UAVing a laugh!?

Richard Baker
14th Feb 2018

OLMAR
CO

3rd Year DPhil

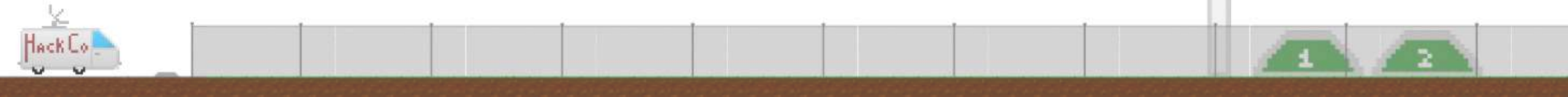
Systems Security Lab

Centre for Doctoral Training in Cybersecurity

~~*"Drone detection"*~~

Side-channel attacks

“Drones”



"Drone" : Completely automatic, dumb craft

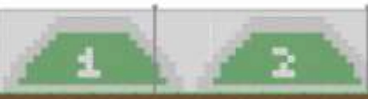
"RC aircraft" : Entirely dependent on remote pilot

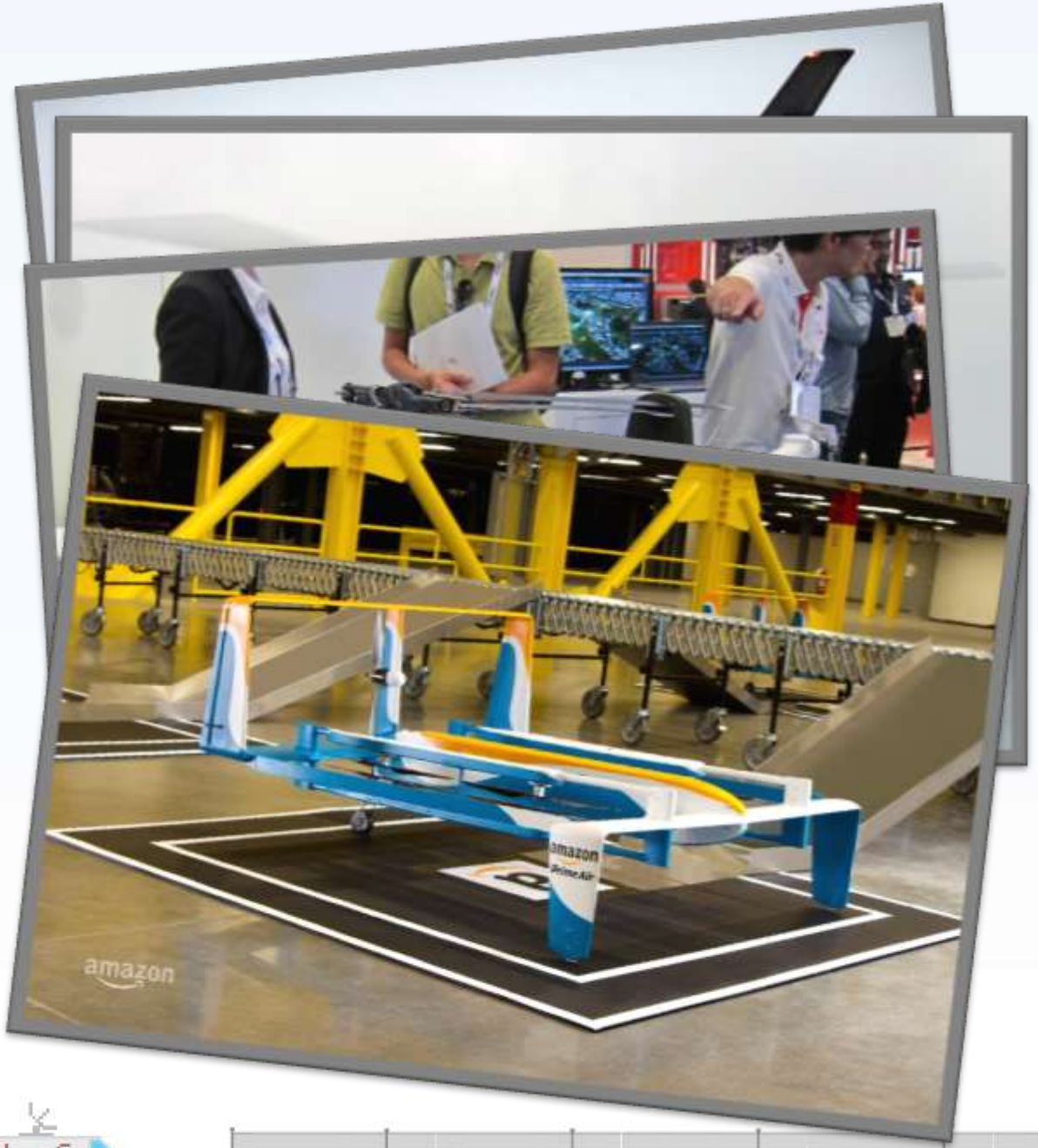
"RPAS" : Remotely-Piloted Aerial System

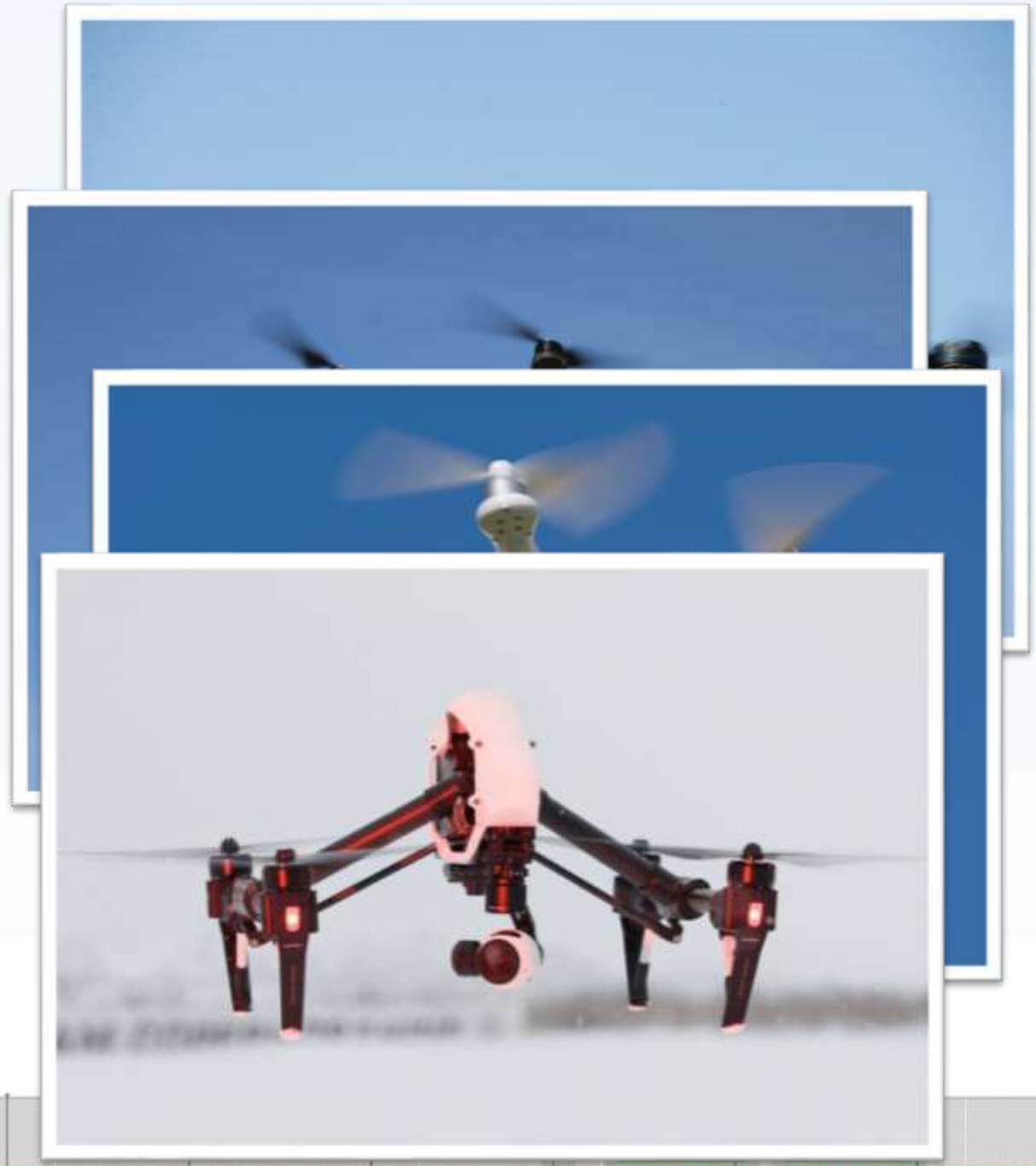
"UAV" : Unmanned Aerial Vehicle

"UAS" : Unmanned Aerial System

"UAV" (again) : Unmanned Autonomous Vehicle

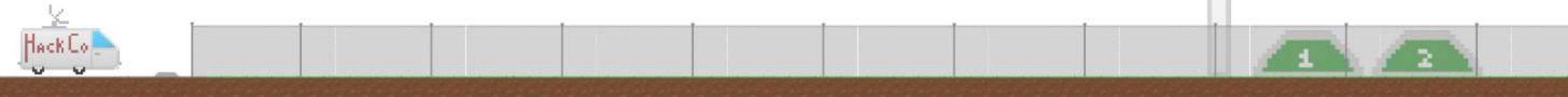



amazon




Lithium-Polymer battery
Uplink/Downlink
– Control, telemetry and video
– Proprietary format (ISM band)
– Wi-Fi
– Bluetooth
– XBee
GPS
Gyro & Accelerometer
Four arms
– 4, 6, 8 (or even 3)
– Weight vs. stability vs. wind profile
Flight controller
– Motor control
– Stability management
– Position holding
– Waypoint following
– Special features
Eight motors
– Direct drive
Eight rotors
– Some reversed
X8+

