Welcome

“From Zero to SSRF to RCE and back again”

- Bsides Basingstoke (2022-07-15) ~ Presented by Thomas Cope

Hello World!

- Thomas Cope (https://tomcope.com)
- Chief Security Officer (CSO) at Qush Security
- Working in Cyber Security ~9 years
- MSc in Software and Systems Security
- CISSP
- Part time Security Researcher (CVE-2020-5014 + CVE-2021-29707)

AWS Certified Solutions Architect – Associate
Amazon Web Services Training and Certification

CompTIA Security+ ce Certification
CompTIA

Certified Information Systems Security Professional (CISSP)
(ISC)²

IBM Mentor
IBM

Docker Essentials: A Developer Introduction
IBM

IBM Recognized Teacher/ Educator
IBM

Security and Privacy by Design Foundations
IBM

Think Like a Hacker
IBM

Government Insights and Solutions (Silver)
IBM

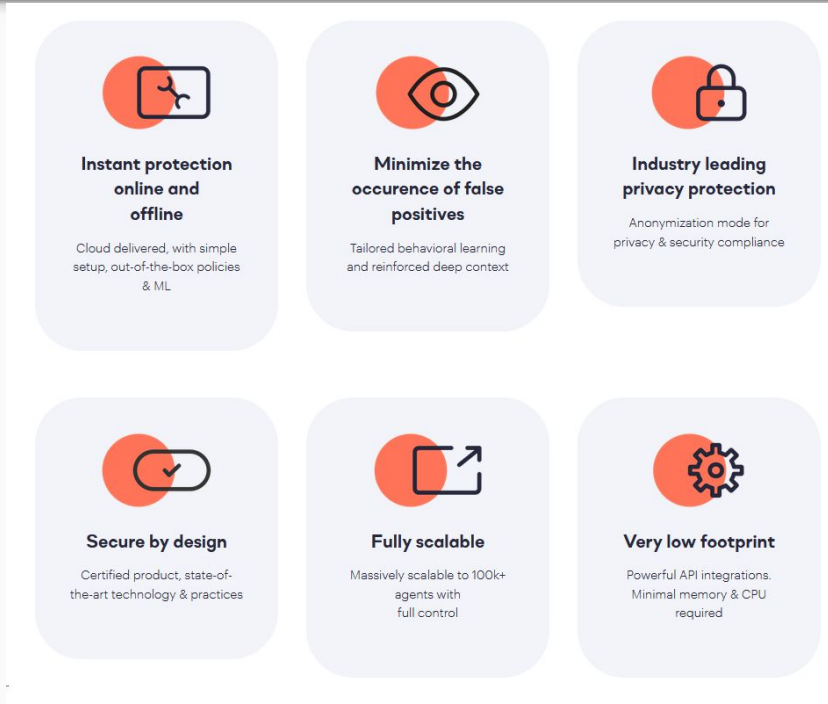
IBM Security Essentials for Architects
IBM

Get started with Kubernetes and IBM Cloud Container Service
IBM

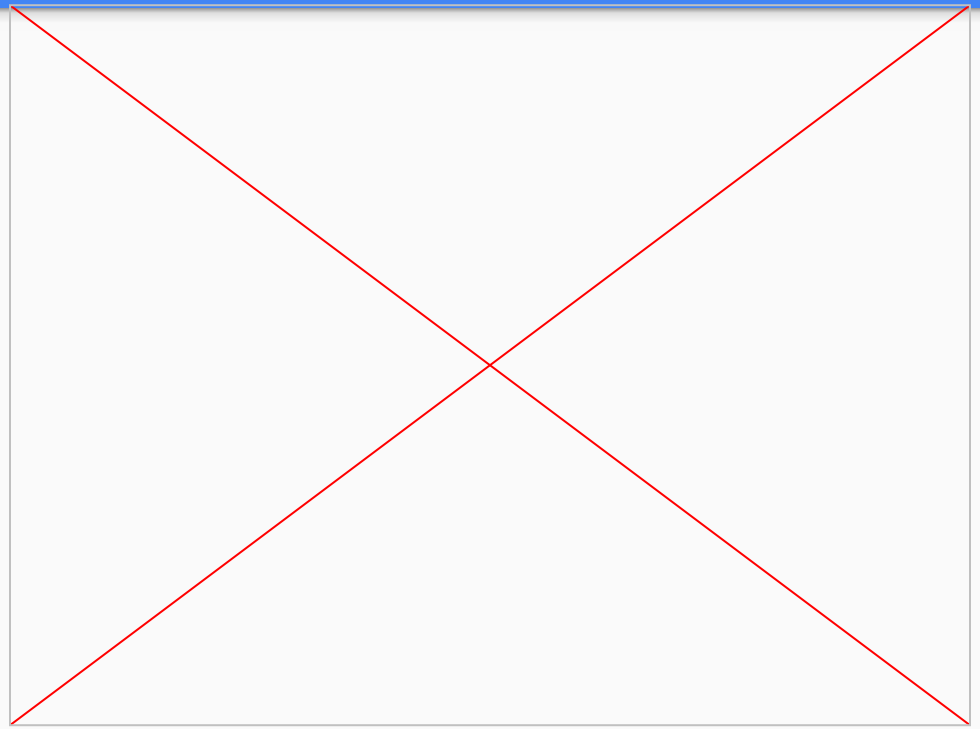
Cloud Security Architect and Engineer Fundamentals
IBM

Qush Security
https://www.qush.com

- “Enterprise Grade AI Powered Human Centered DLP Solution”
- EDR Capability
- Extensive policy platform
  - “If user in dev team uploads source code to their personal gdrive on a work computer then block the upload and display a notification with a link to the AUP where my must provide a business reason to perform another upload”



Qush - Reveal



Enough about me, Lets begin!

What is up with the title?

