
Under Pressure
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#partnersincrime

Ikea Standing Coat Rack
(don't ask...)

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Concept & Full Setup

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Radio and DSP

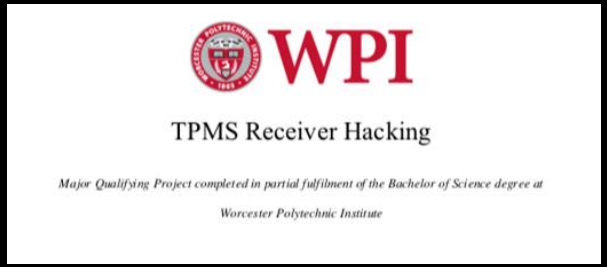
Shir Mousseri
Packet Analysis

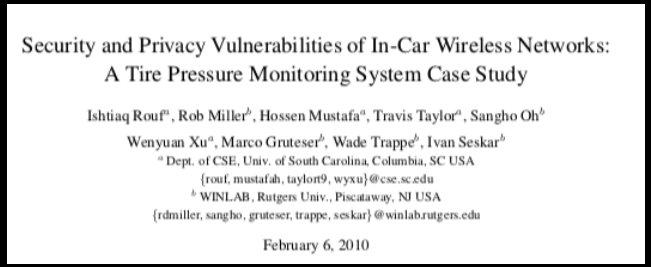
So, TPMS

Tire Pressure Monitoring System

- “An electronic system designed to monitor the air pressure inside the pneumatic tires on various types of vehicles” (Wikipedia)
- TPMS sensor reports in real-time to the driver of the vehicle, either via a gauge, a pictogram display, or a simple low-pressure warning light
- Mandatory in many countries for every new vehicle
- Many models; many suppliers; both by Auto manufacturers and aftermarket suppliers
- We’ll be talking about Direct TPMS technology

Already Researched Extensively





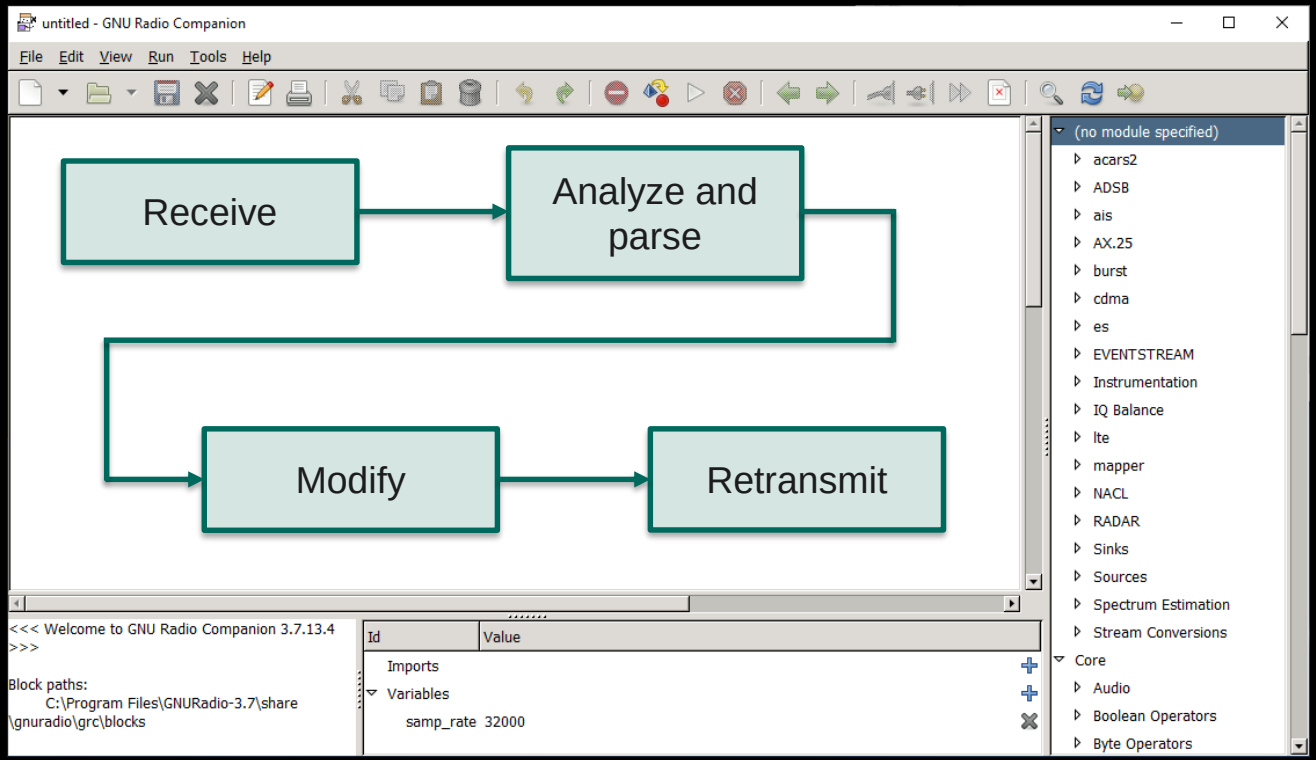
Deemed Mostly Harmless

"This can set off an alarm in the car and possibly cause someone to pull over. More alarmingly, they discuss how tractors have automatic tire inflation systems which work using similar sensors. A false low pressure reading could cause the tractor tires to over inflate and be damaged."

"Though the study concedes that the potential for danger is very small, it also points to the inherent vulnerability in secure software development for new automobiles…"


MCL Cinema, Hong Kong

The Plan: One Vehicle



The Plan: One Vehicle

The objective is to decode data

WPI

TPMS Receiver Hacking

Table 3 Packet Structure for Personal Car TPMS Sensor and Example Data.