Uses




Here we are

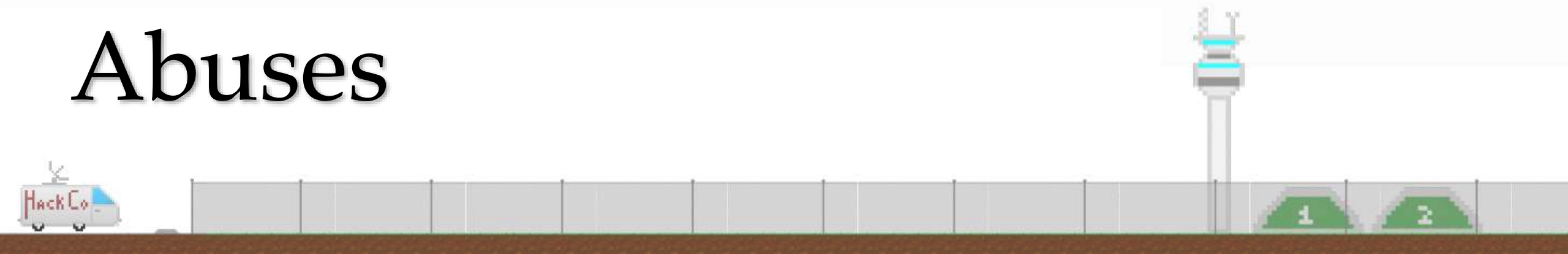

QUARTZ


AERO-M

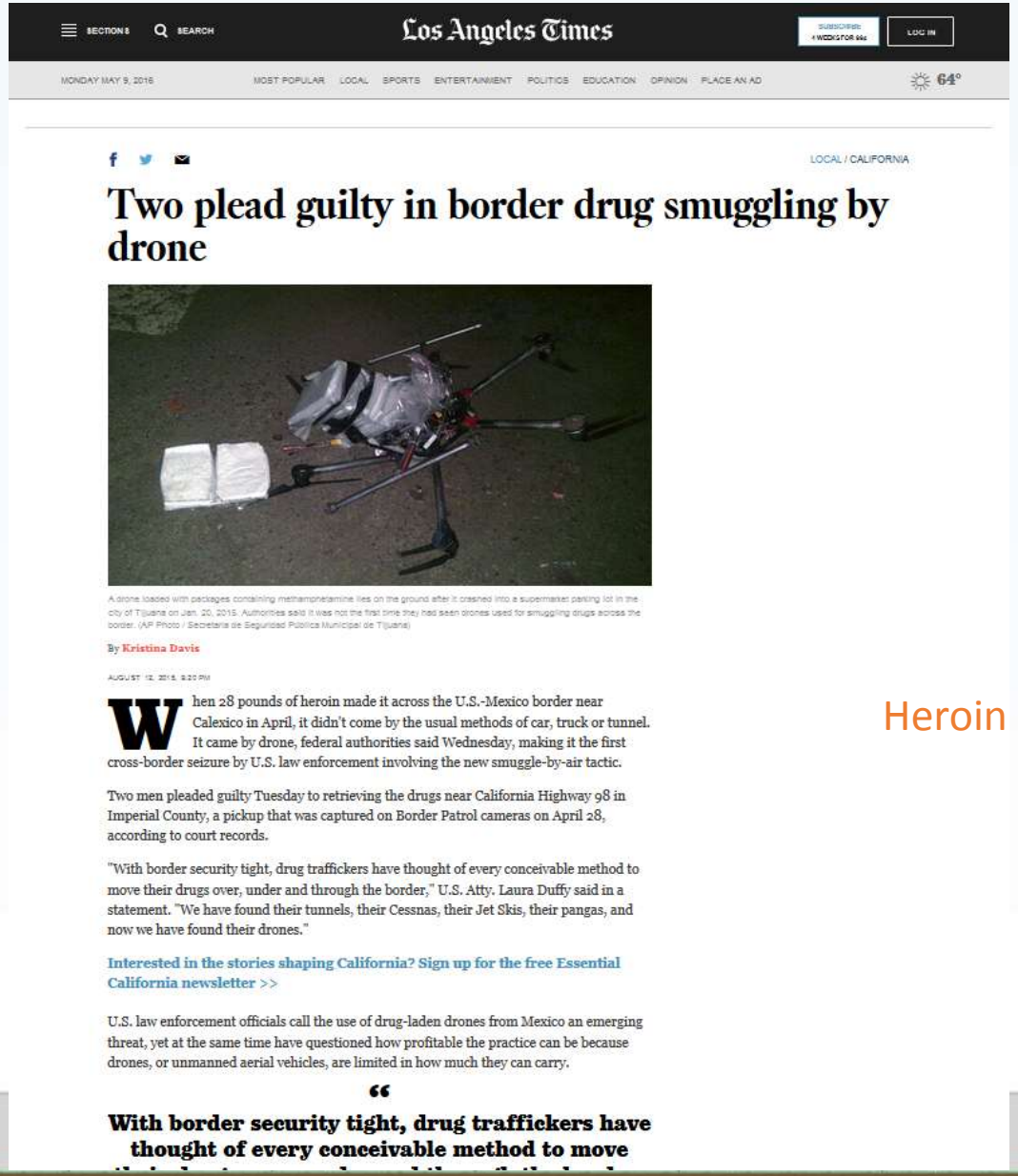

Maker Faire




Abuses



Smuggle drugs



Los Angeles Times

LOCAL / CALIFORNIA

Two plead guilty in border drug smuggling by drone

A drone loaded with packages containing methamphetamine lies on the ground after it crashed into a supermarket parking lot in the city of Tijuana on Jan. 20, 2015. Authorities said it was not the first time they had seen drones used for smuggling drugs across the border. (AP Photo / Secretaría de Seguridad Pública Municipal de Tijuana)

By Kristina Davis

When 28 pounds of heroin made it across the U.S.-Mexico border near Calexico in April, it didn't come by the usual methods of car, truck or tunnel. It came by drone, federal authorities said Wednesday, making it the first cross-border seizure by U.S. law enforcement involving the new smuggle-by-air tactic.

Two men pleaded guilty Tuesday to retrieving the drugs near California Highway 98 in Imperial County, a pickup that was captured on Border Patrol cameras on April 28, according to court records.

"With border security tight, drug traffickers have thought of every conceivable method to move their drugs over, under and through the border," U.S. Atty. Laura Duffy said in a statement. "We have found their tunnels, their Cessnas, their Jet Skis, their pangas, and now we have found their drones."

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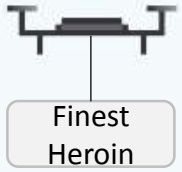
U.S. law enforcement officials call the use of drug-laden drones from Mexico an emerging threat, yet at the same time have questioned how profitable the practice can be because drones, or unmanned aerial vehicles, are limited in how much they can carry.

With border security tight, drug traffickers have thought of every conceivable method to move

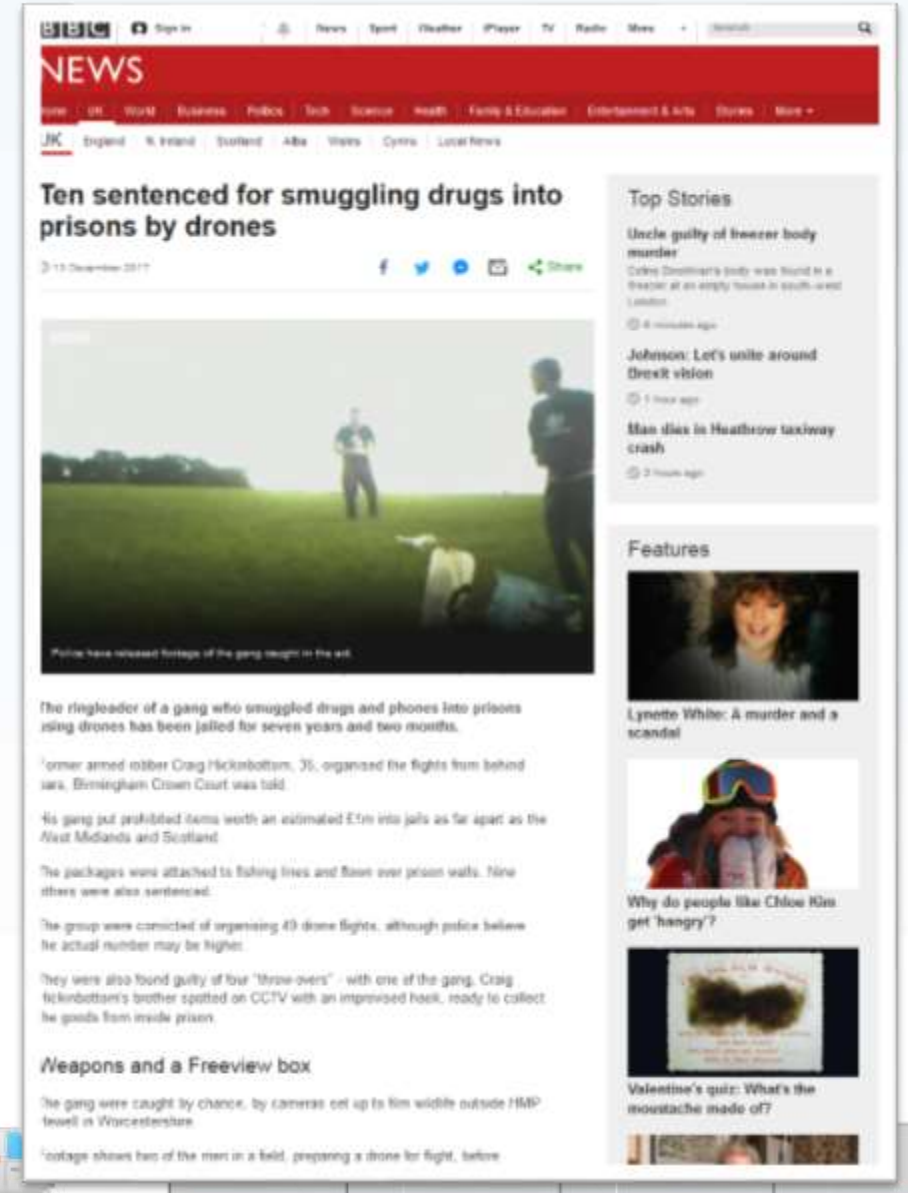


28 pounds (12.7kg)

So a big drone, circa £2500

Heroin worth around £665,000

Prison delivery


BBC

NEWS

UK

Ten sentenced for smuggling drugs into prisons by drones

Top Stories

Uncle guilty of freezer body murder

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Features

Lynette White: A murder and a scandal

Why do people like Chloe Kim get 'hangry'?

Valentine's quiz: What's the moustache made of?

The ringleader of a gang who smuggled drugs and phones into prisons using drones has been jailed for seven years and two months.

Former armed robber Craig Hickinbottom, 35, organised the flights from behind bars, Birmingham Crown Court was told.

His gang put prohibited items worth an estimated £1m into jails as far apart as the West Midlands and Scotland.

The packages were attached to fishing lines and flown over prison walls. Nine others were also sentenced.

The group were convicted of organising 49 drone flights, although police believe the actual number may be higher.

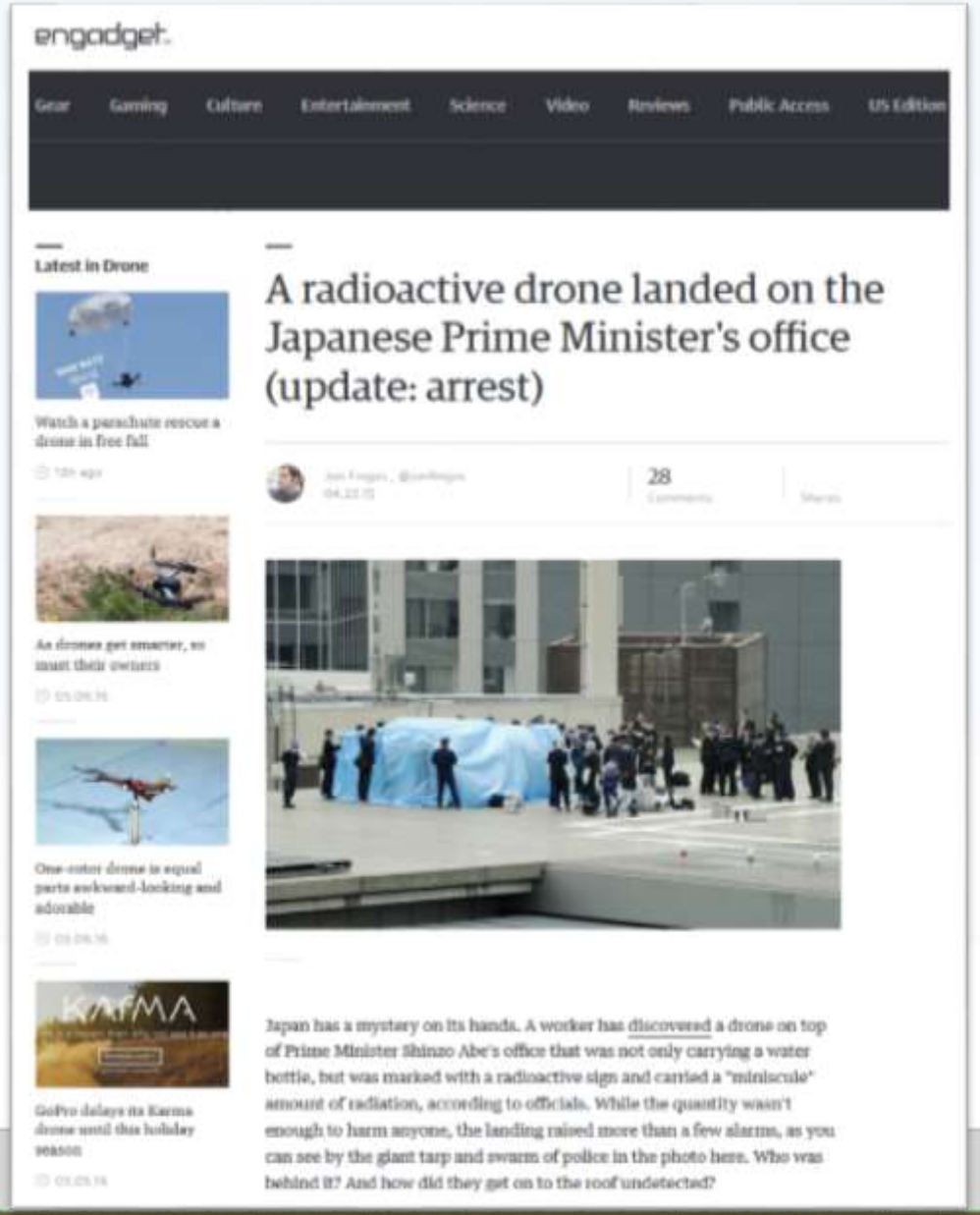
They were also found guilty of four "throw-overs" - with one of the gang, Craig Hickinbottom's brother spotted on CCTV with an improvised hook, ready to collect the goods from inside prison.