Security Research Process

Server Side Request Forgery

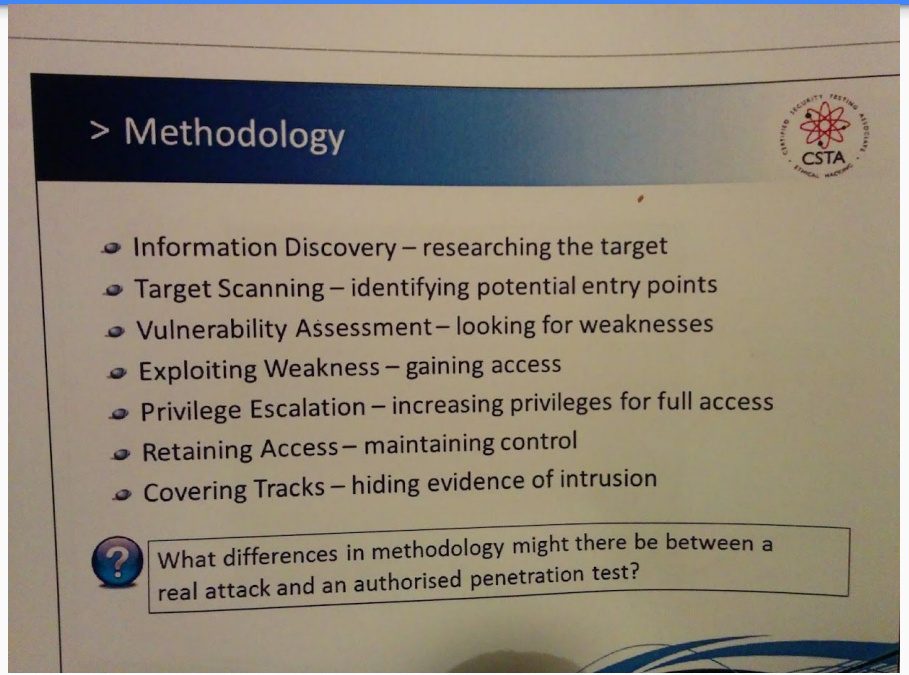
Remote Code Execution

"From Zero to SSRF to RCE and back again"

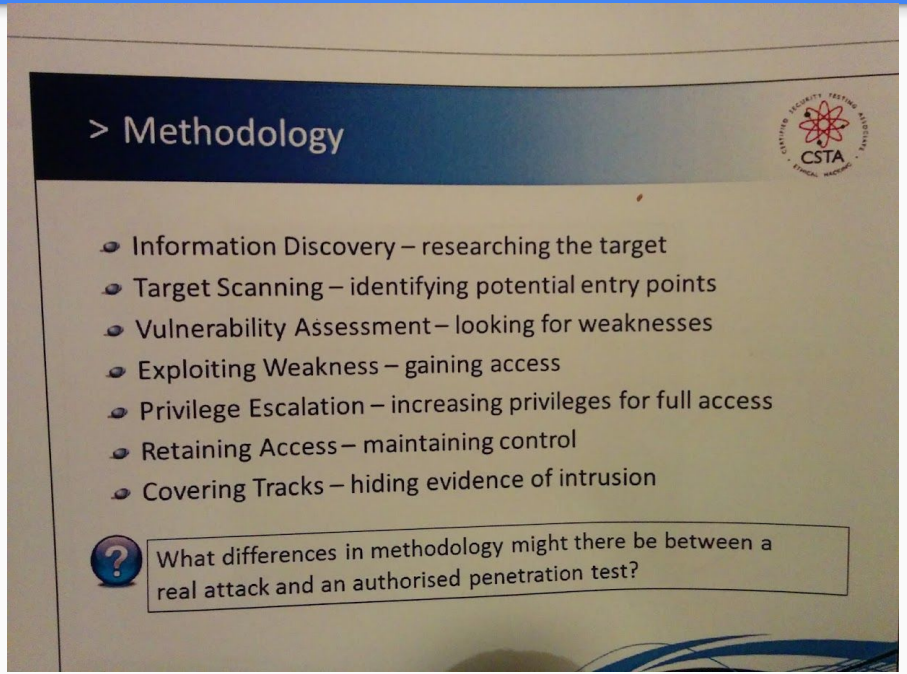
Real world impact

Security Research
datapower-redis-rce-exploit
(CVE-2020-5014)

Ethical Hacking Journey - Attackers Mindset



Information Discovery - What are you going to hack?



- Pick something fun!
  - Cool and enjoyable
  - Relevant to your current role
- Easy Access to support, images and documentation
- Real world impact
- Has a reporting program (HackerOne)
- Reward
  - Monies $£$£$£$£
  - Credit (CVE)
  - Hall of Fame - Google
  - For Fun
  - Gray hat side (Selling exploits to brokers)
    - Not Recommended

I picked - IBM Datapower

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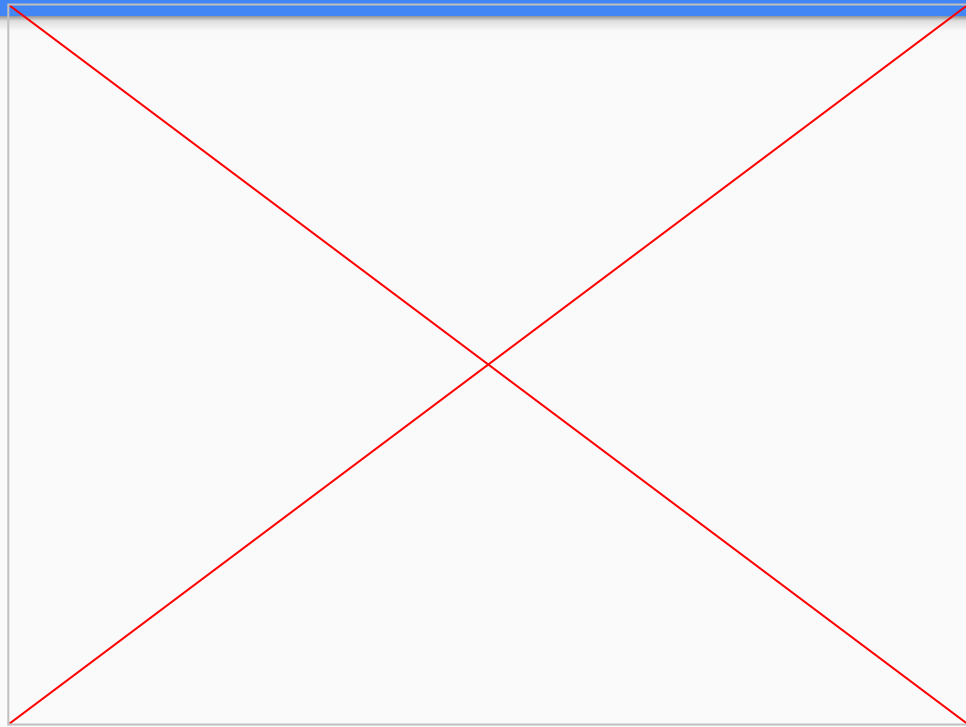
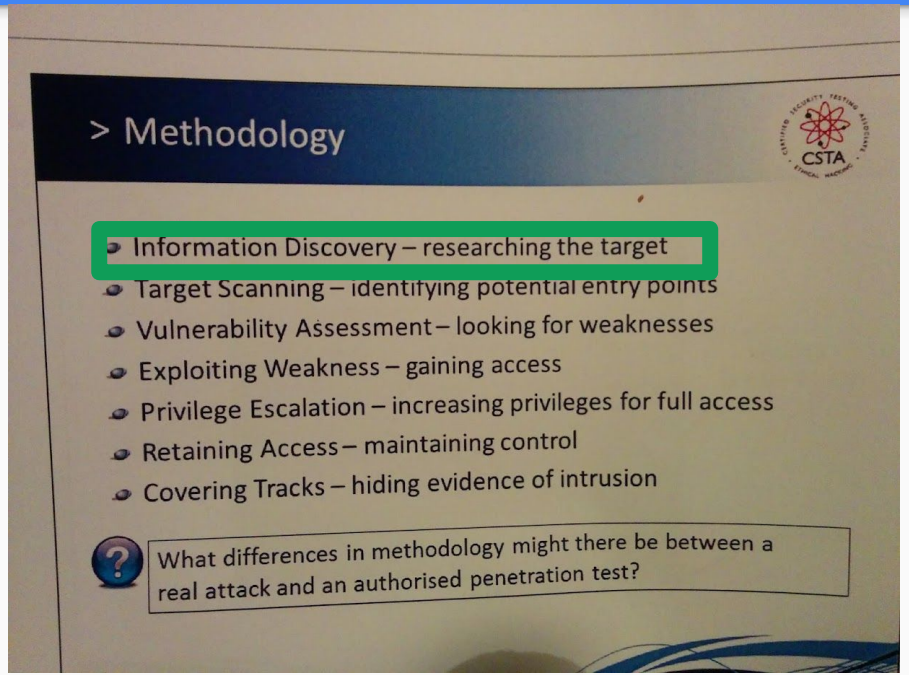