Trial	Preamble	ID	Temperature (F)	Pressure (kPa)	Flags	CRC
Packet in Binary	1110 0000 0	1000 1000 0111 1100 0110 1001 1111 1001	0101 1010	1111 0000	1111 1000	0101 1100
Packet Values	N/A	887C69F9	90	240	F8	5C

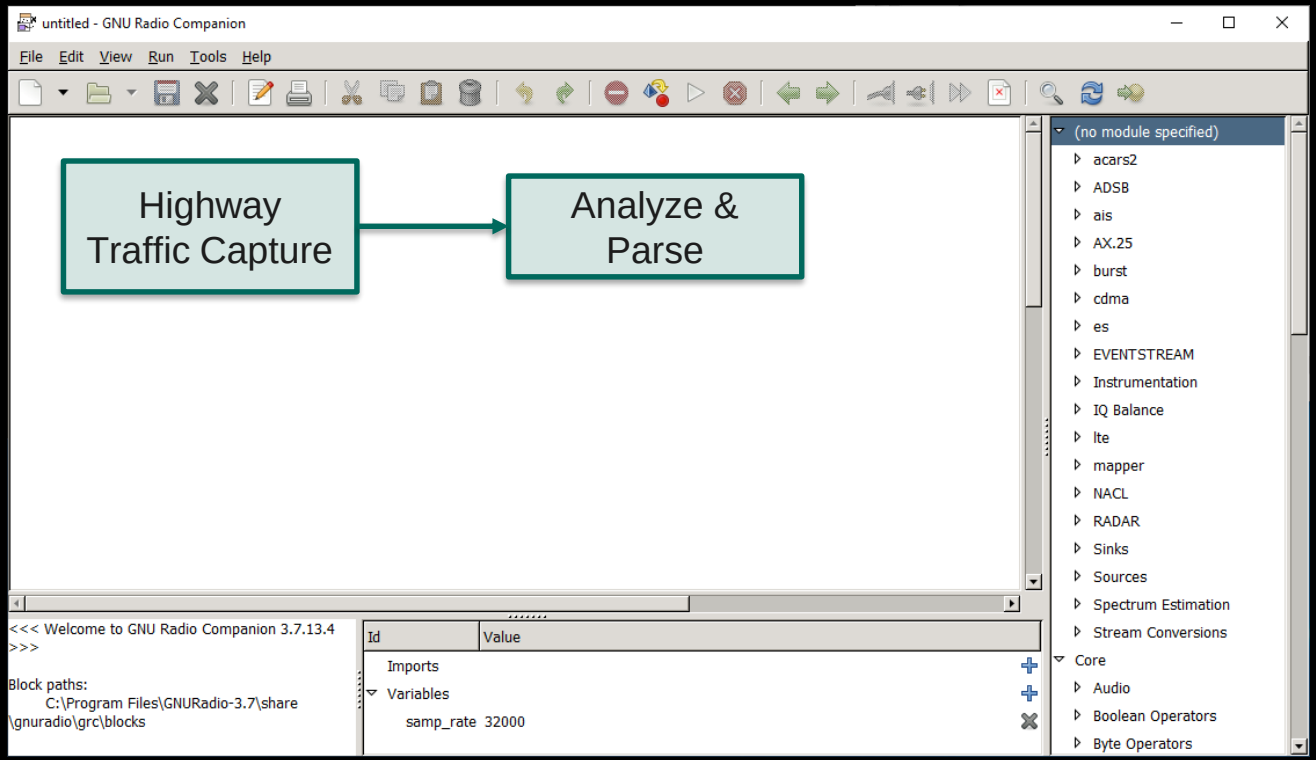