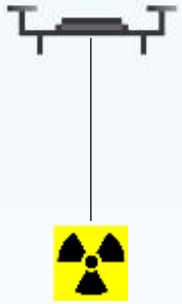
Weapons and a Freeview box

The gang were caught by chance, by cameras set up to film wildlife outside HMP Hewell in Worcestershire.

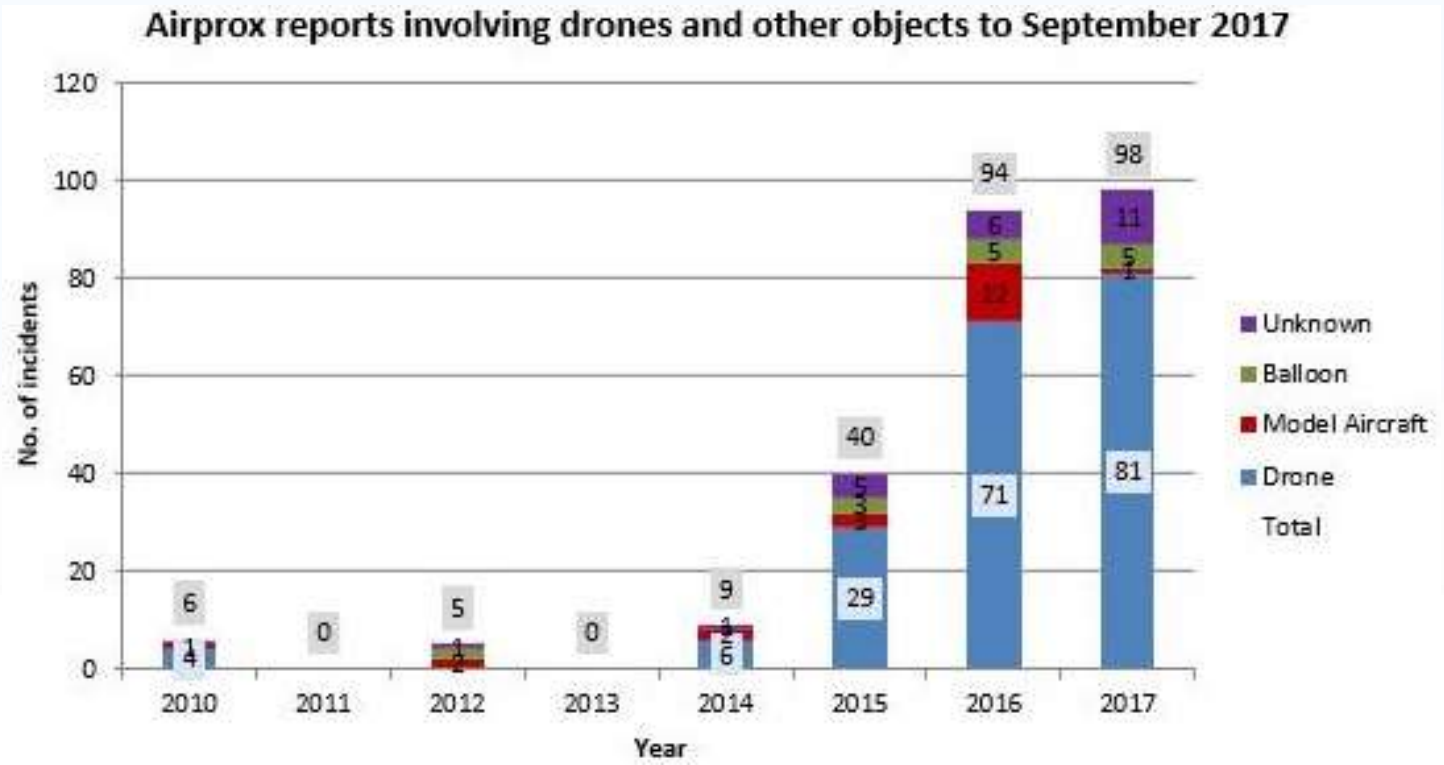
Footage shows two of the men in a field, preparing a drone for flight, before

Make a statement

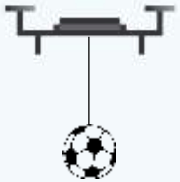




See a plane up close



Watch the football



Watch a film

GIZMODO

The Next *Star Wars* Movie Has Recruited a Team of Drones to Protect Its Secrets

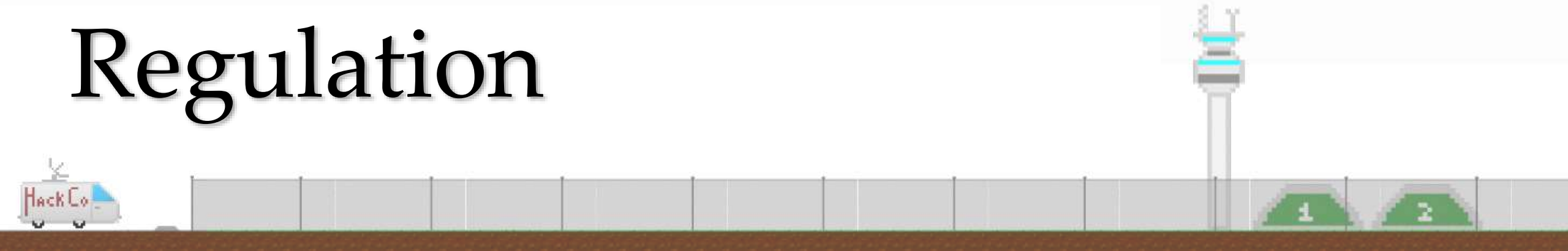
Accessible drone technology is creating a bizarre future in the world of movie making. In 2014, pictures taken by drones of filming for *The Force Awakens* prompted the production team to consider buying an anti-drone "shield" to protect secrets. For *Episode VIII*, they're deploying drones of their own to take down rebel scum.

Star Wars Producers Wanted a Fully Operational Drone Defense System

When it comes to spoilers, commenters from all corners of the internet are quick to demonize...

A Croatian website, *MovCroatia* first reported the drone detail in a larger update about *Episode VIII* will be doing some location filming in Dubrovnik, a popular tourist destination in the southern part of the country. Aside from reportedly having *six hundred* guards being deployed on location to try and prevent the public from snapping any sneaky pictures, the skies above filming will be protected by a team of remote-controlled drones that will target anyone attempting to fly a drone of their own over the set

Regulation



Civil Aviation Authority

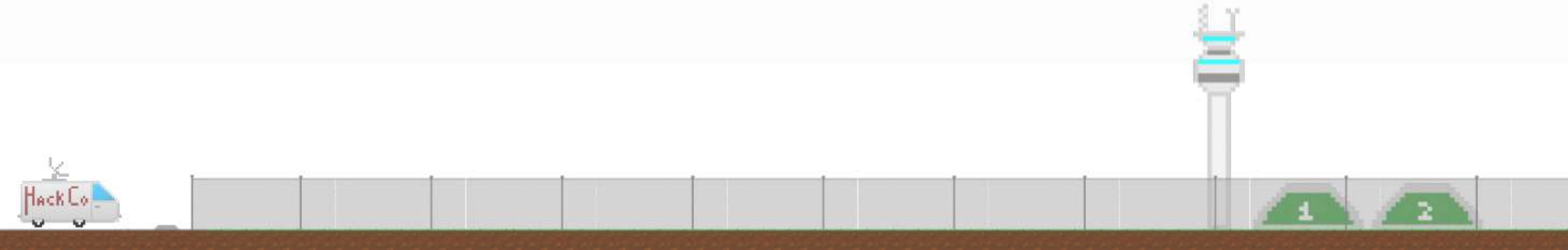
Below 400ft

Within 500m

Line-of-sight

50m away from anyone or anything

http://dronesafe.uk/drone-code

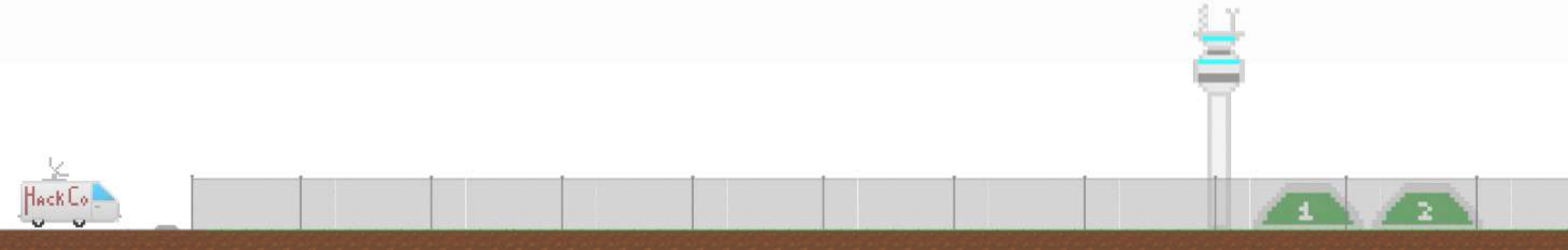


Enforcement

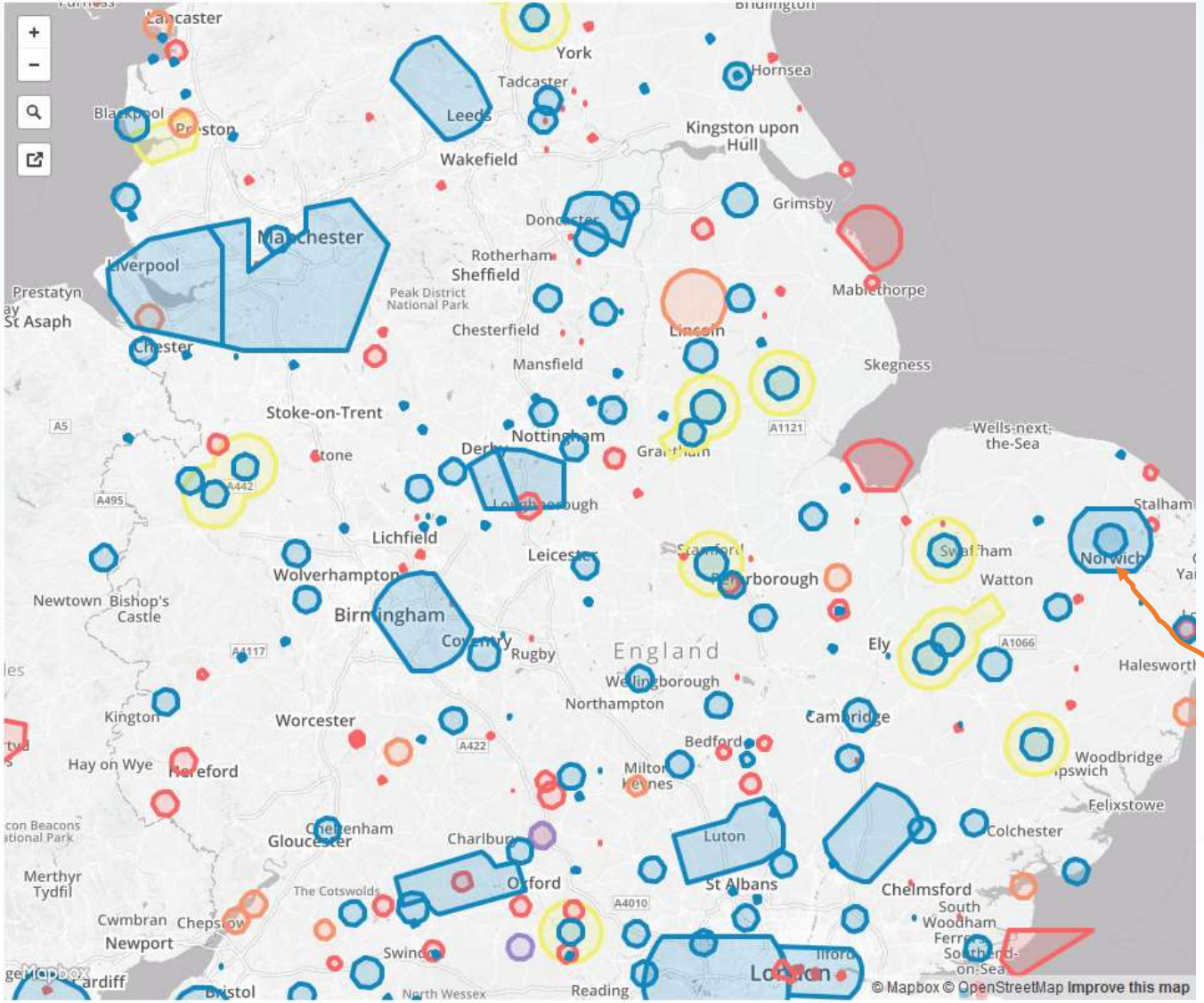
Constant concern for me

Remains post hoc

Little real-time enforcement outside airports or CNI

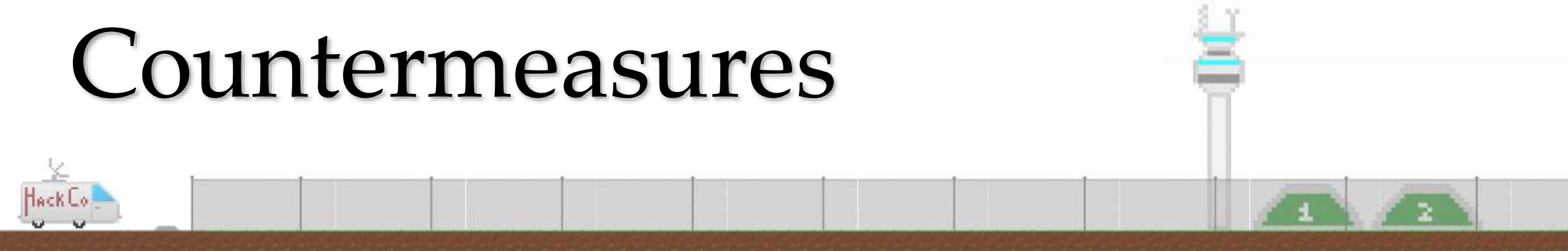


Co-operation



"Geofences"