IBM Datapower - Explained

- Hardened by design
  - No Shell access
  - Can’t access the underlying operating system
  - Holds really important data like encryption keys
- Docker version allows you access to the inner workings
  - Physical Box is more common
  - Used in banks to process transactions at high speed
- If you forget the password you need to send it back to the factory
- Only access it via the GUI + Restricted management interfaces
- **Designed to be a really tough nut to crack**

Making Progress…



Setup

- Download
- Configure
- Look at the webgui
- “admin” “admin”
  - Shodan search???? - Scan the internet
  - Break into unconfigured docker containers (with approval from system owner, if your doing a pentest)

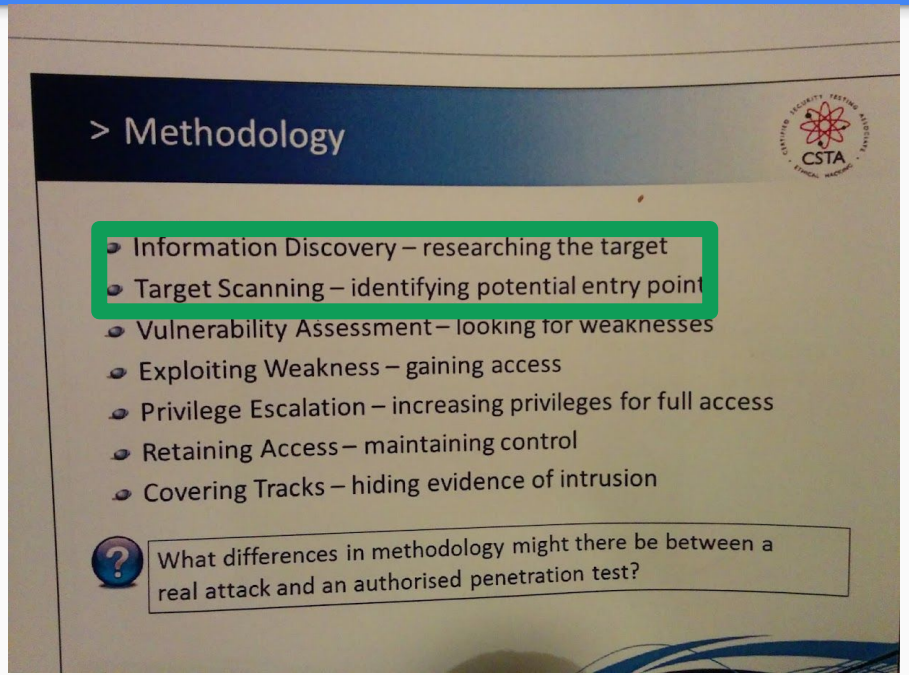
Target Scanning

- Break apart the container and have a look inside, see if we can find a good target!
  - Anyone know the docker commands?
  - What's running?
  - What's on the file system?

We have a few Options…

- Reverse engineer ”drouter” (ghidra, Ida Pro) - String Search
- Web scanning of the WebGUI
- Telnet?
- SSH?
- **Redis looks like a good target**

Making Progress…



Vulnerability Assessment

Is Redis Vulnerable?

…

…

…

…

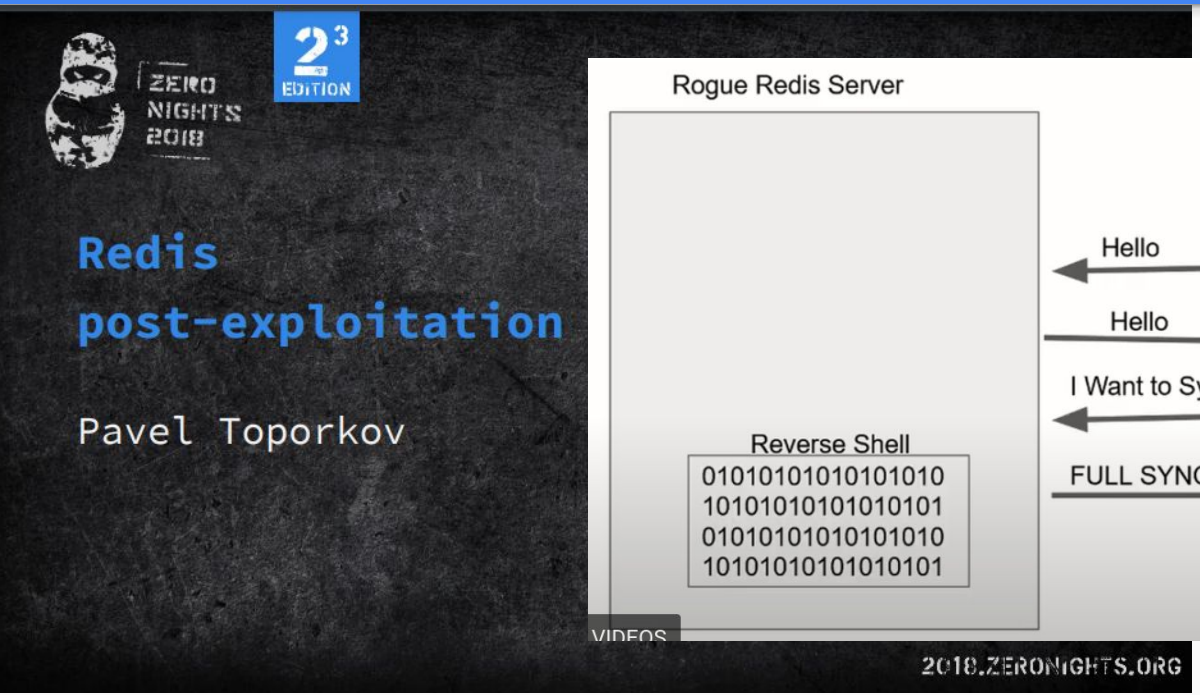
Let’s find out!