Alexander Arnold _____

Stephanie Piscitelli _____

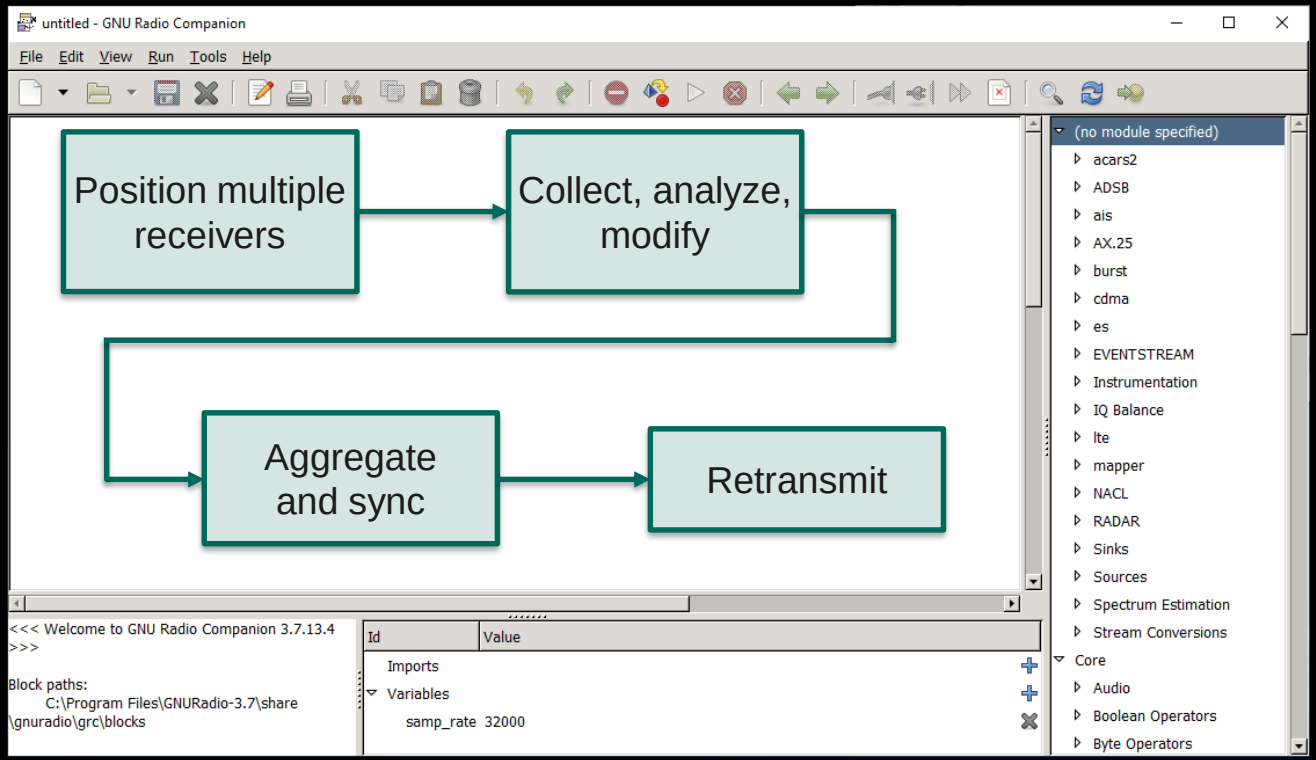
TIRE PRESSURE SENSOR - MQP AW1 - CAR1

March 16, 2015 - September 11, 2015

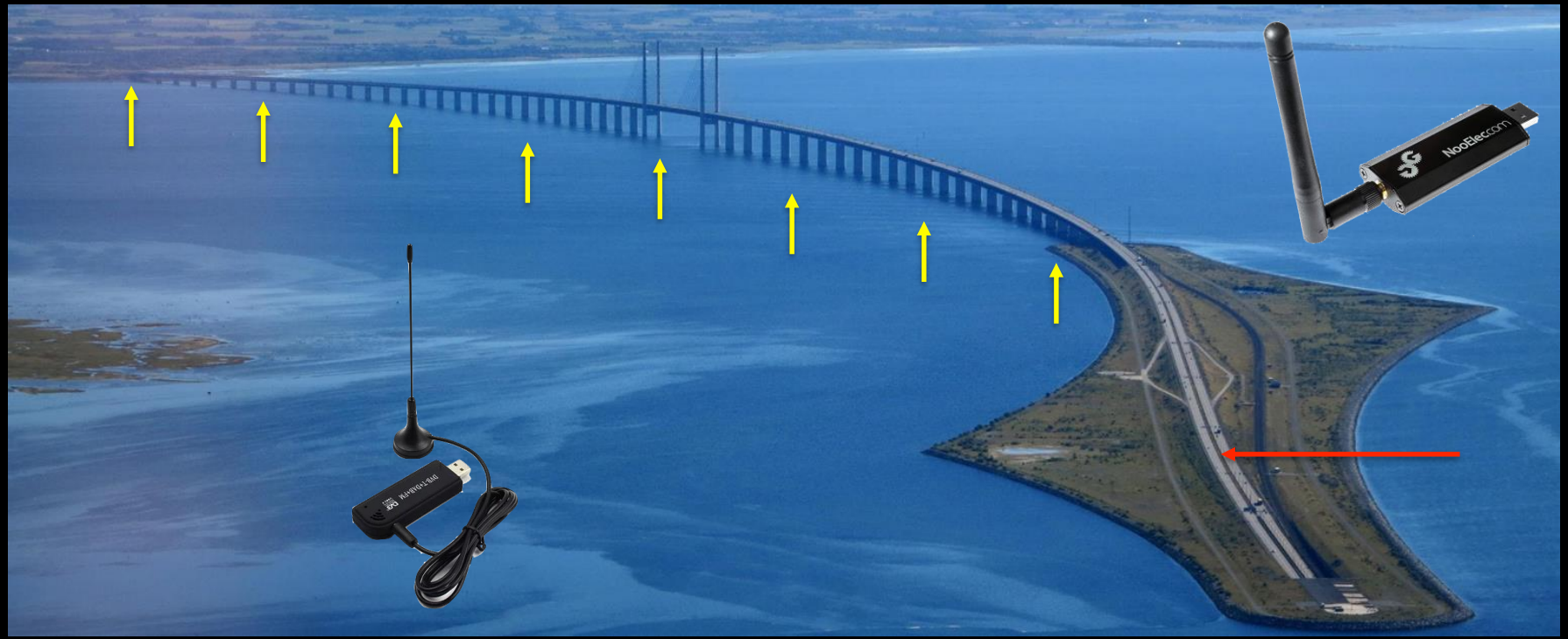