Countermeasures

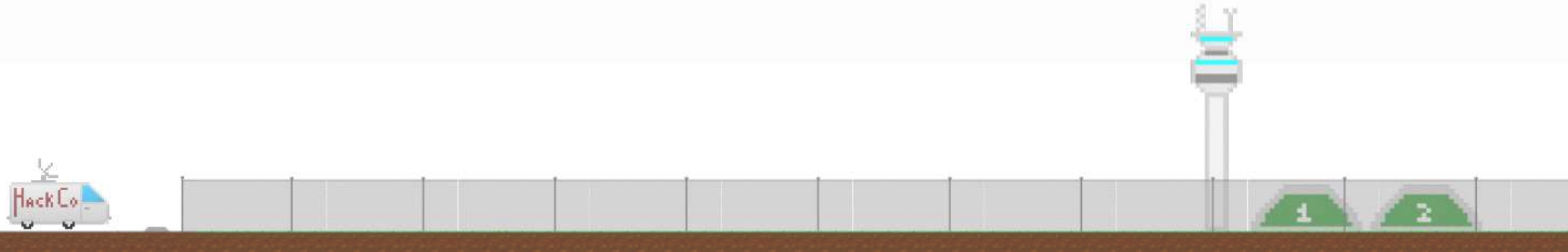


Detection

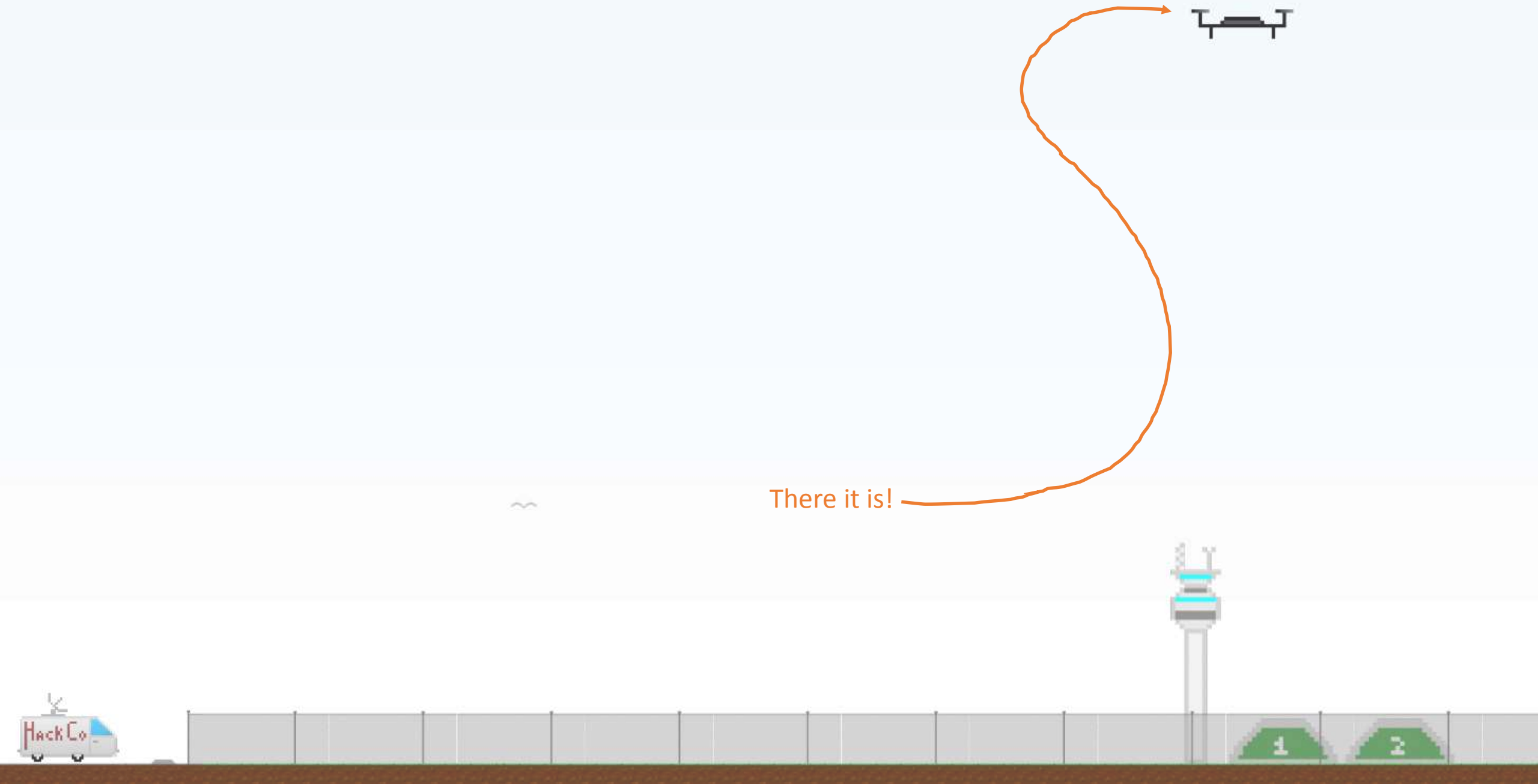
Timeliness

Conditions

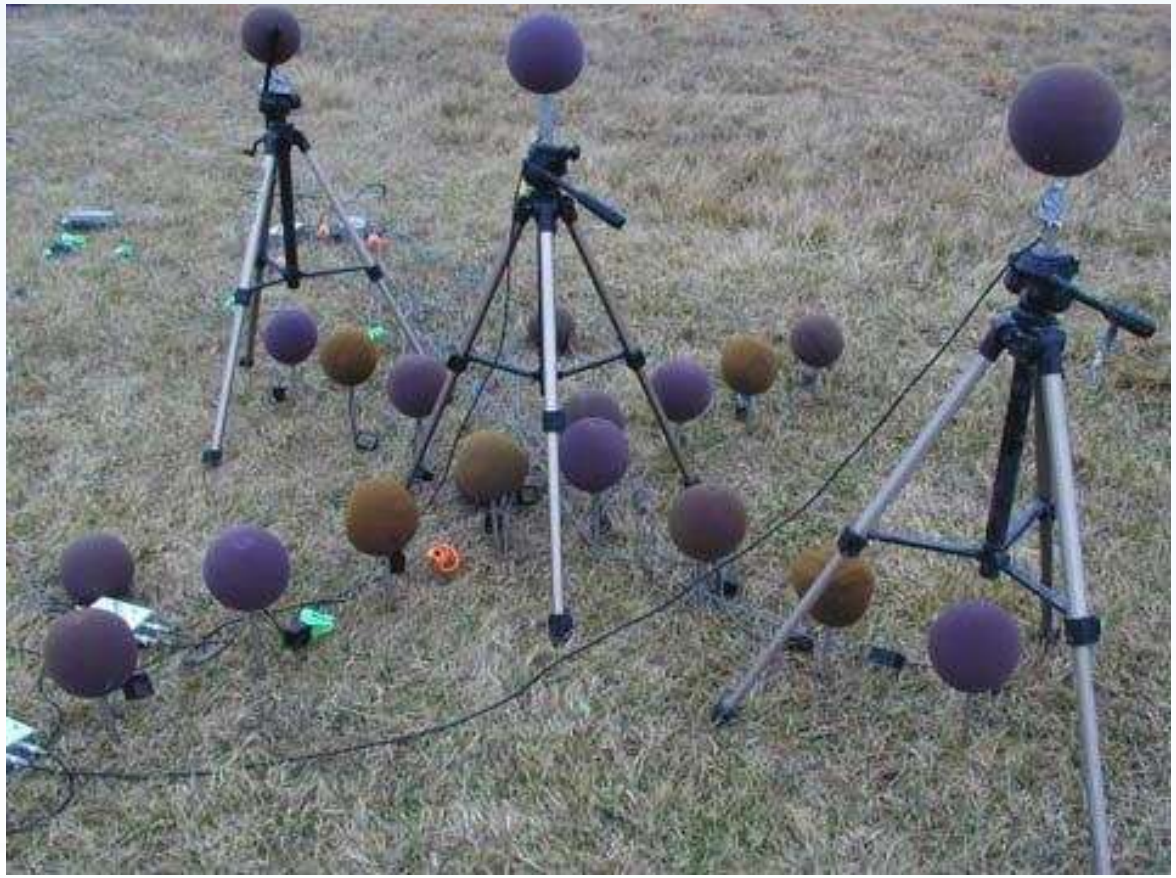
Evidence collection



Manual detection



Acoustic detection



Drones are quite loud

Circa 150m range

Visual detection

Visible light or infra-red

Image processing to tell drones from birds

Limited usefulness at night

Radar detection

Doppler shifts can identify rotorcraft

Active is expensive, usually needs licence

RF detection

Listen to control and telemetry signals

Signal properties identify drone

Standard localisation approaches

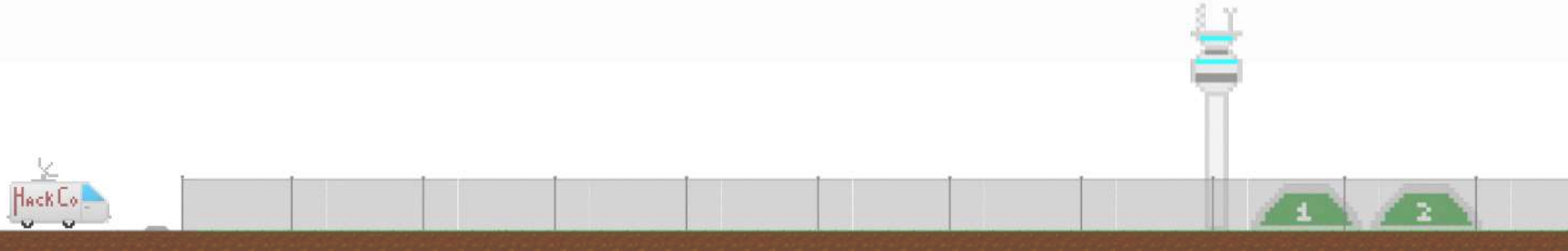
Response

Disable or Destroy or Commandeer

Safety

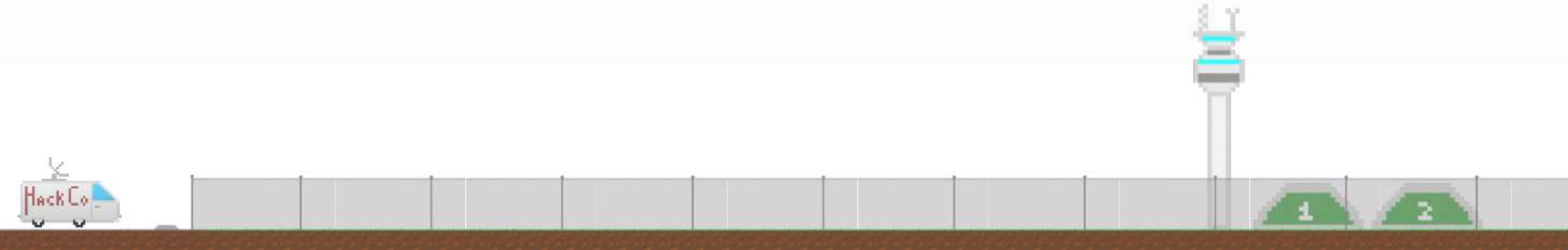
Drone or operator

Immediacy



Shooting

Guns, mostly



Jamming

Uplink/Downlink
- Control, telemetry and video

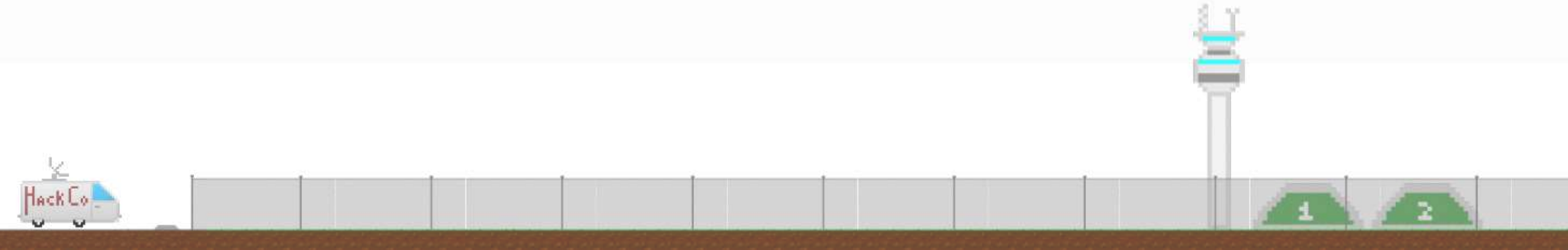
Hacking

Ryan Satterfield – AR.Drone crashed

Michael Robinson – Parrot Bebop crashed

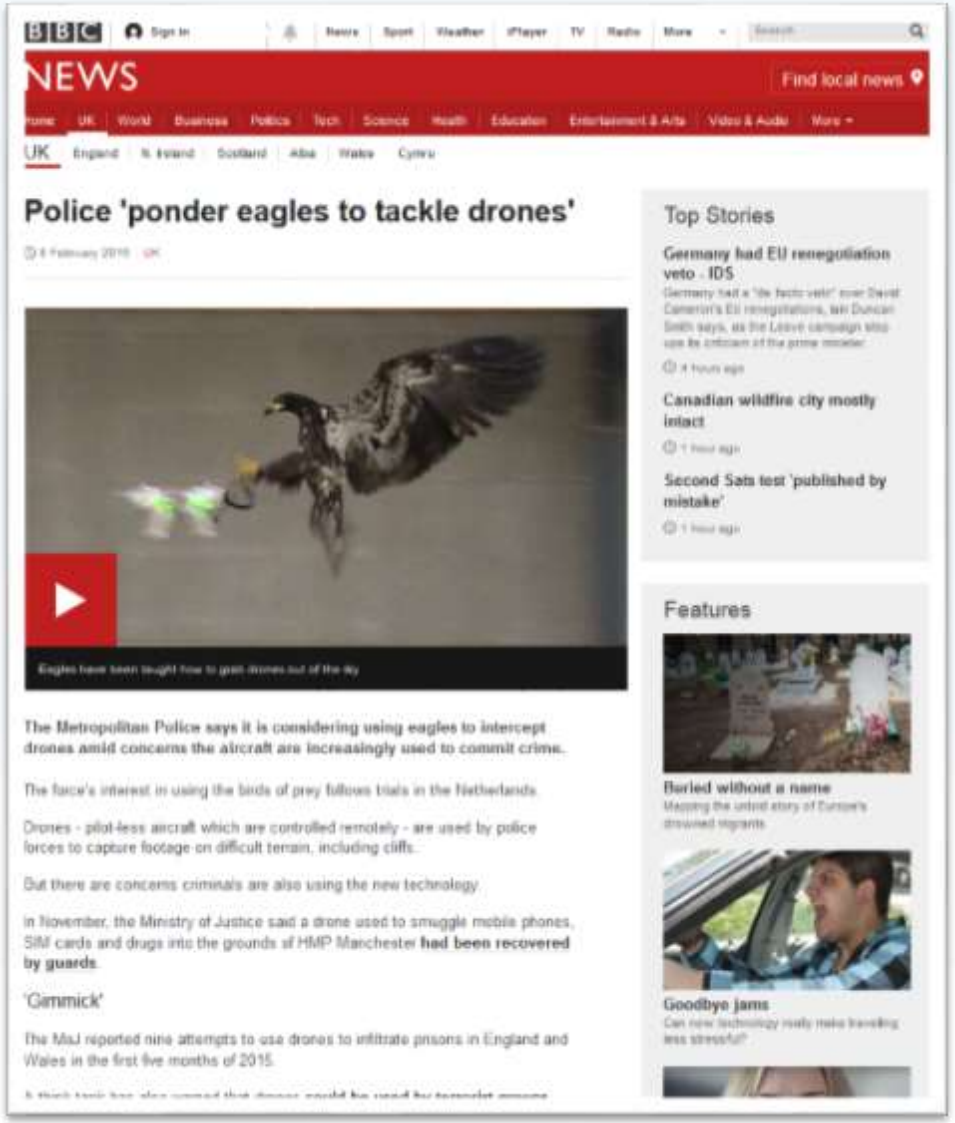
Samy Kamkar – AR.Drone 2.0 zombies