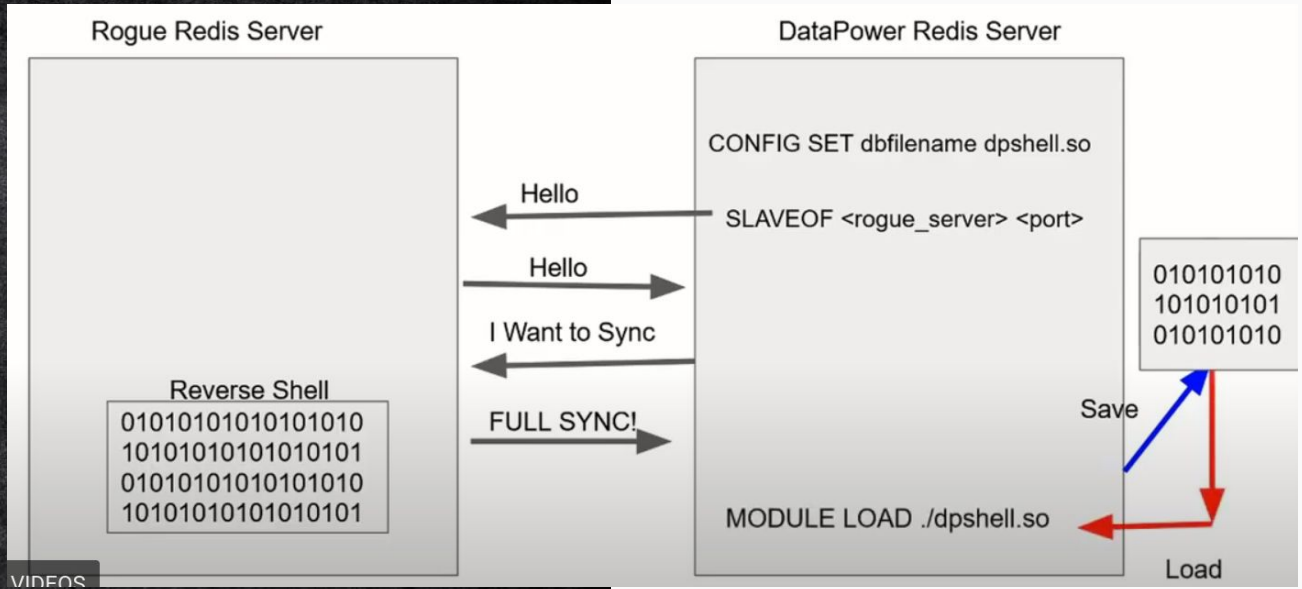
(127.0.0.1:16379)

Vulnerability Assessment

- Info Command
- Password needed
- Hard Coded Password
- Is it hard coded???
- Google Redis exploits

Vulnerability Assessment - Redis RCE



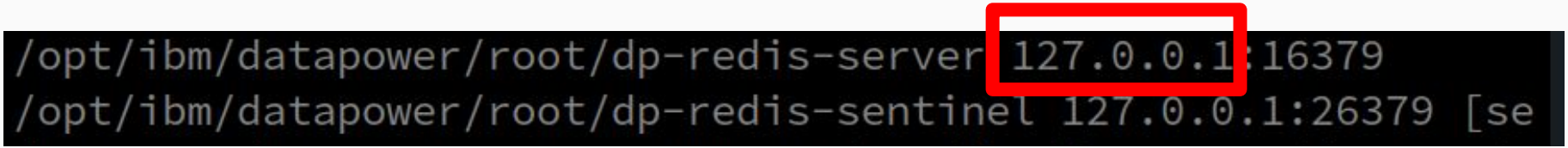


Rogue Redis Exploit

- Crazy Powerful exploit
- Any Redis server on the internet
- **Instant Remote Code Execution!**
- Redis introduced “Protected Mode” by default to help prevent this
  - Defaults to only listening on localhost
  - Redis Security guide recommends disabling the use of the “module” command
- Do people follow any of this advice or use the “Protected Mode”?
- If you Look at Shodan right now -> You’ll find some Vulnerable ones

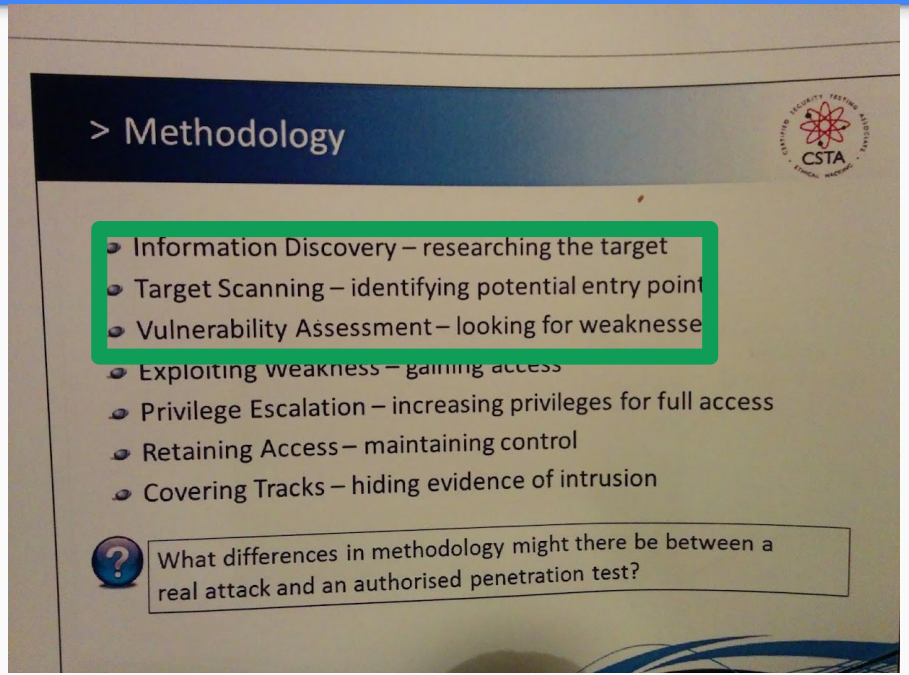
Vulnerability Assessment

Redis looks like a good target! But…… How to talk to it?



127.0.0.1 - Localhost - No external connections
-> Not protected mode - Datapower team hardening

Making Progress…



Exploiting Weakness

We need a SSRF!

https://portswigger.net/web-security/ssrf

What is SSRF?

