Capturing WPA2 Enterprise credentials with a Pi

Richard Frovarp
Principal Software Engineer
North Dakota State University

Standard disclaimer

What I say is my own opinion and not that of my employer

Why a Pi and not a Pineapple?

$35 < $Pineapple

Everything described will work on a Pineapple, and possibly work better.

Types of WPA2

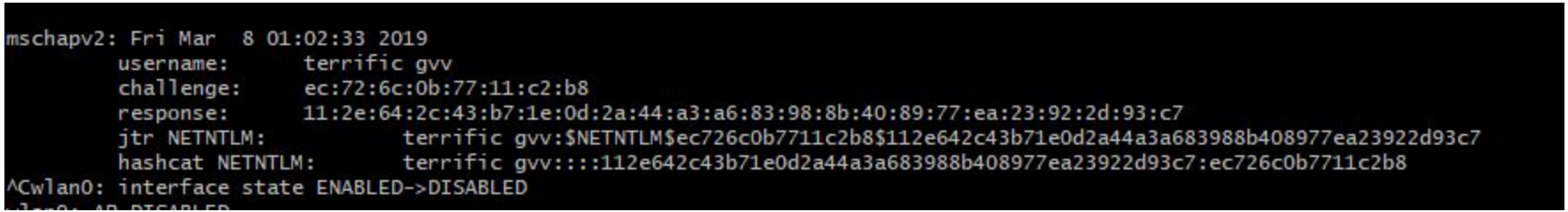
- Personal
  - PSK (PreShared Key) that is the same between devices
  - Exceedingly common at home and consumer devices
  - Some systems can do per MAC PSK, but it using Personal mechanisms
- Enterprise
  - For when you want each user to use their own credentials
    - Much easier to manage who has access across the enterprise. One person leaves, just revoke their credential and don't have to update every other device with new PSK.
  - Credential typically takes two forms:
    - Username and password, frequently against an enterprise directory like OpenLDAP or AD
    - x509 certificates

WPA2 Enterprise credentials

- x509 requires PKI to sign certificates
  - However, since it is just a cert, you can't compromise standard directory credentials
- Username and password
  - Can we perhaps compromise the password?

hostapd-wpe

- Install Kali on your favorite Pi. 3B's are the easiest, 3B+ and 4's require additional hardware
- sudo apt install hostapd-wpe
  - This time OpenSSL isn't lying when it says that it will take a while
- kill dhcp
  - watch out for this
- Maybe edit the SSID
- Launch, and watch credentials come in


mschapv2: Fri Mar 8 01:02:33 2019
username: terrific gvv
challenge: ec:72:6c:0b:77:11:c2:b8
response: 11:2e:64:2c:43:b7:1e:0d:2a:44:a3:a6:83:98:8b:40:89:77:ea:23:92:2d:93:c7
jtr NETNTLM: terrific gvv:$NETNTLM$ec726c0b7711c2b8$112e642c43b71e0d2a44a3a683988b408977ea23922d93c7
hashcat NETNTLM: terrific gvv::::112e642c43b71e0d2a44a3a683988b408977ea23922d93c7:ec726c0b7711c2b8
^Cwlan0: interface state ENABLED->DISABLED

Method being attacked

- Targeting PEAP using MSCHAPv2
  - MSCHAPv2 was state of the art for Windows 98 / NT 4.0 SP 4
  - PEAP from 2005

Abstracted process

- Device looks for the SSID
- Sends anonymous identity in the plain to connected RADIUS system
- Is connected with end RADIUS responsible for account
- TLS session is created between device and end RADIUS
- Identity is sent in plain and creds are sent in MSCHAPv2 format

hostapd-wpe

- Acts as the destination RADIUS
- Gets username and creds

```
mschapv2: Fri Mar  8 01:02:33 2019
         username:      terrific gvv
         challenge:     ec:72:6c:0b:77:11:c2:b8
         response:      11:2e:64:2c:43:b7:1e:0d:2a:44:a3:a6:83:98:8b:40:89:77:ea:23:92:2d:93:c7
         jtr NETNTLM:           terrific gvv:$NETNTLM$ec726c0b7711c2b8$112e642c43b71e0d2a44a3a683988b408977ea23922d93c7
         hashcat NETNTLM:       terrific gvv::::112e642c43b71e0d2a44a3a683988b408977ea23922d93c7:ec726c0b7711c2b8
^Cwlan0: interface state ENABLED->DISABLED
```

asleap

- Developed 2004 by Joshua Wright
- We end up with control of the random value
- Protocol DES encrypts same number three times using NTLM hash
- 16 byte NT hash is split into 7 + 7 + 2
  - Third DES is 2^16 possible permutations
- Dictionary search