Nils Rodday – $30,000 police drone controlled



Nets

Eagles


BBC
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Police 'ponder eagles to tackle drones'
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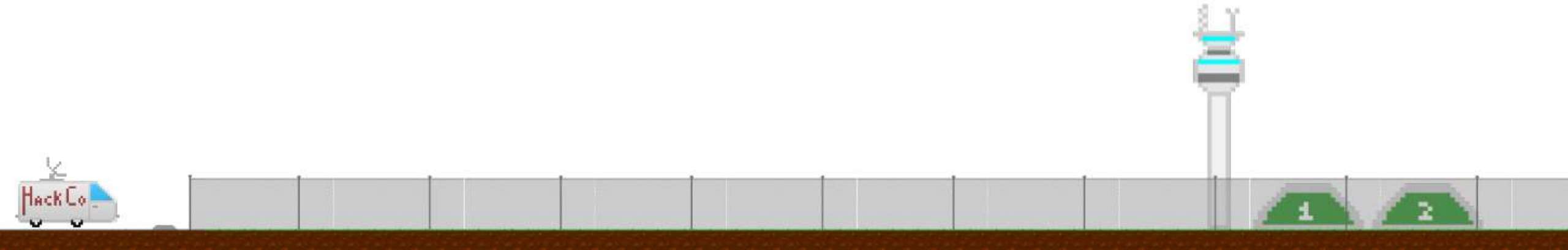
Second Sats test 'published by mistake'
Features
Buried without a name
Goodbye jams
The Metropolitan Police says it is considering using eagles to intercept drones amid concerns the aircraft are increasingly used to commit crime.
The force's interest in using the birds of prey follows trials in the Netherlands.
Drones - pilot-less aircraft which are controlled remotely - are used by police forces to capture footage on difficult terrain, including cliffs.
But there are concerns criminals are also using the new technology.
In November, the Ministry of Justice said a drone used to smuggle mobile phones, SIM cards and drugs into the grounds of HMP Manchester had been recovered by guards.
'Gimmick'
The MoJ reported nine attempts to use drones to infiltrate prisons in England and Wales in the first five months of 2015.