Server **S**ide **R**equest **F**orgery

“A Web Security vulnerability that allows an attacker to induce the server-side application to make HTTP requests to an arbitrary domain of the attacker's choosing”

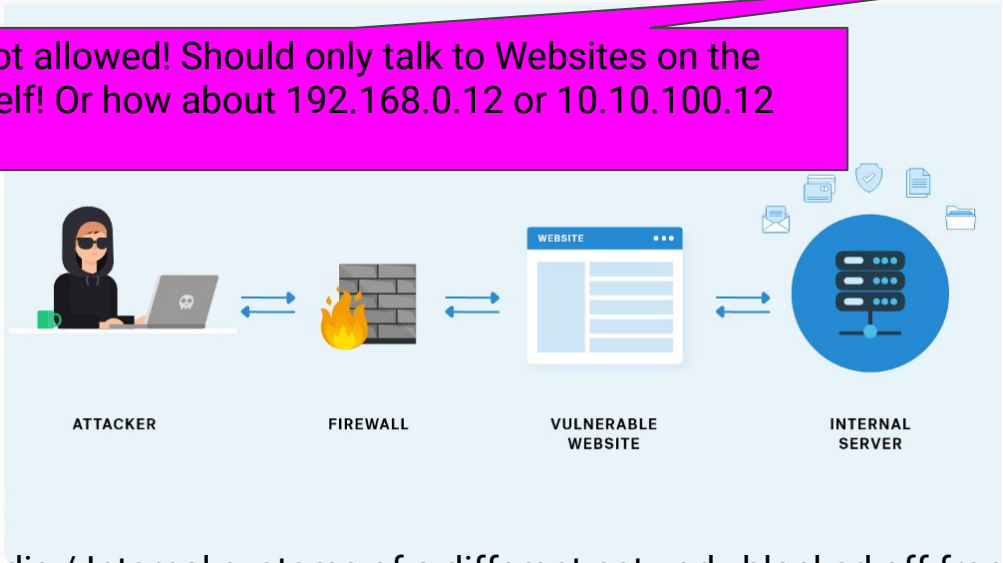
- Connecting to itself
- Internal Services
- Third Party Systems

A Scary class of exploits

Quick Example

https://app.com/api/v1/webhook?name=test?addr=127.0.0.1

Woops! That not allowed! Should only talk to Websites on the internet! Not itself! Or how about 192.168.0.12 or 10.10.100.12



You put your Database / Redis / Internal systems of a different network, blocked off from the internet but your own application is tricked into sending malicious requests by an attacker

Possible Impacts

- Used as a hopping point to attack another company.
  - Request would originate from a different - Reputation Damage / DDOS
- Access to internal APIs / Services
  - Database endpoints
  - Authentication services
  - **Redis**
- Cloud Metadata
  - Potential access to service accounts credentials
  - Could then be used to access restricted cloud buckets / databases
- K8s
  - Access to K8s APIs, Secrets, Config Maps
  - Service accounts for further access to K8s

In the Wild - Exploiting JIRA (CVE-2017–9506)

```
/plugins/servlet/oauth/users/icon-uri?consumerUri=https://www.attacker.com
```

AWS - IAM role will leak AWS key

```
http://169.254.169.254/latest/meta-data/
```

Docker - List Containers

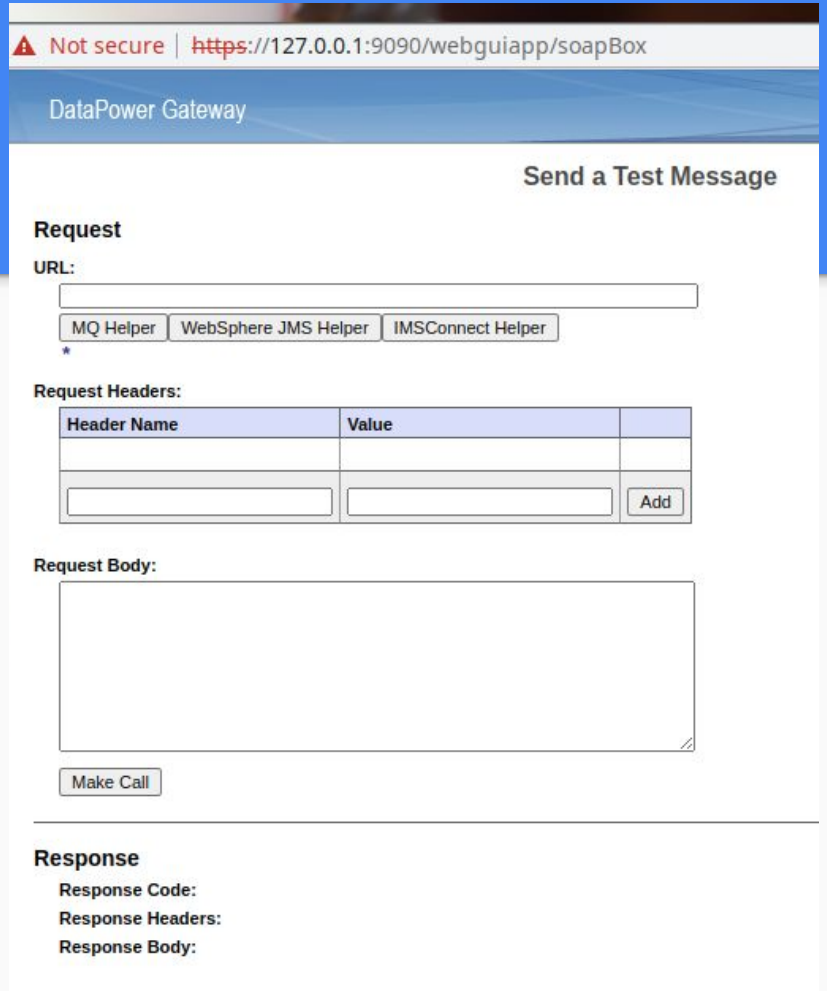
```
http://127.0.0.1:2375/v1.24/containers/json
```