The Plan: Scaling Up



The Plan: Scaled Up

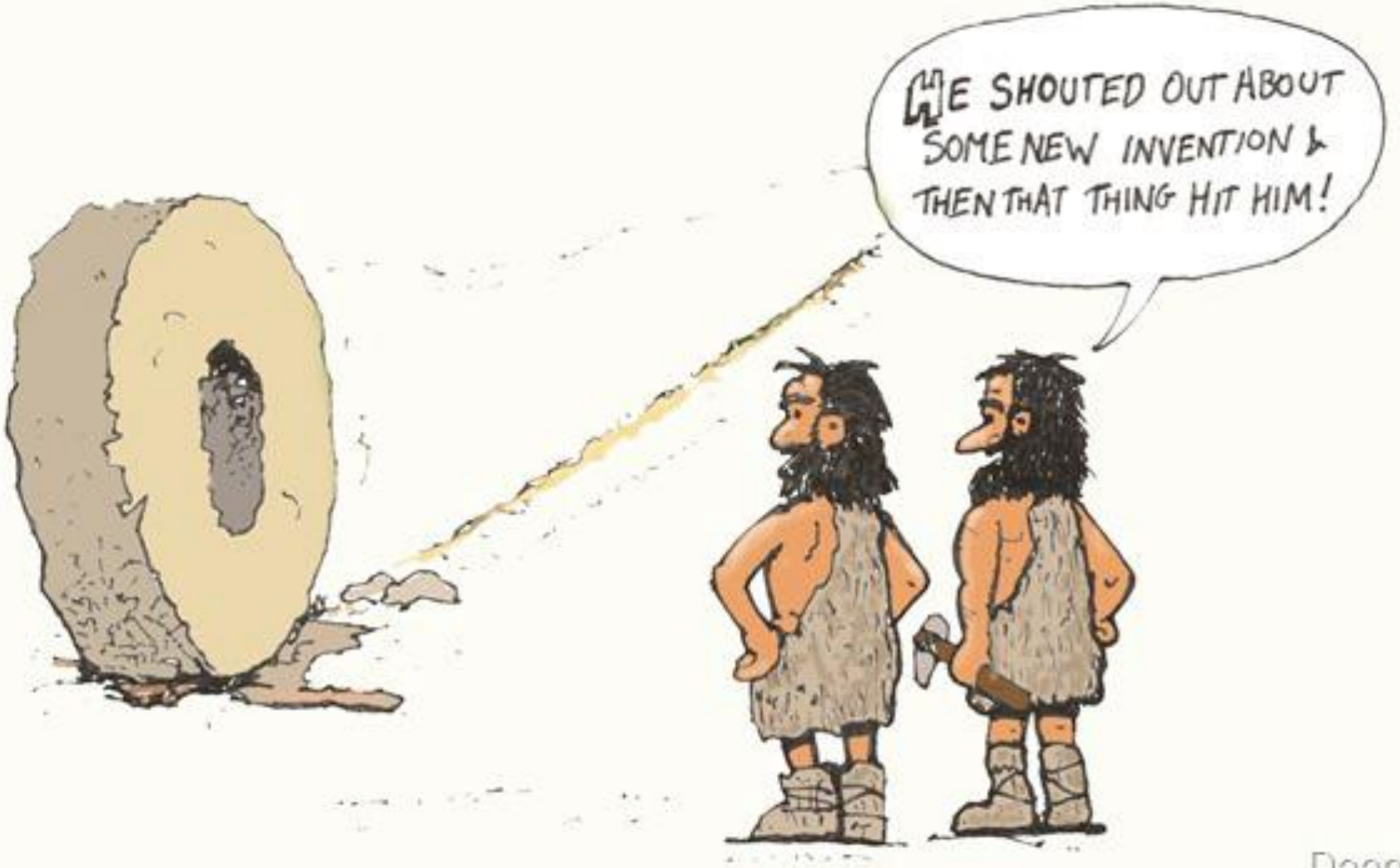


Attack scenario



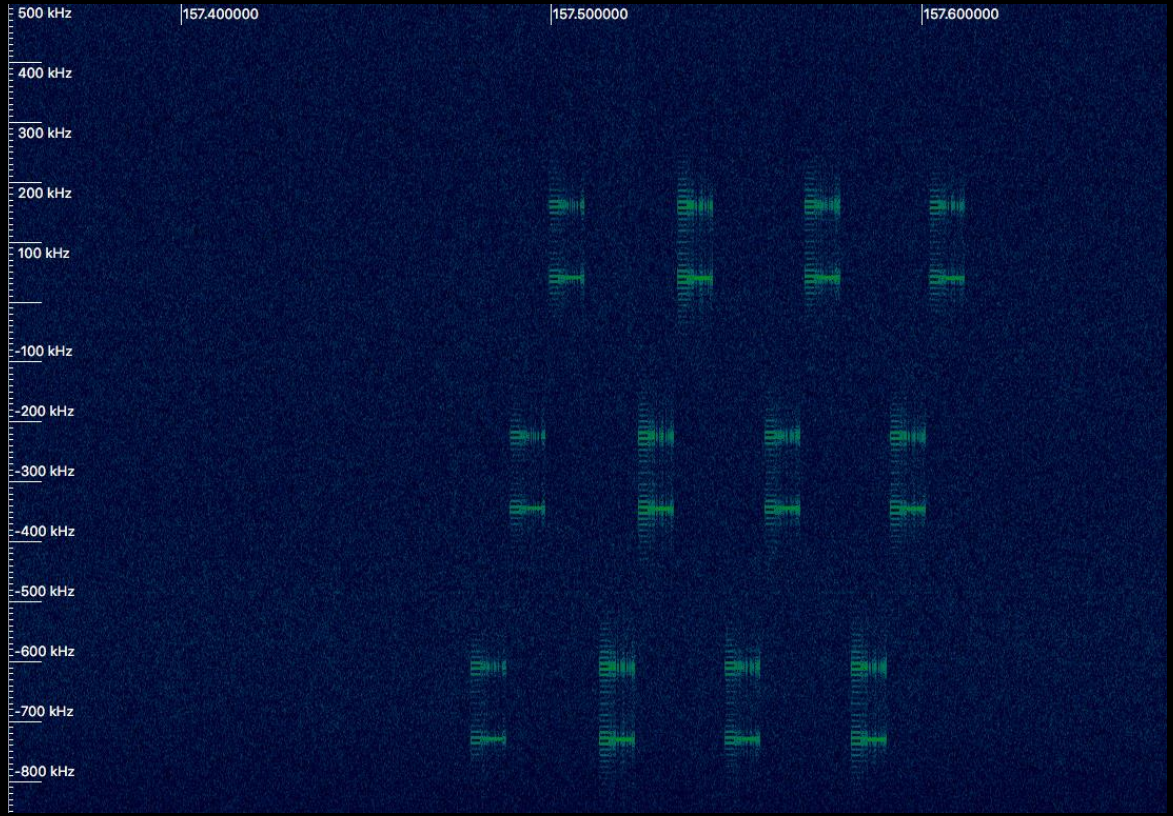
Status Report


LEARN

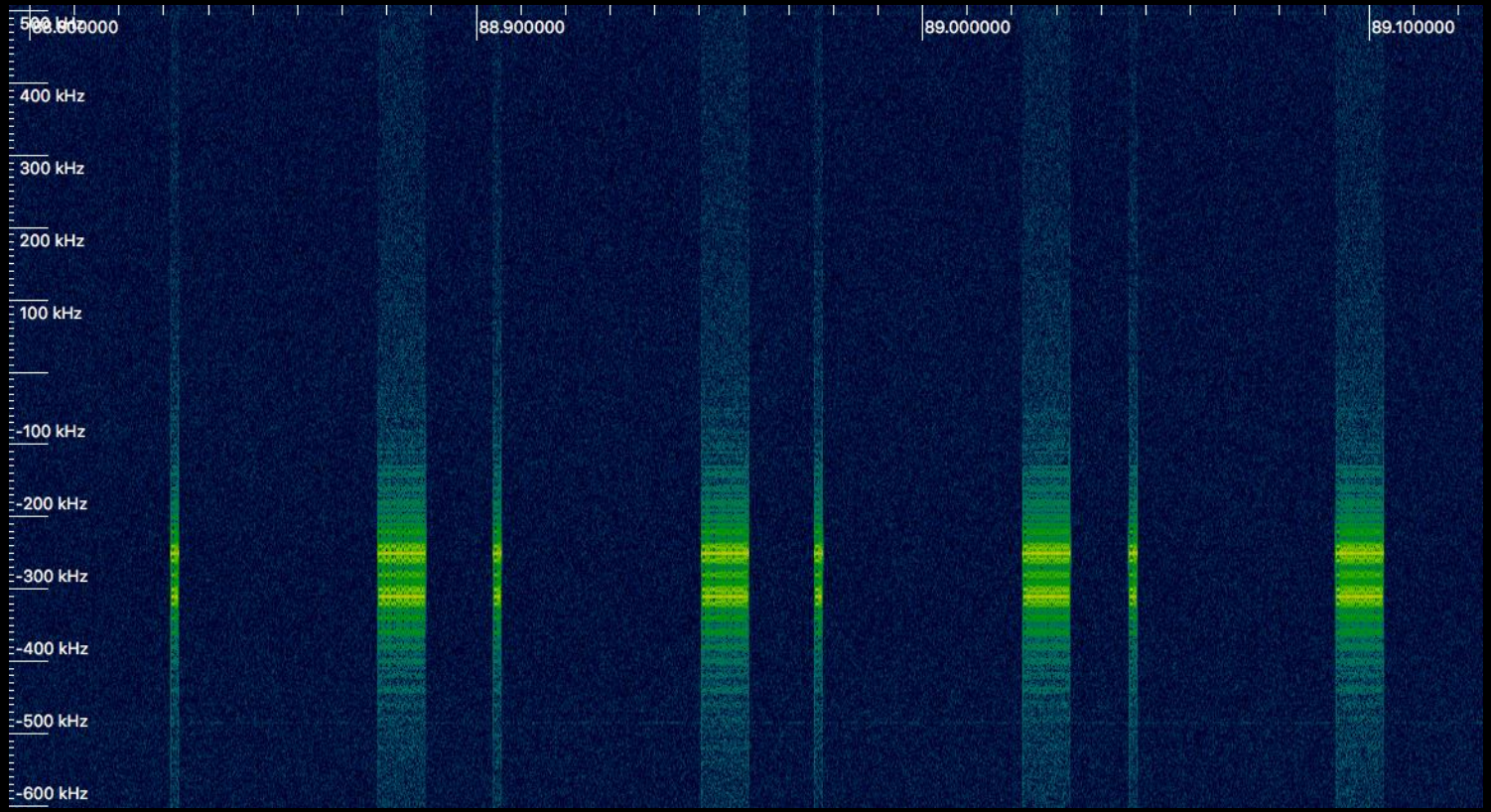

WE SHOUTED OUT ABOUT SOME NEW INVENTION & THEN THAT THING HIT HIM!

