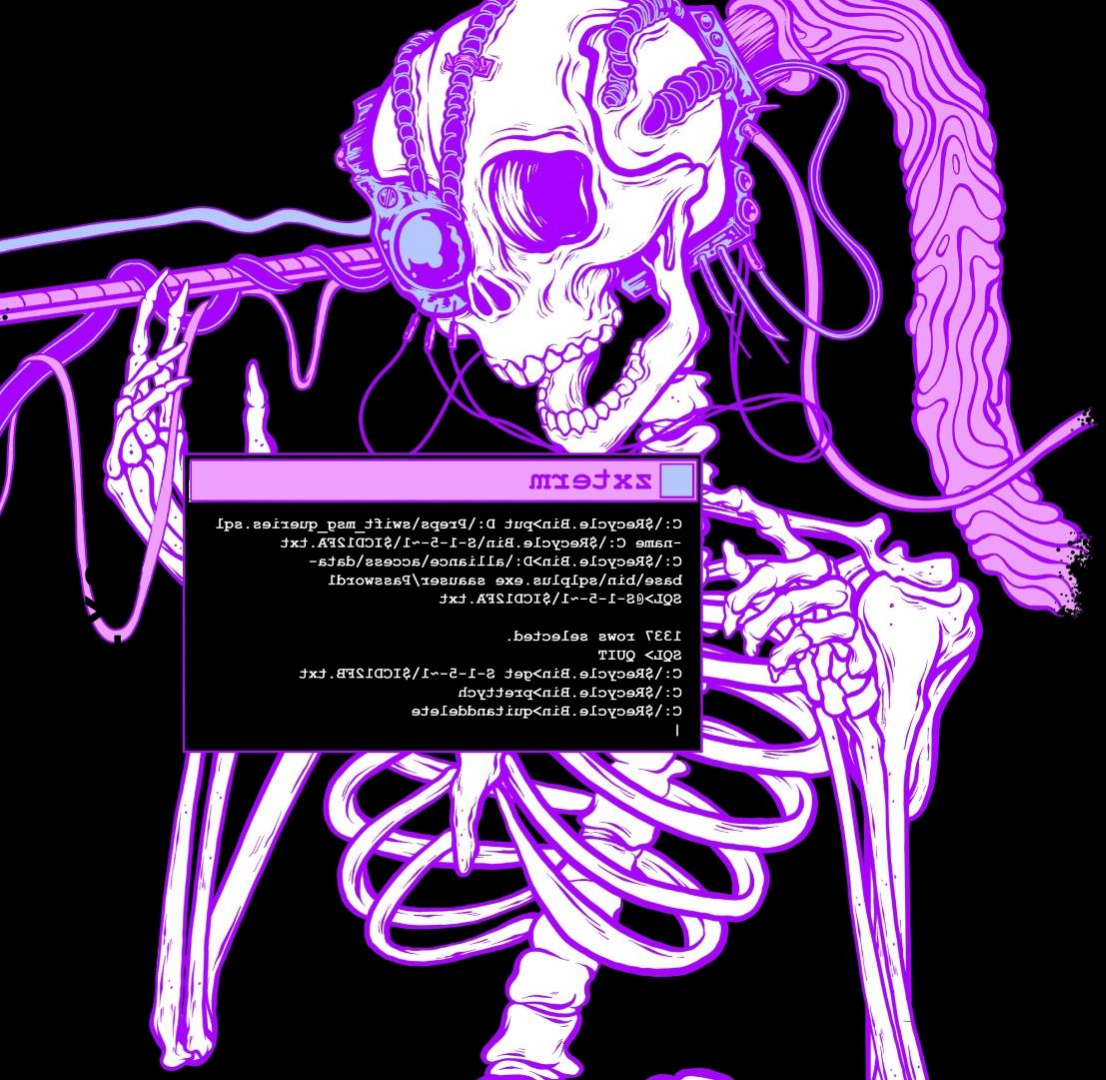
# Roughly distils down to

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 the BSides Crew for accepting my talk
- ZX Team for bouncing ideas off & giving me content



# Thanks

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