Kubernetes ETCD - Can contain API keys and internal ip and ports

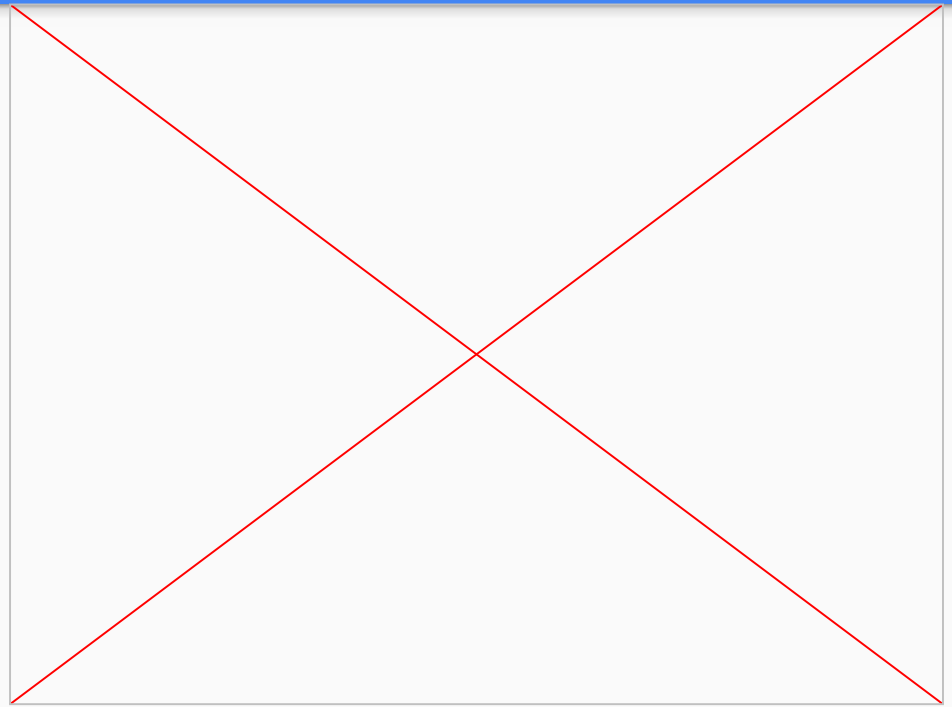
```
http://127.0.0.1:2379/v2/keys/?recursive=true
```

Exploiting Weakness

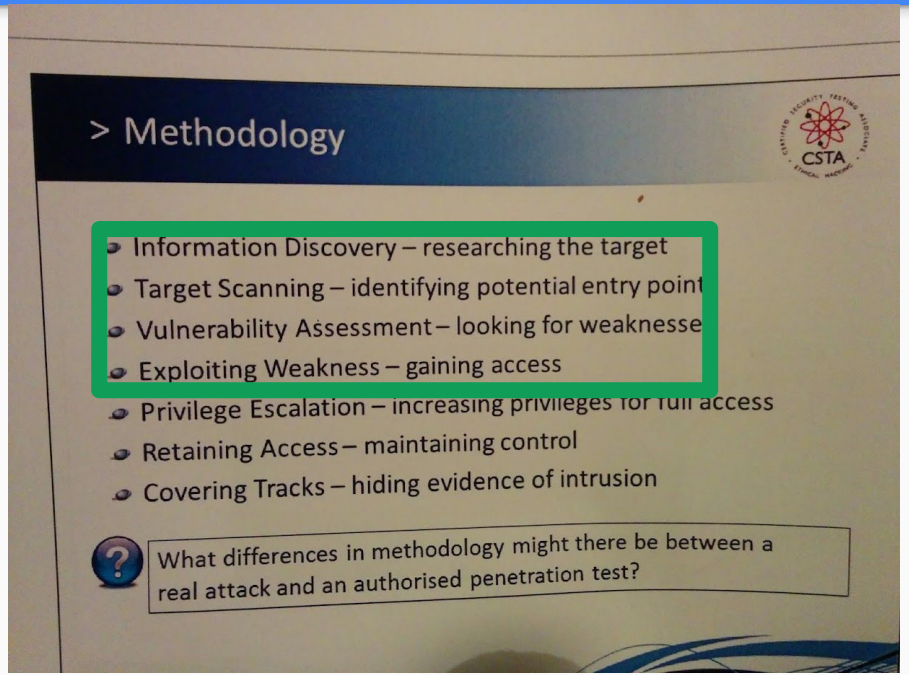
Hmmm… What's this?



Exploiting Weakness



Making Progress…



Next Steps

- Privilege Escalation
  - Redis already runs with high privilege
  - No Principle of least privilege :(
- Retaining Access
  - RCE - easy to add a persistent backdoor / reverse shell
- Covering Tracks
  - Can we make it more sneaky?

Let’s Write the Exploit!

- Golang
- Standard Library
- ~2 Hours

Let’s Run It!

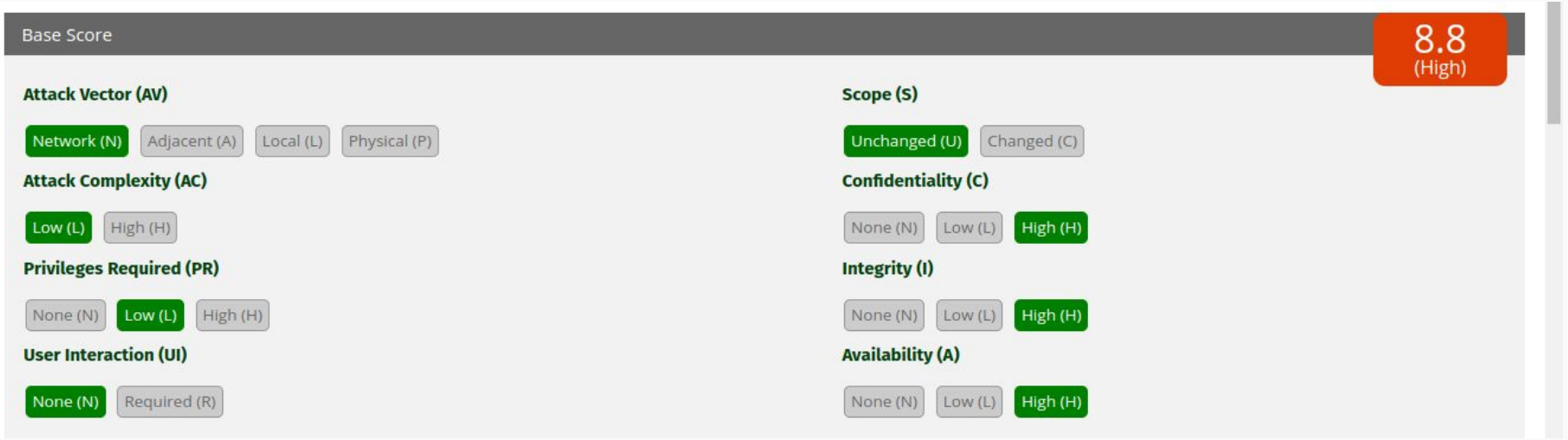
- Demo Time!

It works!