Things We've Learned

Look For The Signal! Is That It?



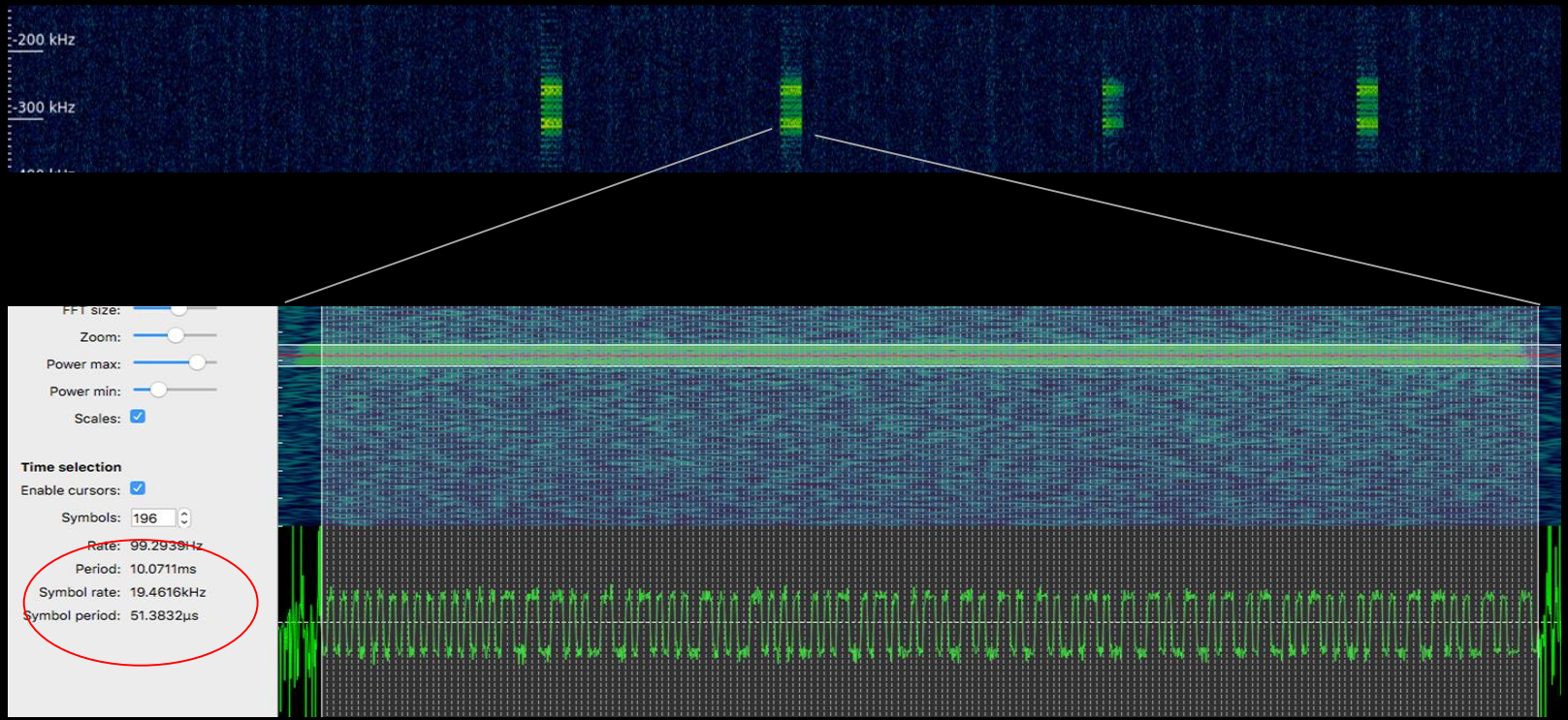
Perhaps This One?



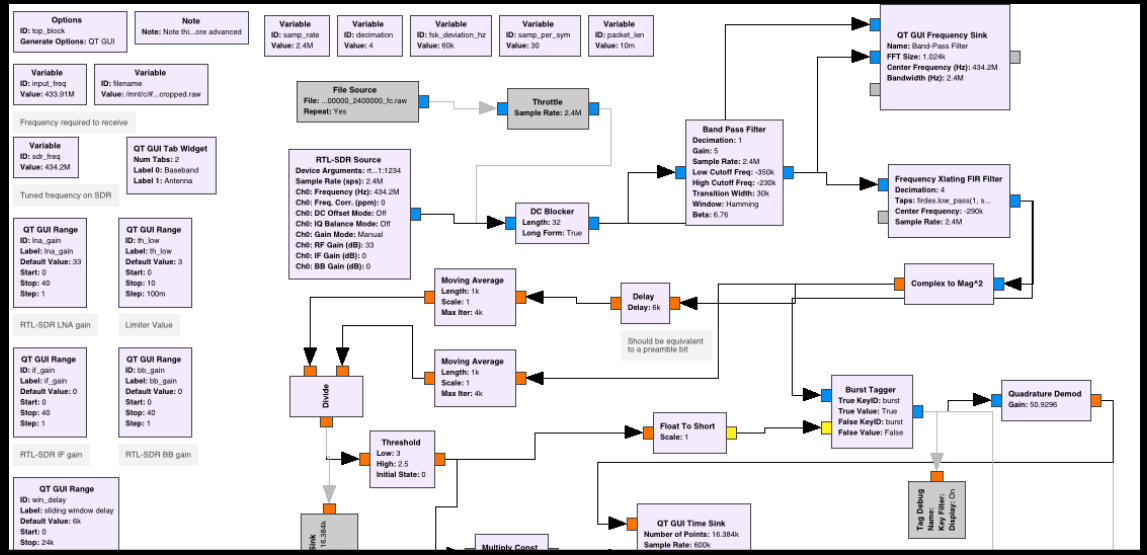
Hard To Get a Good Signal. Wonder Why...