Defenses

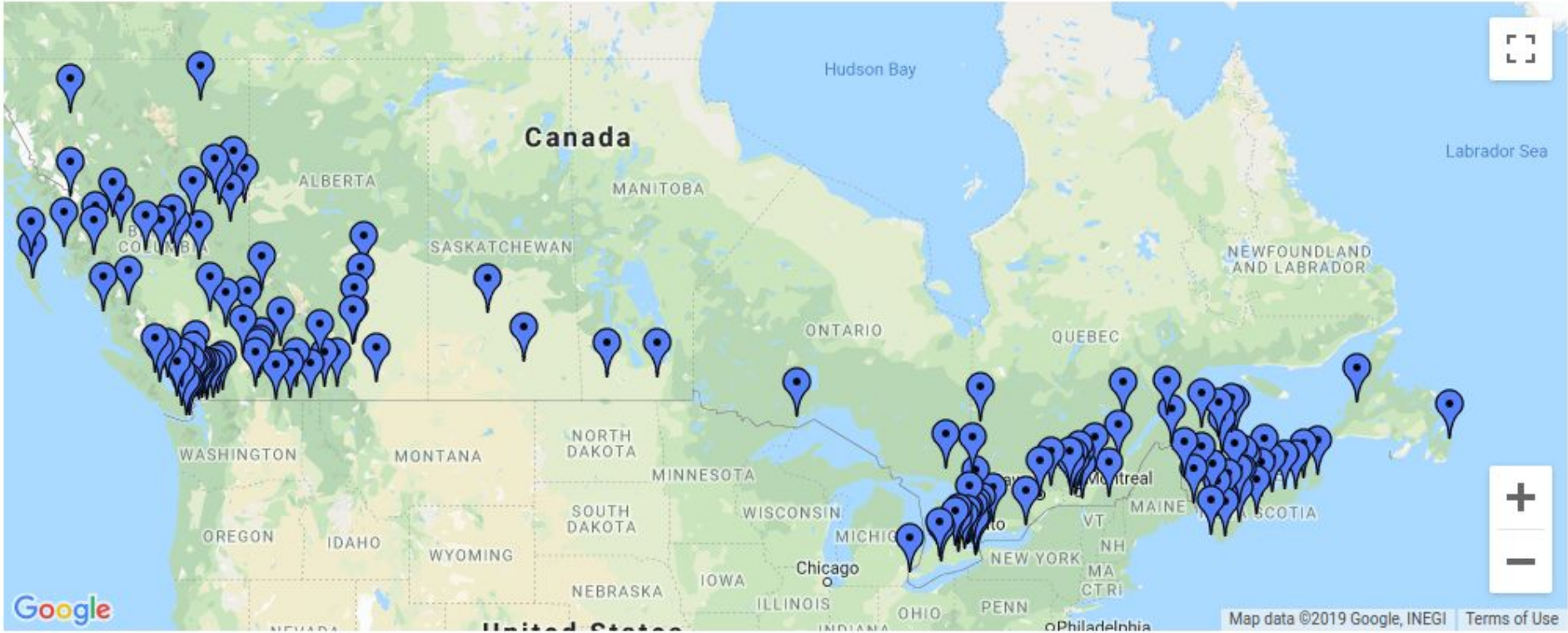
- Run EAP-TLS

Pin RADIUS certificate

- Clients can be configured to validate the identity of the RADIUS system by checking their certificate.
- Apple devices do this by default by requiring that you accept the cert the first time you connect
- However….
  - Sure you could figure out social engineer an Apple user to accept the new cert.
  - It's REALLY easy to setup a device using PEAP. While you may be good, there's nothing stopping a user from setting it up on their phone without your help.
- So really only a partial solution

EAP-TLS

- Secure, but difficult to support
- You need PKI infrastructure to generate and sign certificates
- Apple devices need a profile, which actually works out quite nicely for install.
- Windows and Android devices are more complicated
- Sometime devices are locked down and can't get the custom certificates to join the network
- Android appeared to be all over the place: sometimes it worked, sometimes it didn't. Updates would break it.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Canada
Labrador Sea
ALBERTA
MANITOBA
SASKATCHEWAN
NEWFOUNDLAND AND LABRADOR
ONTARIO
QUEBEC
WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
SOUTH DAKOTA
WISCONSIN
MAINE
OREGON
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eduroam federation

GÉANT project of entities in 101 territories to allow students, faculty, and staff connect to wireless across the globe.

Challenge

- Lots and lots of devices.
- We see about 11k devices a day

Thanks

See https://frovarp.dev for slides and updates.