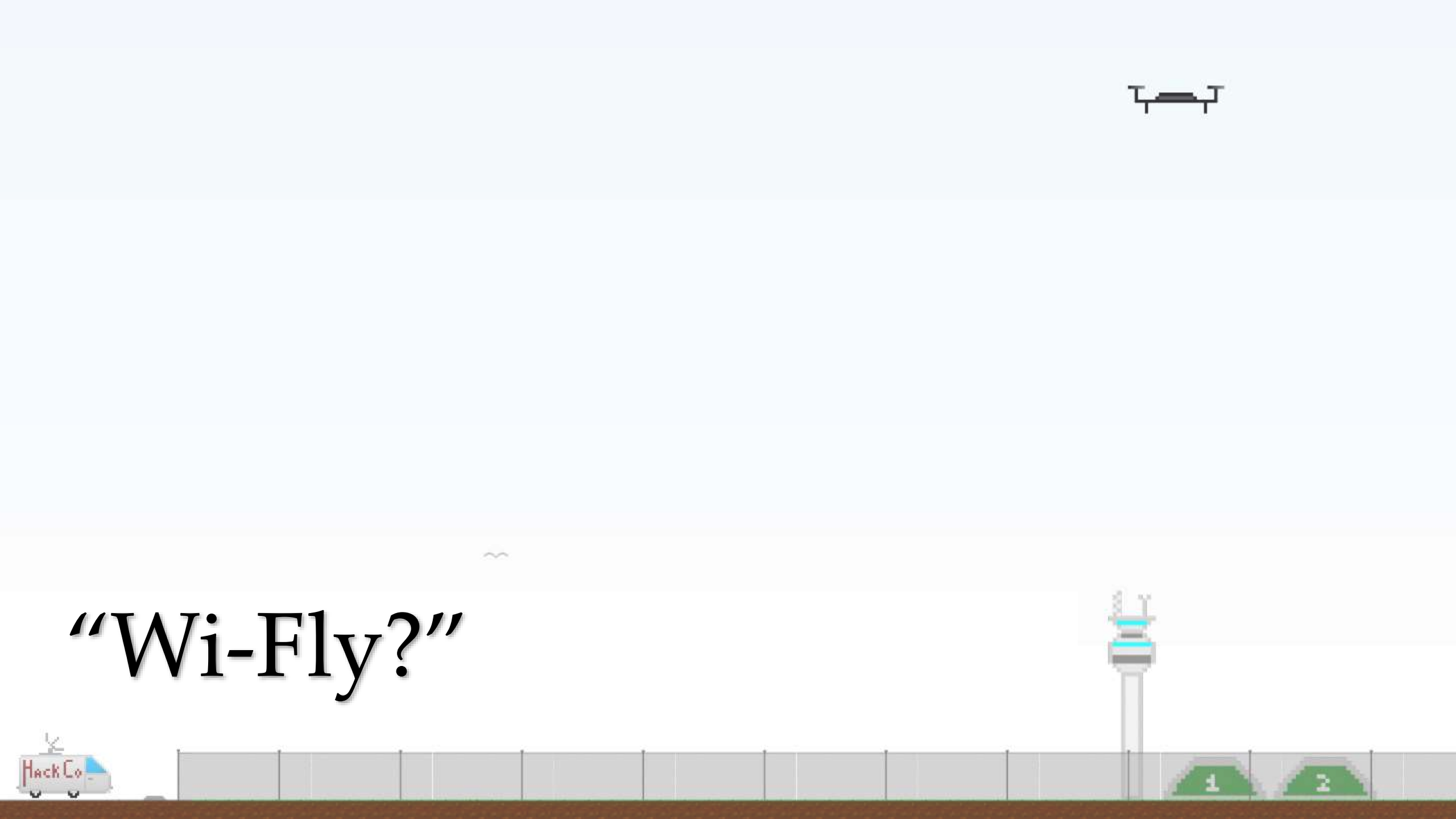

HackCo

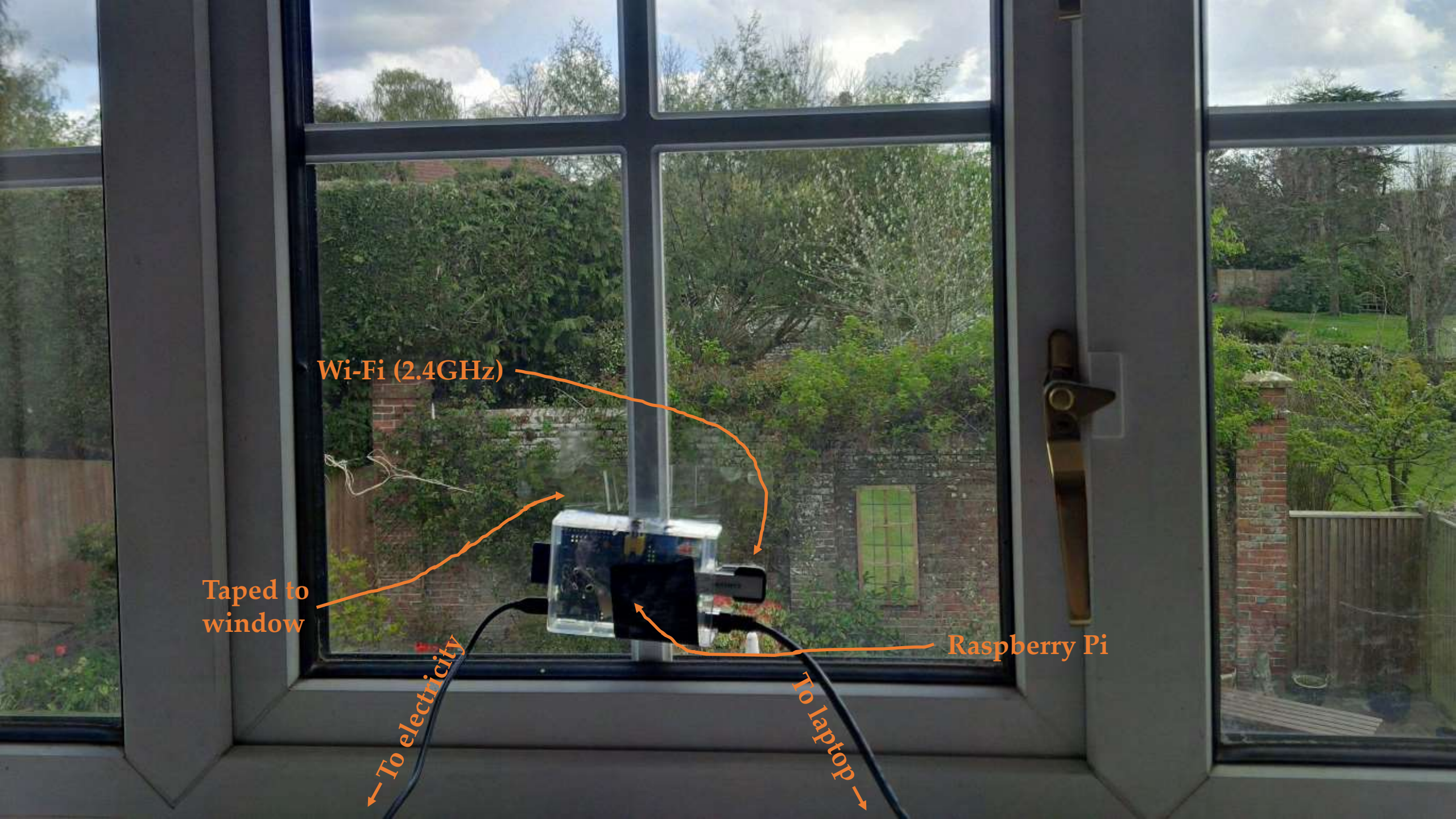
Link activity to operator

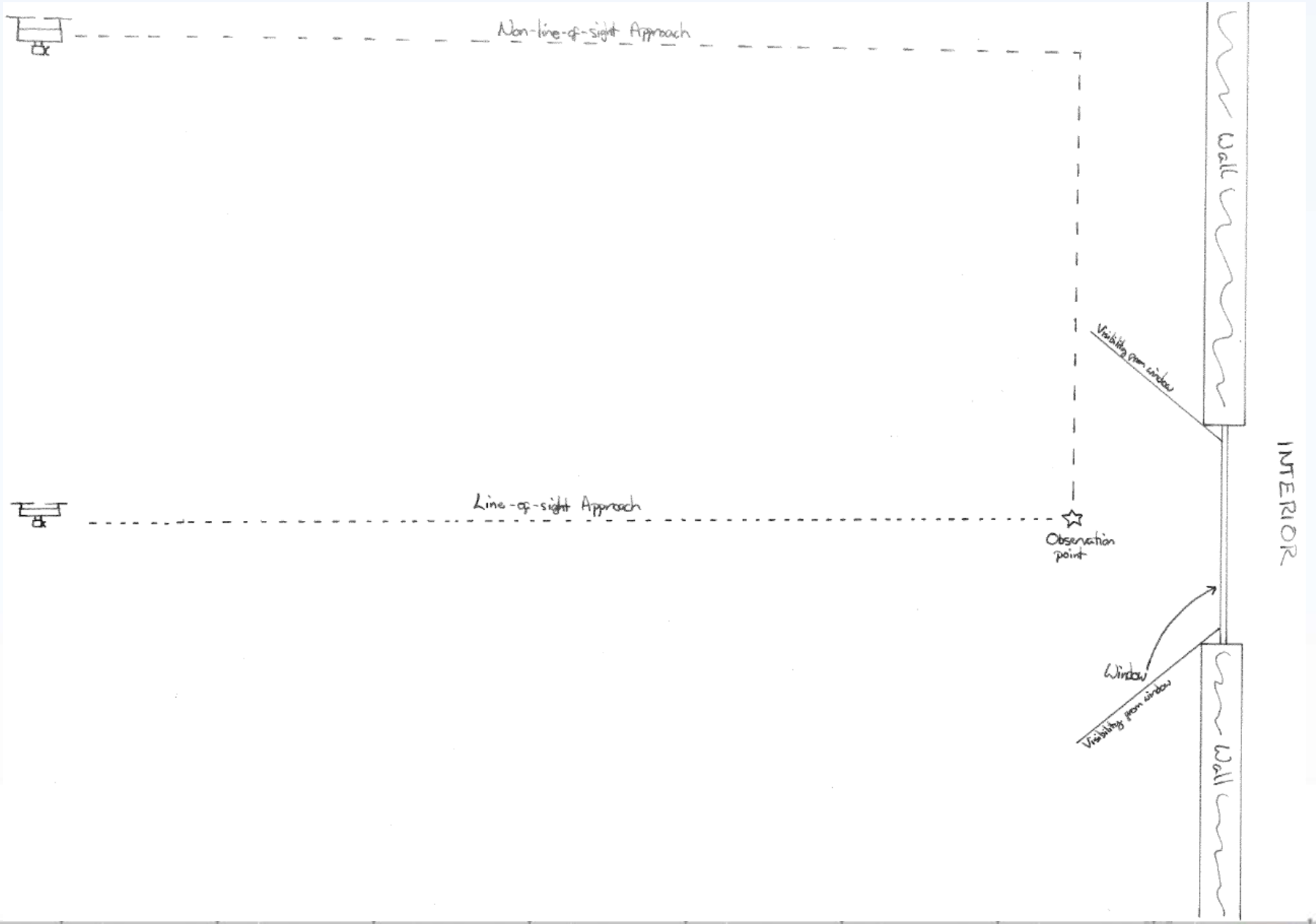
A drone can be replaced

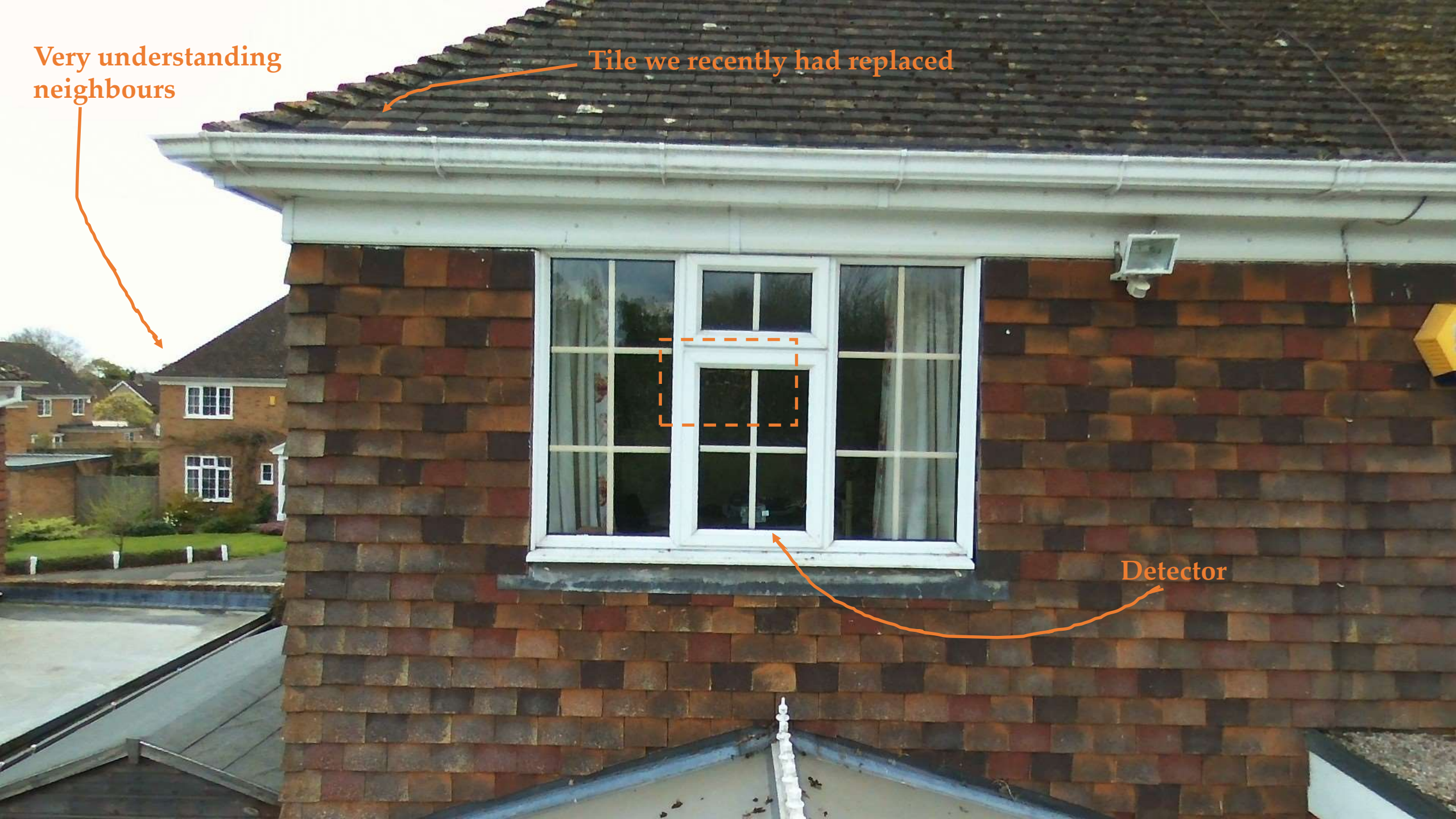
Operator registration is still limited

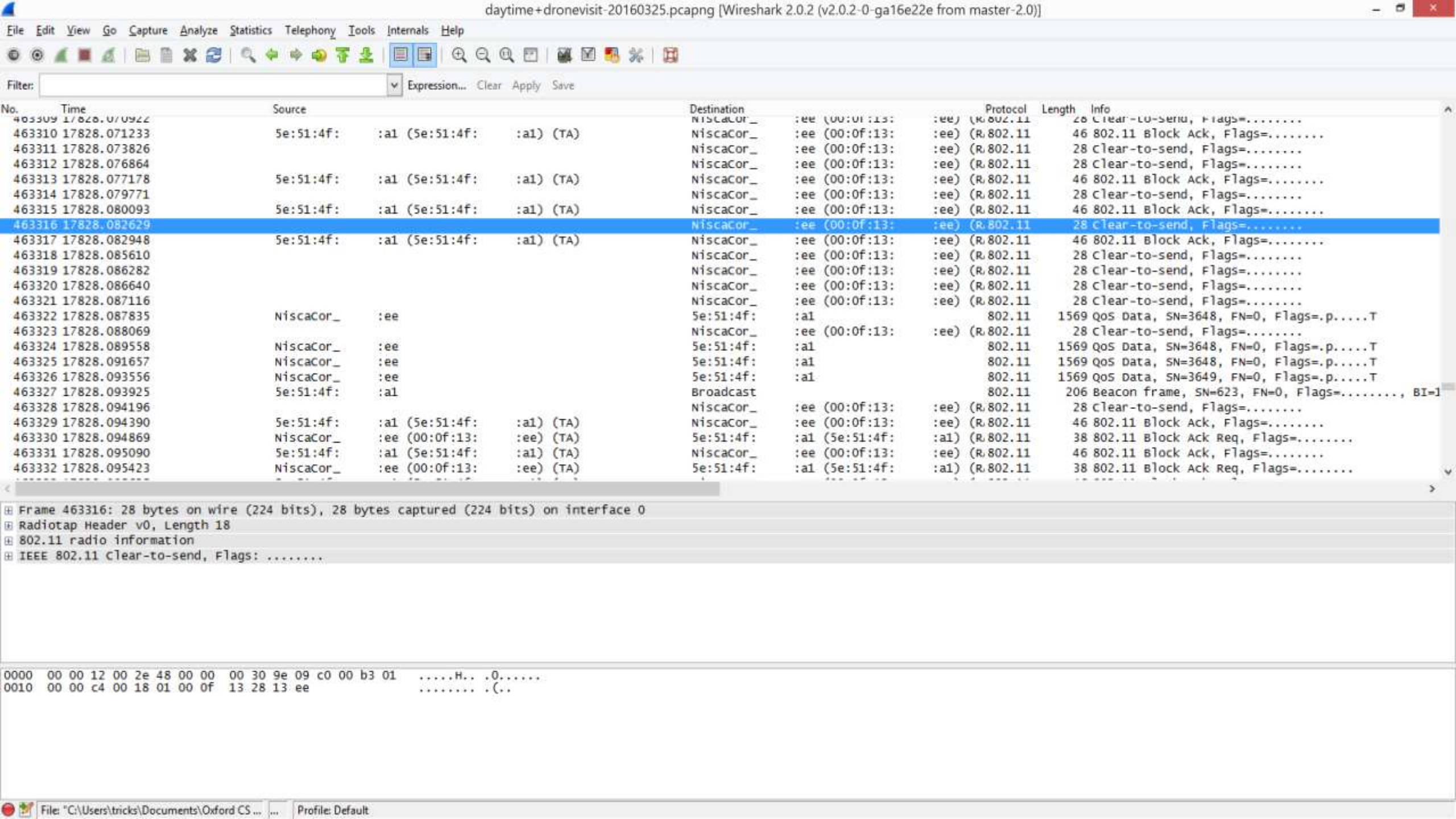



"Wi-Fly?"
HackCo
1
2


Wi-Fi (2.4GHz)
Taped to window
Raspberry Pi
To electricity
To laptop


Non-line-of-sight Approach
Wall
Visibility from window
INTERIOR
Line-of-sight Approach
Observation point
Window
Visibility from window
Wall


Very understanding neighbours
Tile we recently had replaced
Detector


daytime+dronevisit-20160325.pcapng [Wireshark 2.0.2 (v2.0.2-0-ga16e22e from master-2.0)]
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter: Expression... Clear Apply Save
No. Time Source Destination Protocol Length Info
463310 17828.071233 5e:51:4f: :a1 (5e:51:4f: :a1) (TA) NiscaCor_ :ee (00:0f:13: :ee) (R 802.11 46 802.11 Block Ack, Flags=........
463311 17828.073826 NiscaCor_ :ee (00:0f:13: :ee) (R 802.11 28 Clear-to-send, Flags=........
463312 17828.076864 NiscaCor_ :ee (00:0f:13: :ee) (R 802.11 28 Clear-to-send, Flags=........
463313 17828.077178 5e:51:4f: :a1 (5e:51:4f: :a1) (TA) NiscaCor_ :ee (00:0f:13: :ee) (R 802.11 46 802.11 Block Ack, Flags=........
463314 17828.079771 NiscaCor_ :ee (00:0f:13: :ee) (R 802.11 28 Clear-to-send, Flags=........
463315 17828.080093 5e:51:4f: :a1 (5e:51:4f: :a1) (TA) NiscaCor_ :ee (00:0f:13: :ee) (R 802.11 46 802.11 Block Ack, Flags=........
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463318 17828.085610 NiscaCor_ :ee (00:0f:13: :ee) (R 802.11 28 Clear-to-send, Flags=........
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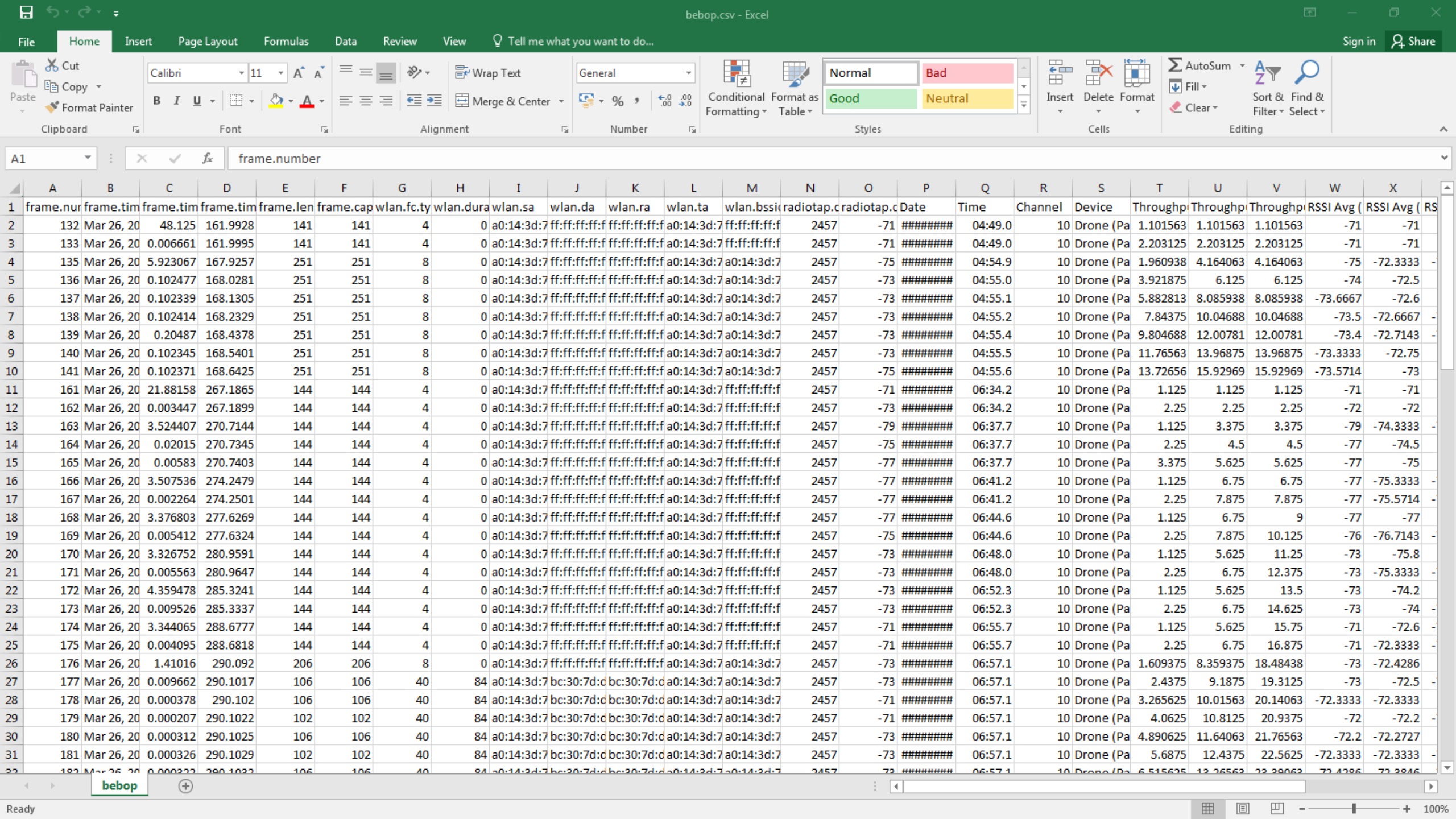