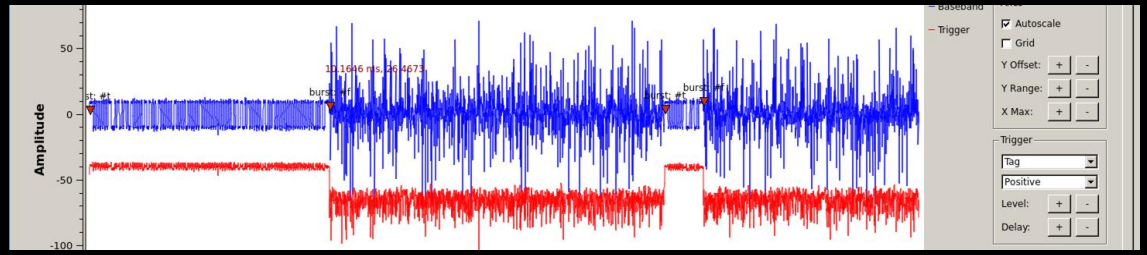
Find the target (like, physically)

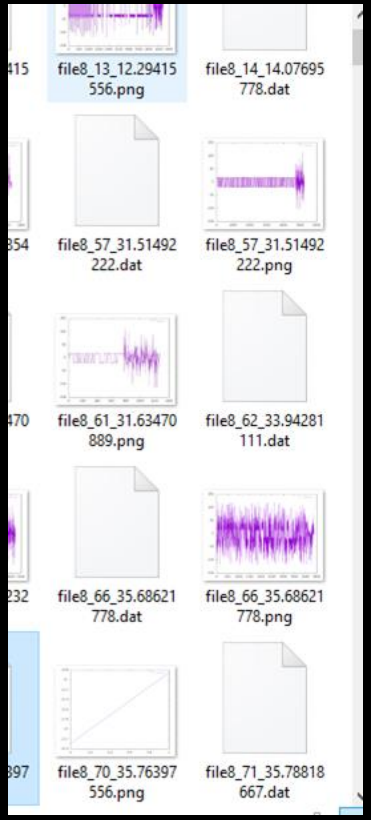
There it is!


-200 kHz
-300 kHz
FFT size:
Zoom:
Power max:
Power min:
Scales:
Time selection
Enable cursors:
Symbols: 196
Rate: 99.2939Hz
Period: 10.0711ms
Symbol rate: 19.4616kHz
Symbol period: 51.3832µs