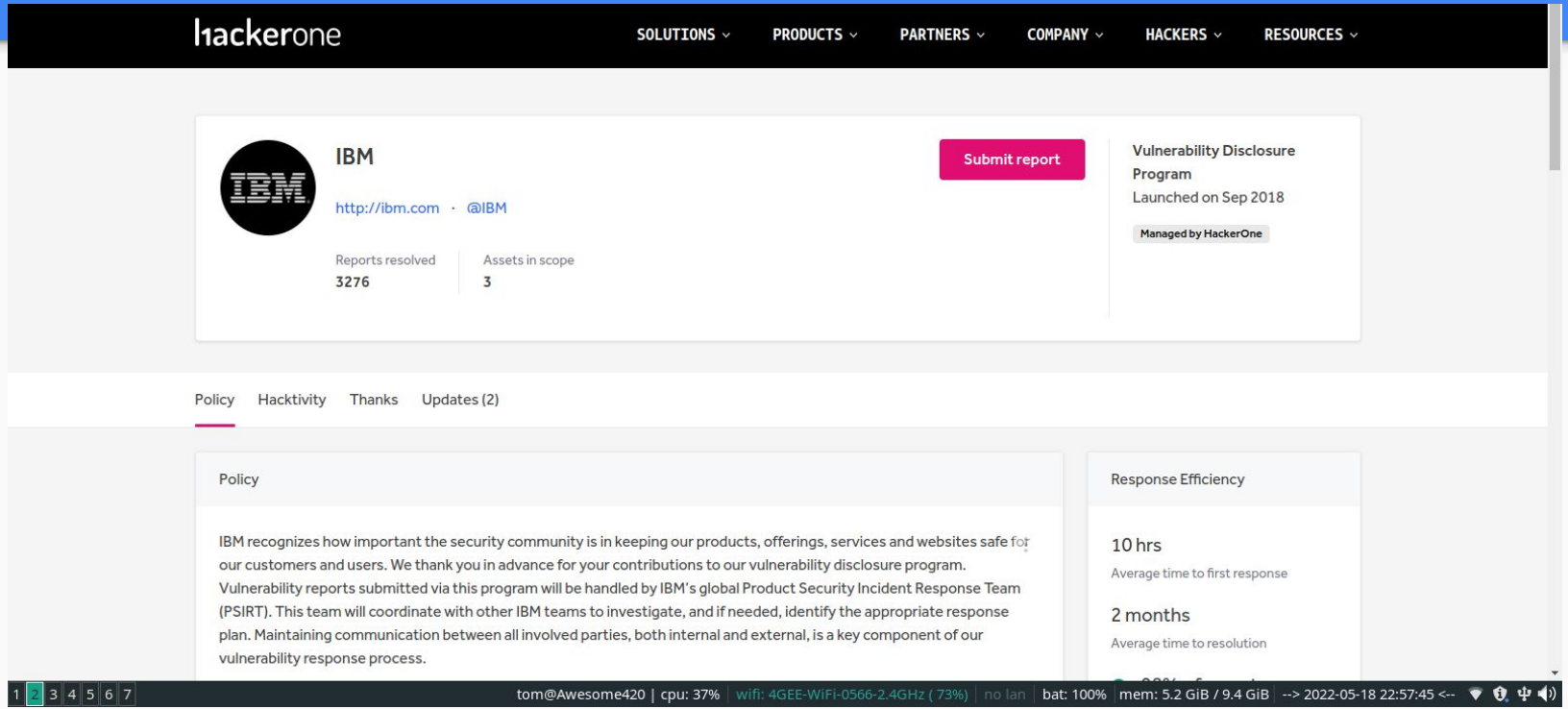
- Zero to SSRF to RCE!
- The Scope
  - Any Datapower
  - Anywhere on the internet
  - Only need any form of login (even the lowest level account)
  - Gain full root access, bypass the restricted environment and run a persistent remote shell
  - Extract encryption keys that were never meant to leave the device

CVE Score - 8.8 (High)

https://www.first.org/cvss/calculator/3.0#CVSS:3.0/AV:N/AC:L/PR:L/UI:N/S:U/C:H/I:H/A:H



Let’s Report It!



Let’s Report It!

> Timeline

- 21st October 2020 = Initial Report filed via Hackerone
- 22nd October 2020 = IBM Confirmed receipt of report
- 4th November 2020 = Asked for a Update
- 10th November 2020 = Initial Review complete → Report moved to Triaged
- 7th December 2020 = Asked for a Update
- 9th December 2020 = IBM are still investigating
- 6th January 2021 = Asked for a Update
- 13th January 2021 = Confirmed valid vulnerability and are working with product teams to develop a fix
- 21st January 2021 = Asked for Acknowledgment
- 22nd January 2021 = Confirmed public acknowledgement with my name - “Thomas Cope”
- 25th January 2021 = Confirmed Acknowledgment and a CVE number would be issued
- 8th February 2021 = Asked for a Update
- 9th February 2021 = IBM are working on a Fix
- 5th March 2021 = Asked for a Update
- 8th March 2021 = IBM confirmed Fix and provided link to public security bulletin

Total time elapsed between initial report and resolution = 139 days (4 months, 16 days)

https://tomcope.com/exploit/2020/10/21/ibm-datapower-exploit-cve-2020-5014.html

All Worth it! - Fixed and CVE!

Security Bulletin: IBM DataPower Gateway vulnerable to an RCE attack (CVE-2020-5014)