463321 17828.087116 NiscaCor_ :ee (00:0f:13: :ee) (R 802.11 28 Clear-to-send, Flags=........
463322 17828.087835 NiscaCor_ :ee 5e:51:4f: :a1 802.11 1569 QoS Data, SN=3648, FN=0, Flags=.p.....T
463323 17828.088069 NiscaCor_ :ee (00:0f:13: :ee) (R 802.11 28 Clear-to-send, Flags=........
463324 17828.089558 NiscaCor_ :ee 5e:51:4f: :a1 802.11 1569 QoS Data, SN=3648, FN=0, Flags=.p.....T
463325 17828.091657 NiscaCor_ :ee 5e:51:4f: :a1 802.11 1569 QoS Data, SN=3648, FN=0, Flags=.p.....T
463326 17828.093556 NiscaCor_ :ee 5e:51:4f: :a1 802.11 1569 QoS Data, SN=3649, FN=0, Flags=.p.....T
463327 17828.093925 5e:51:4f: :a1 Broadcast 802.11 206 Beacon frame, SN=623, FN=0, Flags=........, BI=1
463328 17828.094196 NiscaCor_ :ee (00:0f:13: :ee) (R 802.11 28 Clear-to-send, Flags=........
463329 17828.094390 5e:51:4f: :a1 (5e:51:4f: :a1) (TA) NiscaCor_ :ee (00:0f:13: :ee) (R 802.11 46 802.11 Block Ack, Flags=........
463330 17828.094869 NiscaCor_ :ee (00:0f:13: :ee) (TA) 5e:51:4f: :a1 (5e:51:4f: :a1) (R 802.11 38 802.11 Block Ack Req, Flags=........
463331 17828.095090 5e:51:4f: :a1 (5e:51:4f: :a1) (TA) NiscaCor_ :ee (00:0f:13: :ee) (R 802.11 46 802.11 Block Ack, Flags=........
463332 17828.095423 NiscaCor_ :ee (00:0f:13: :ee) (TA) 5e:51:4f: :a1 (5e:51:4f: :a1) (R 802.11 38 802.11 Block Ack Req, Flags=........
Frame 463316: 28 bytes on wire (224 bits), 28 bytes captured (224 bits) on interface 0
Radiotap Header v0, Length 18
802.11 radio information
IEEE 802.11 Clear-to-send, Flags: ....
0000 00 00 12 00 2e 48 00 00 00 30 9e 09 c0 00 b3 01 .....H.. .0......
0010 00 00 c4 00 18 01 00 0f 13 28 13 ee ....(..
File: "C:\Users\tricks\Documents\Oxford CS ... Profile: Default