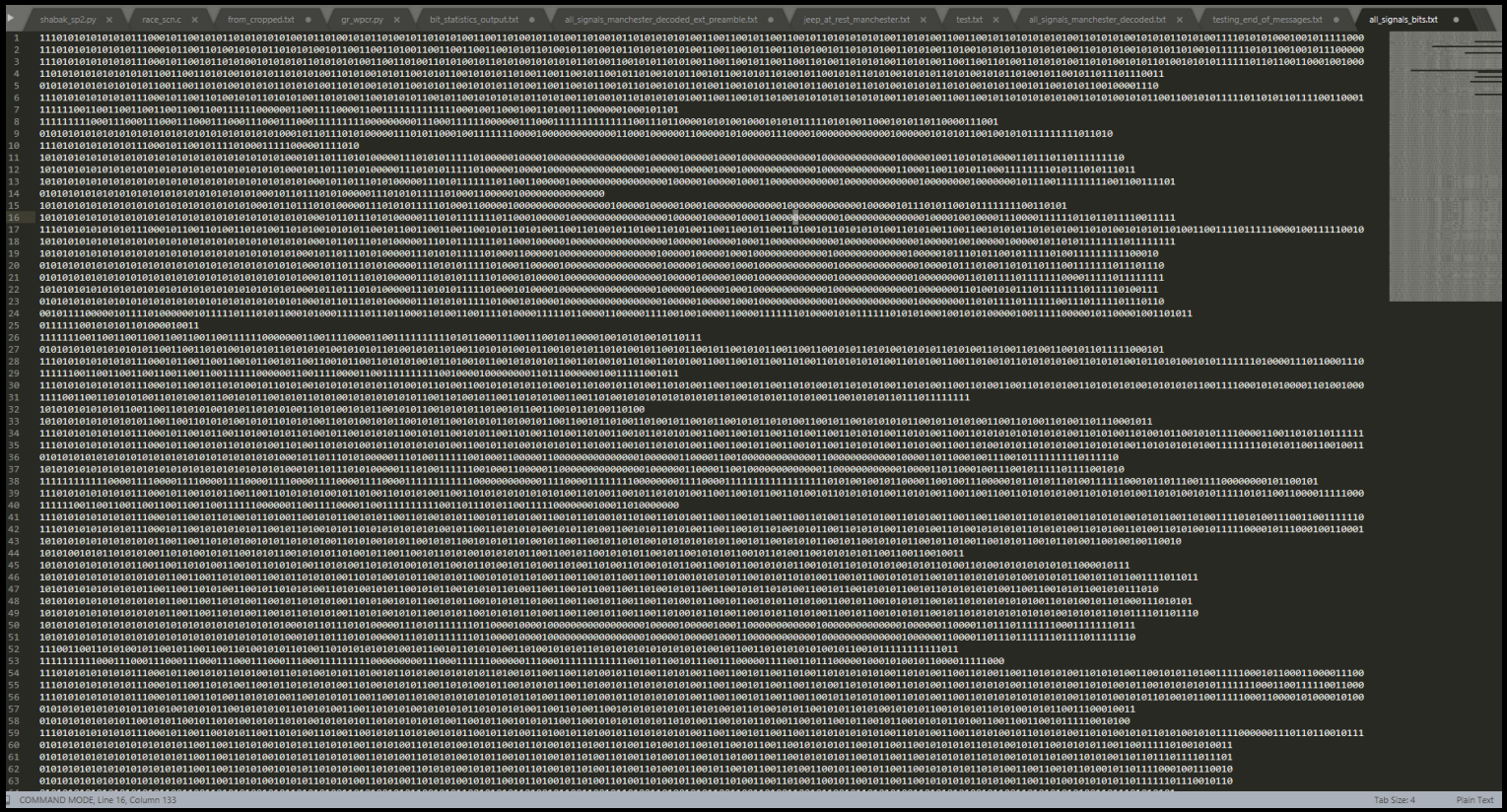
Collect multiple packets for analysis





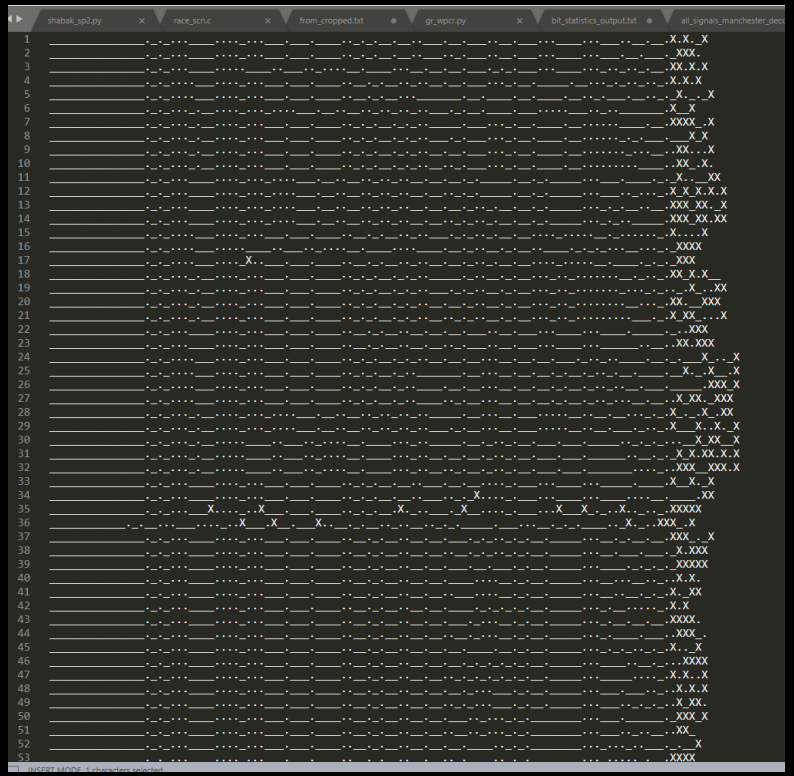


Losing Yourself



Packet Analysis

- Statistical analysis == a lot of packets
- Manchester encoded helps:
  - Identifying when a packet is “over”
  - Throw away corrupted packets
- Enumerate on ID options (i.e possible lengths of ID field and CRC fields)



Packet Statistical Analysis

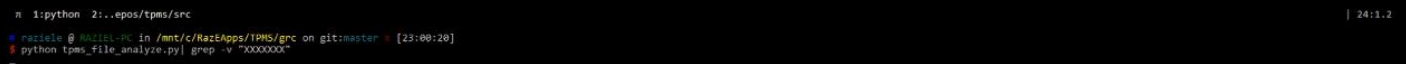
Find Tire ID

```
$ ./find_device_id.sh /mnt/c/\#_Record_Files/tpms_records/all_signals_manchester_decoded_ext_preamble.txt 32 96
Range 24:56
 c1e721bc   3253150140 11000001111001110010000110111100:   5 *****
 c221d992   3256998290 11000010001000011101100110010010:  13 *************
 c23bbcad   3258694829 11000010001110111011110010101101:  23 ************************
 c23bbcd6   3258694870 11000010001110111011110011010110:  42 ******************************************
```

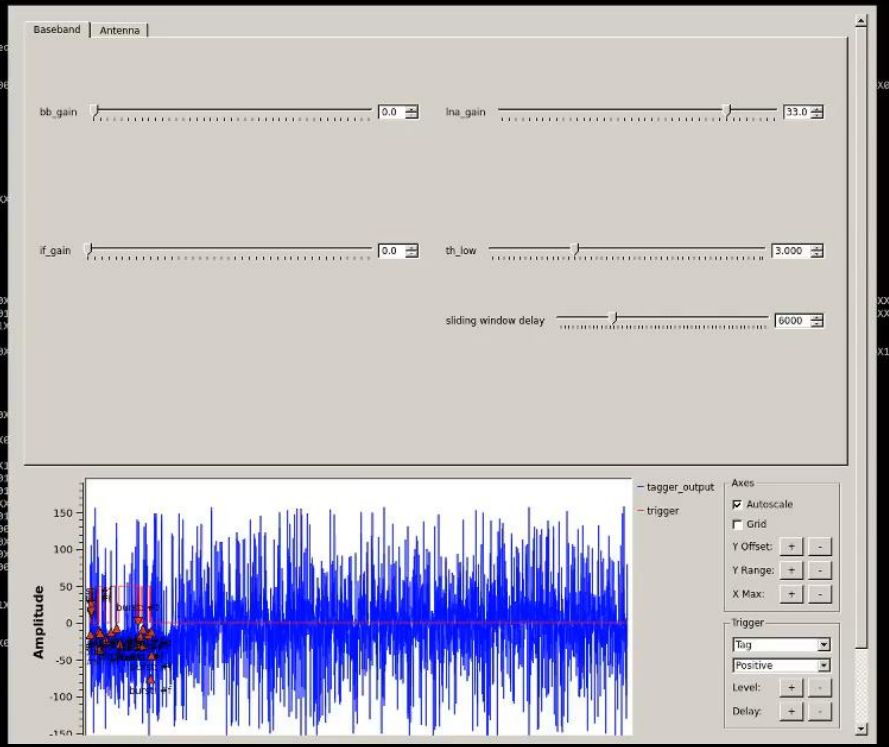
Find CRC Parameters

```
$ cat /mnt/c/ExClonRepos/bruteforce-crc/out.txt
Polynomial, Initial, Final XOR, Reflected Input, Reflected Output
0x7,0xcb,0x0,false,false
```