Security Bulletin

Summary

IBM has addressed the relevant CVE

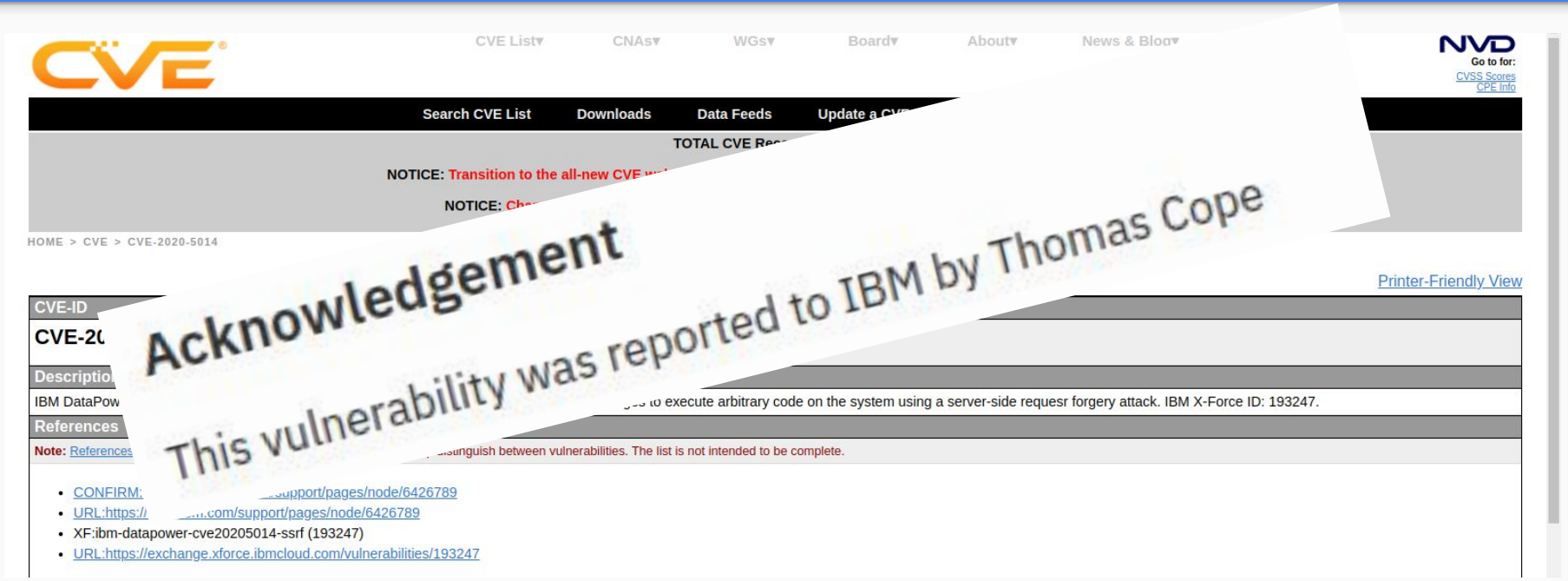
Vulnerability Details

CVEID: CVE-2020-5014
DESCRIPTION: IBM DataPower Gateway could allow a local attacker with administrative privileges to execute arbitrary code on the system using a server-side requesr forgery attack.
CVSS Base score: 6.7
CVSS Temporal Score: See: https://exchange.xforce.ibmcloud.com/vulnerabilities/193247 for the current score.
CVSS Vector: (CVSS:3.0/AV:L/AC:L/PR:H/UI:N/S:U/C:H/I:H/A:H)

Affected Products and Versions

Affected Product(s)	Version(s)
IBM DataPower Gateway	10.0.0.0-10.0.1.1
IBM DataPower Gateway	2018.4.1.0-2018.4.1.14

All Worth it! - Fixed and CVE!



The fix

If you are looking for a side project…

The Real World…

Qush Impacted - Customer Pentest

- PSIRT 416 - Aware webhooks can make requests against internal components
- PSIRT 417 - Cyber internal IP blacklist not configured
- PSIRT 418 - Aware webhooks can make requests against cloud components
- PSIRT 420 - Video vulnerable to various SSRF attacks

4 Security Issues!

Pentest

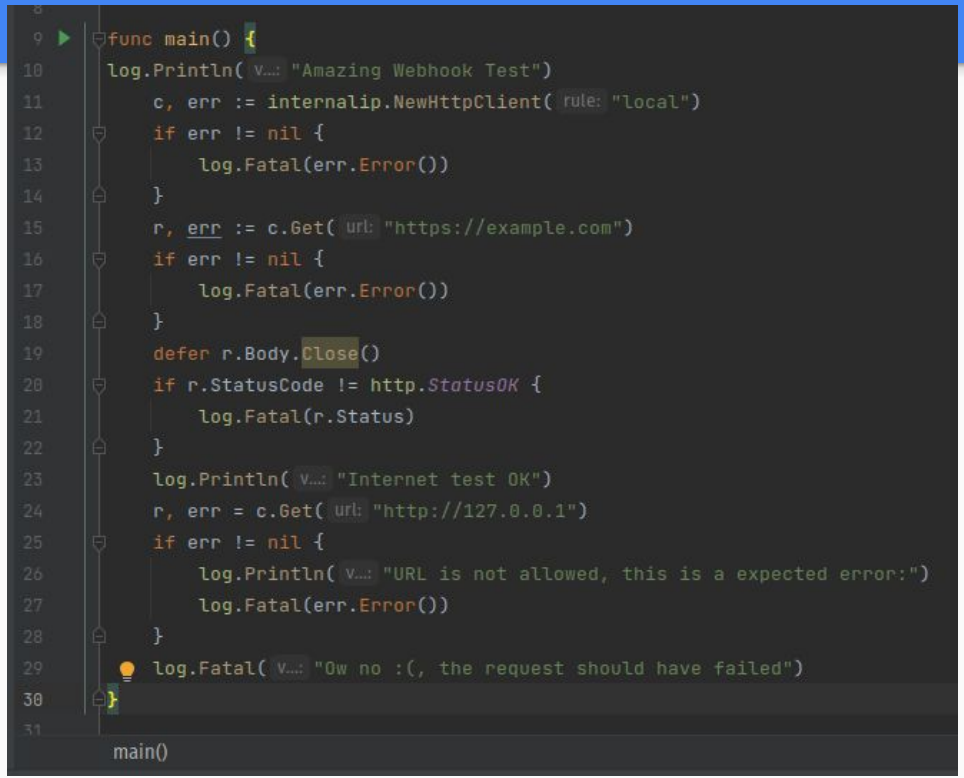
Timestamp	Score	Policy	Description
20/04/2021, 04:36	Critical	nothing to see here	This sensor was not created by a webhook.
20/04/2021, 04:36	Critical	nothing to see here	This sensor was not created by a webhook.
20/04/2021, 04:36	Critical	nothing to see here	This sensor was not created by a webhook.
20/04/2021, 04:36	Critical	nothing to see here	This sensor was not created by a webhook.

Threat Modeling Identified the issue -> Created library to handle checks (with tests + code review) -> Implemented the library -> BUT
On Closer inspection library was not integrated correctly. Integration tests are important!

The Solution

- Following Guidance from: https://cheatsheetseries.owasp.org/cheatsheets/Server_Side_Request_Forgery_Prevention_Cheat_Sheet.html
  - -> Defence in Depth <-
  - **Whitelist domain accessible by the service - Done in code**
  - Network protections - K8s Network Policy + Firewalls
  - Proactive monitoring of network traffic
  - Isolation of services
  - Require authentication to all backend services

The Solution - Custom Library



The Solution

```
2021/05/24 10:22:16 Amazing example using the 'internalip' HTTP Client
2021/05/24 10:22:17 Internet test OK
2021/05/24 10:22:17 URL is not allowed, this is a expected error:
2021/05/24 10:22:17 Get "http://127.0.0.1/": 127.0.0.1 failed to resolve into any permitted hostnames
exit status 1
```

My Personal Security Research helped prepare me for handling the incident at work

Before I Close out…

Now Hiring!

Graduate Software Engineer careers

- Test Automation
- Cloud architecture / infrastructure
- Security product development
- Backend or Frontend
- Machine Learning
- Data Pipeline
- Kernel layer OS systems

- Go (Golang)
- C
- C++
- C#
- Python
- Elm
- Typescript
- Kafka
- Kubernetes
- Docker
- Flink
- Spark
- GKE
- GCP
- Postgres
- ML

https://www.qush.com/careers

Thankyou! Any Questions?

Qush