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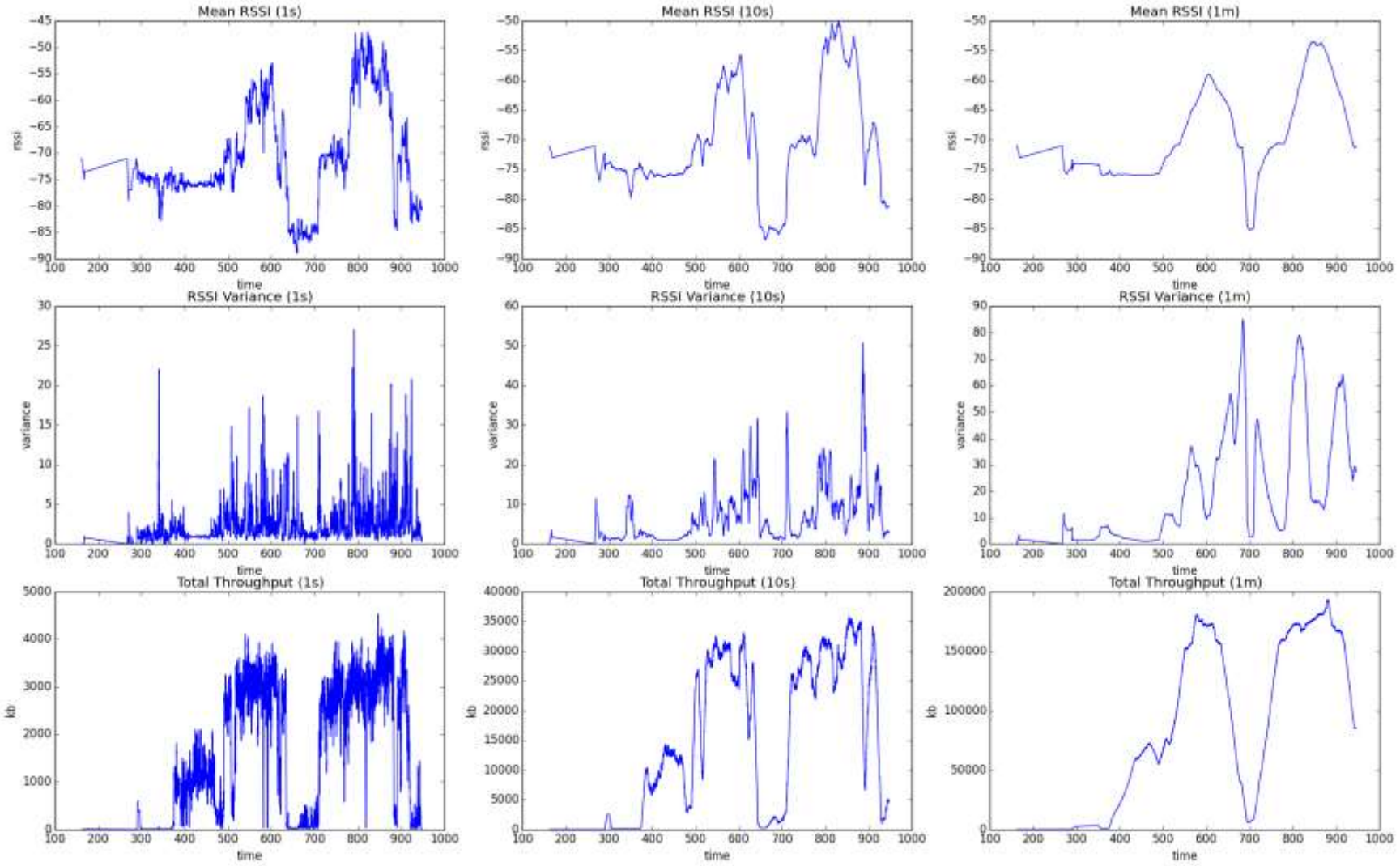
2	132	Mar 26, 20	48.125	161.9928	141	141	4	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	ff:ff:ff:ff:f	2457	-71	########	04:49.0	10	Drone (Pa	1.101563	1.101563	1.101563	-71	-71
3	133	Mar 26, 20	0.006661	161.9995	141	141	4	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	ff:ff:ff:ff:f	2457	-71	########	04:49.0	10	Drone (Pa	2.203125	2.203125	2.203125	-71	-71
4	135	Mar 26, 20	5.923067	167.9257	251	251	8	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	a0:14:3d:7	2457	-75	########	04:54.9	10	Drone (Pa	1.960938	4.164063	4.164063	-75	-72.3333
5	136	Mar 26, 20	0.102477	168.0281	251	251	8	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	a0:14:3d:7	2457	-73	########	04:55.0	10	Drone (Pa	3.921875	6.125	6.125	-74	-72.5
6	137	Mar 26, 20	0.102339	168.1305	251	251	8	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	a0:14:3d:7	2457	-73	########	04:55.1	10	Drone (Pa	5.882813	8.085938	8.085938	-73.6667	-72.6
7	138	Mar 26, 20	0.102414	168.2329	251	251	8	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	a0:14:3d:7	2457	-73	########	04:55.2	10	Drone (Pa	7.84375	10.04688	10.04688	-73.5	-72.6667
8	139	Mar 26, 20	0.20487	168.4378	251	251	8	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	a0:14:3d:7	2457	-73	########	04:55.4	10	Drone (Pa	9.804688	12.00781	12.00781	-73.4	-72.7143
9	140	Mar 26, 20	0.102345	168.5401	251	251	8	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	a0:14:3d:7	2457	-73	########	04:55.5	10	Drone (Pa	11.76563	13.96875	13.96875	-73.3333	-72.75
10	141	Mar 26, 20	0.102371	168.6425	251	251	8	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	a0:14:3d:7	2457	-75	########	04:55.6	10	Drone (Pa	13.72656	15.92969	15.92969	-73.5714	-73
11	161	Mar 26, 20	21.88158	267.1865	144	144	4	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	ff:ff:ff:ff:f	2457	-71	########	06:34.2	10	Drone (Pa	1.125	1.125	1.125	-71	-71
12	162	Mar 26, 20	0.003447	267.1899	144	144	4	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	ff:ff:ff:ff:f	2457	-73	########	06:34.2	10	Drone (Pa	2.25	2.25	2.25	-72	-72
13	163	Mar 26, 20	3.524407	270.7144	144	144	4	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	ff:ff:ff:ff:f	2457	-79	########	06:37.7	10	Drone (Pa	1.125	3.375	3.375	-79	-74.3333
14	164	Mar 26, 20	0.02015	270.7345	144	144	4	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	ff:ff:ff:ff:f	2457	-75	########	06:37.7	10	Drone (Pa	2.25	4.5	4.5	-77	-74.5
15	165	Mar 26, 20	0.00583	270.7403	144	144	4	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	ff:ff:ff:ff:f	2457	-77	########	06:37.7	10	Drone (Pa	3.375	5.625	5.625	-77	-75
16	166	Mar 26, 20	3.507536	274.2479	144	144	4	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	ff:ff:ff:ff:f	2457	-77	########	06:41.2	10	Drone (Pa	1.125	6.75	6.75	-77	-75.3333
17	167	Mar 26, 20	0.002264	274.2501	144	144	4	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	ff:ff:ff:ff:f	2457	-77	########	06:41.2	10	Drone (Pa	2.25	7.875	7.875	-77	-75.5714
18	168	Mar 26, 20	3.376803	277.6269	144	144	4	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	ff:ff:ff:ff:f	2457	-77	########	06:44.6	10	Drone (Pa	1.125	6.75	9	-77	-77
19	169	Mar 26, 20	0.005412	277.6324	144	144	4	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	ff:ff:ff:ff:f	2457	-75	########	06:44.6	10	Drone (Pa	2.25	7.875	10.125	-76	-76.7143
20	170	Mar 26, 20	3.326752	280.9591	144	144	4	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	ff:ff:ff:ff:f	2457	-73	########	06:48.0	10	Drone (Pa	1.125	5.625	11.25	-73	-75.8
21	171	Mar 26, 20	0.005563	280.9647	144	144	4	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	ff:ff:ff:ff:f	2457	-73	########	06:48.0	10	Drone (Pa	2.25	6.75	12.375	-73	-75.3333
22	172	Mar 26, 20	4.359478	285.3241	144	144	4	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	ff:ff:ff:ff:f	2457	-73	########	06:52.3	10	Drone (Pa	1.125	5.625	13.5	-73	-74.2
23	173	Mar 26, 20	0.009526	285.3337	144	144	4	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	ff:ff:ff:ff:f	2457	-73	########	06:52.3	10	Drone (Pa	2.25	6.75	14.625	-73	-74
24	174	Mar 26, 20	3.344065	288.6777	144	144	4	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	ff:ff:ff:ff:f	2457	-71	########	06:55.7	10	Drone (Pa	1.125	5.625	15.75	-71	-72.6
25	175	Mar 26, 20	0.004095	288.6818	144	144	4	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	ff:ff:ff:ff:f	2457	-71	########	06:55.7	10	Drone (Pa	2.25	6.75	16.875	-71	-72.3333
26	176	Mar 26, 20	1.41016	290.092	206	206	8	0	a0:14:3d:7	ff:ff:ff:ff:f	ff:ff:ff:ff:f	a0:14:3d:7	a0:14:3d:7	2457	-73	########	06:57.1	10	Drone (Pa	1.609375	8.359375	18.48438	-73	-72.4286
27	177	Mar 26, 20	0.009662	290.1017	106	106	40	84	a0:14:3d:7	bc:30:7d:d	bc:30:7d:d	a0:14:3d:7	a0:14:3d:7	2457	-73	########	06:57.1	10	Drone (Pa	2.4375	9.1875	19.3125	-73	-72.5
28	178	Mar 26, 20	0.000378	290.102	106	106	40	84	a0:14:3d:7	bc:30:7d:d	bc:30:7d:d	a0:14:3d:7	a0:14:3d:7	2457	-71	########	06:57.1	10	Drone (Pa	3.265625	10.01563	20.14063	-72.3333	-72.3333
29	179	Mar 26, 20	0.000207	290.1022	102	102	40	84	a0:14:3d:7	bc:30:7d:d	bc:30:7d:d	a0:14:3d:7	a0:14:3d:7	2457	-71	########	06:57.1	10	Drone (Pa	4.0625	10.8125	20.9375	-72	-72.2
30	180	Mar 26, 20	0.000312	290.1025	106	106	40	84	a0:14:3d:7	bc:30:7d:d	bc:30:7d:d	a0:14:3d:7	a0:14:3d:7	2457	-73	########	06:57.1	10	Drone (Pa	4.890625	11.64063	21.76563	-72.2	-72.2727
31	181	Mar 26, 20	0.000326	290.1029	102	102	40	84	a0:14:3d:7	bc:30:7d:d	bc:30:7d:d	a0:14:3d:7	a0:14:3d:7	2457	-73	########	06:57.1	10	Drone (Pa	5.6875	12.4375	22.5625	-72.3333	-72.3333


Mean RSSI (1s)
Mean RSSI (10s)
Mean RSSI (1m)
RSSI Variance (1s)
RSSI Variance (10s)
RSSI Variance (1m)
Total Throughput (1s)
Total Throughput (10s)
Total Throughput (1m)
rssi
variance
kb
time

Matthan (Nguyen et al., 2017)

- RF method
- Detects movement and vibration
- Don't need to know drone in advance

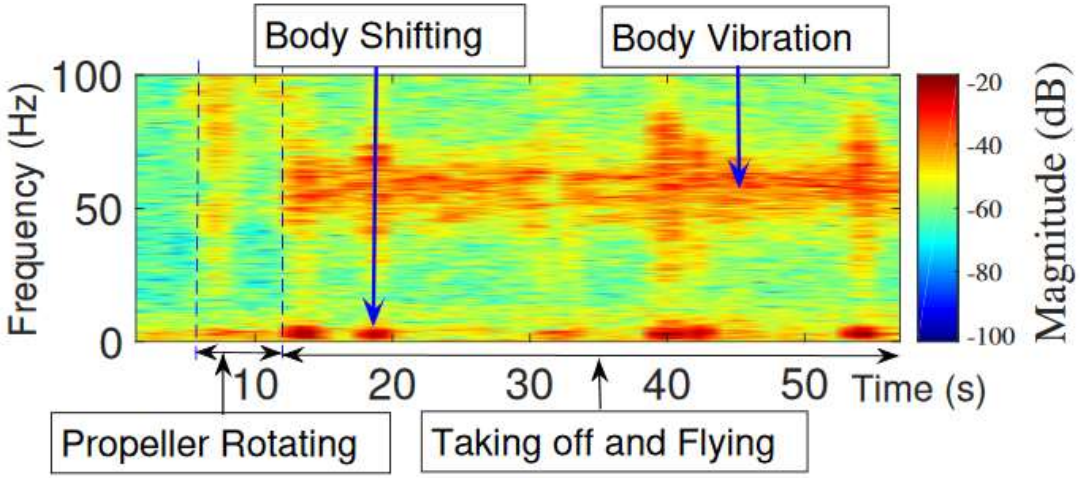


Figure 3: An example illustrates the movement captured by IMUs attached to the Bebop drone.

Game of Drones (Nassi, 2018)

- Traffic analysis method
- Video bandwidth varies based on content
  - Static scene is low bandwidth
  - Changing scene is high bandwidth
- Change the scene and correlate the bandwidth to detect a camera

Questions etc.

(richard.baker@cybersecurity.ox.ac.uk)

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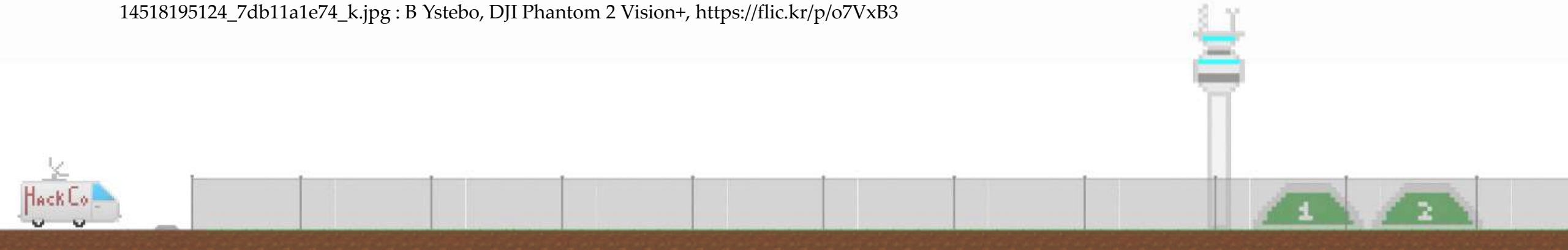

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