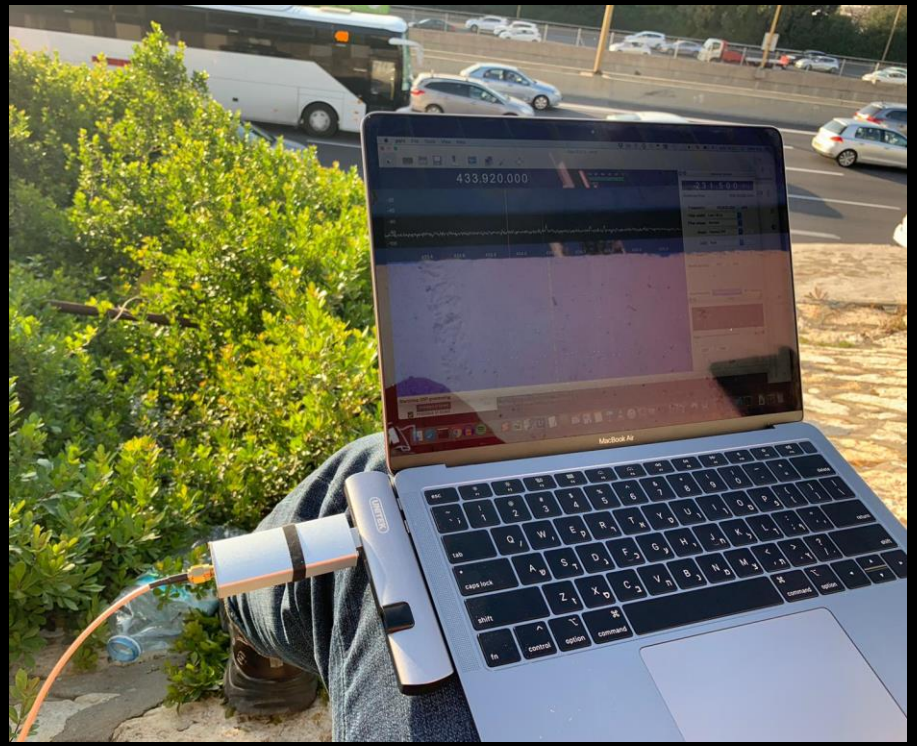
Improving Our Setup: Receiving Multiple Packets



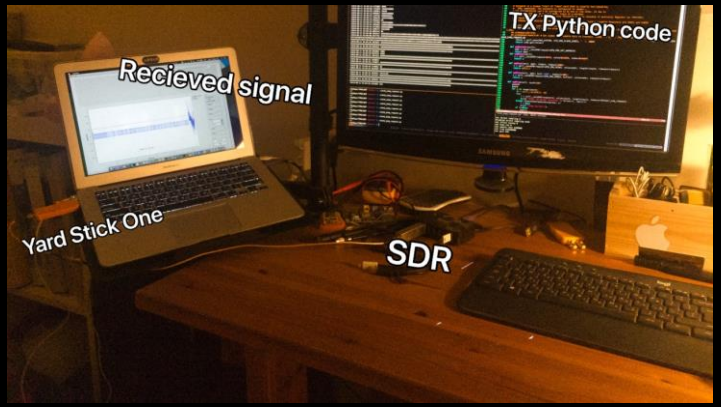
Less Smooth In Real Life...



Theory Vs. Reality



Spoofing The Signal



Don’t underestimate the value of a lab bench setup…

Experimenting with the transmitter setup

Experimenting with the transmitter setup

Distance measurement results

- Managed to receive TPMS transmissions from highway shoulders
- Succeeded in spoofing a vehicle from > 30 meters (approx. 6 lanes!)
- Succeeded stripping a TPMS transmission, rebuilding it and spoofing the vehicle

Backend setup

- Multiple field-deployed Raspberry-Pi devices, with a receiving SDR and an Internet connection
- All devices send the collected data to the processing station
- Implementation used a simple VPN – completely scalable setup

What’s Next?

Challenges

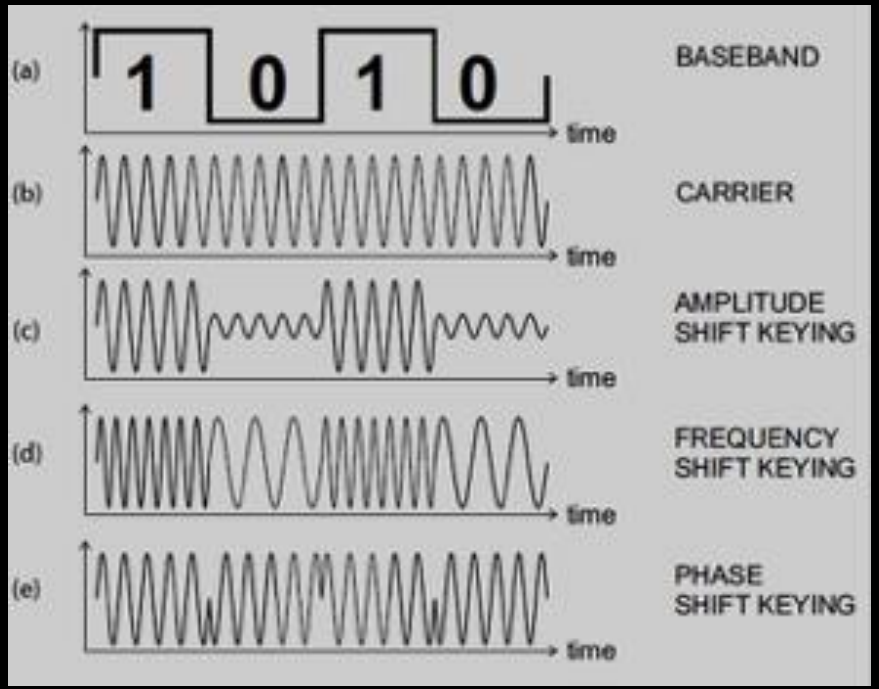


Image: ResearchGate/Harpreet Kaur Channi

- Multiple modulation and encoding methods

Challenges

- Multiple modulation and encoding methods
- Multiple vendors and packet formats

Challenges

- Multiple modulation and encoding methods
- Multiple vendors and packet formats
- Signal synchronization

Mitigation

Mitigation

- Encrypt the transmission

Mitigation

- Encrypt the transmission
- Polling-only operation

Mitigation

- Encrypt the transmission
- Polling-only operation
- Correlate with other sensors

But the easiest and most important mitigation...


Keep your
eyes on the road
...LIVES DEPEND ON IT

An Important Message

It’s doable

Where there’s a way There’s malice

Richard Pietravalle

Scale Matters

Is also a step forward!

Thank you!
Questions?

ARGUS
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