Using Starlink in the field – lessons learned

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Our lab’s kit: rectangular Starlink Dishy with RV subscription


Foot
Mast
“Dishy”
THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
UOA431170 - OPEX Asset
Space X Starlink RV
Satellite Internet / Network Lab
The University of Auckland
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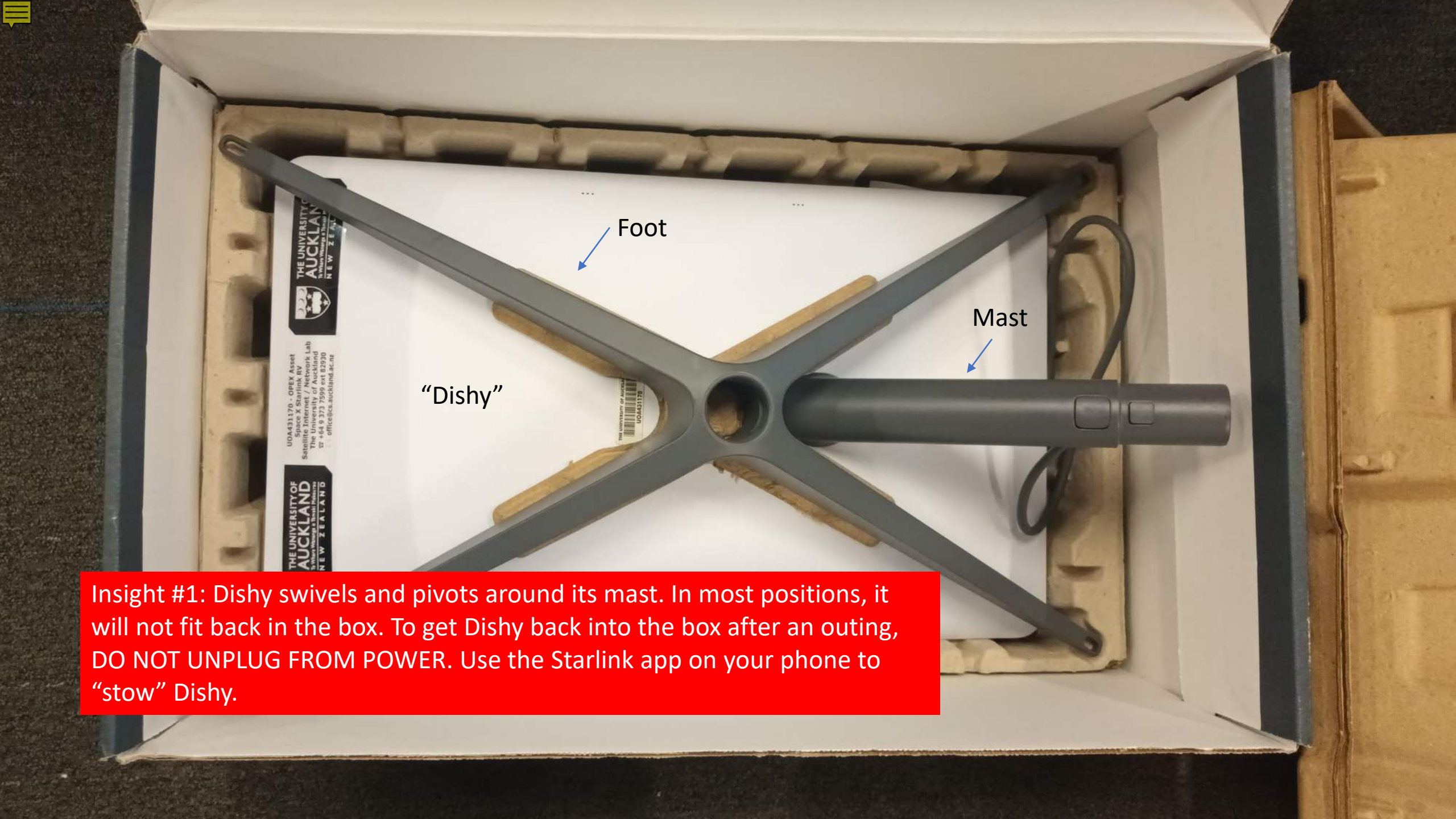
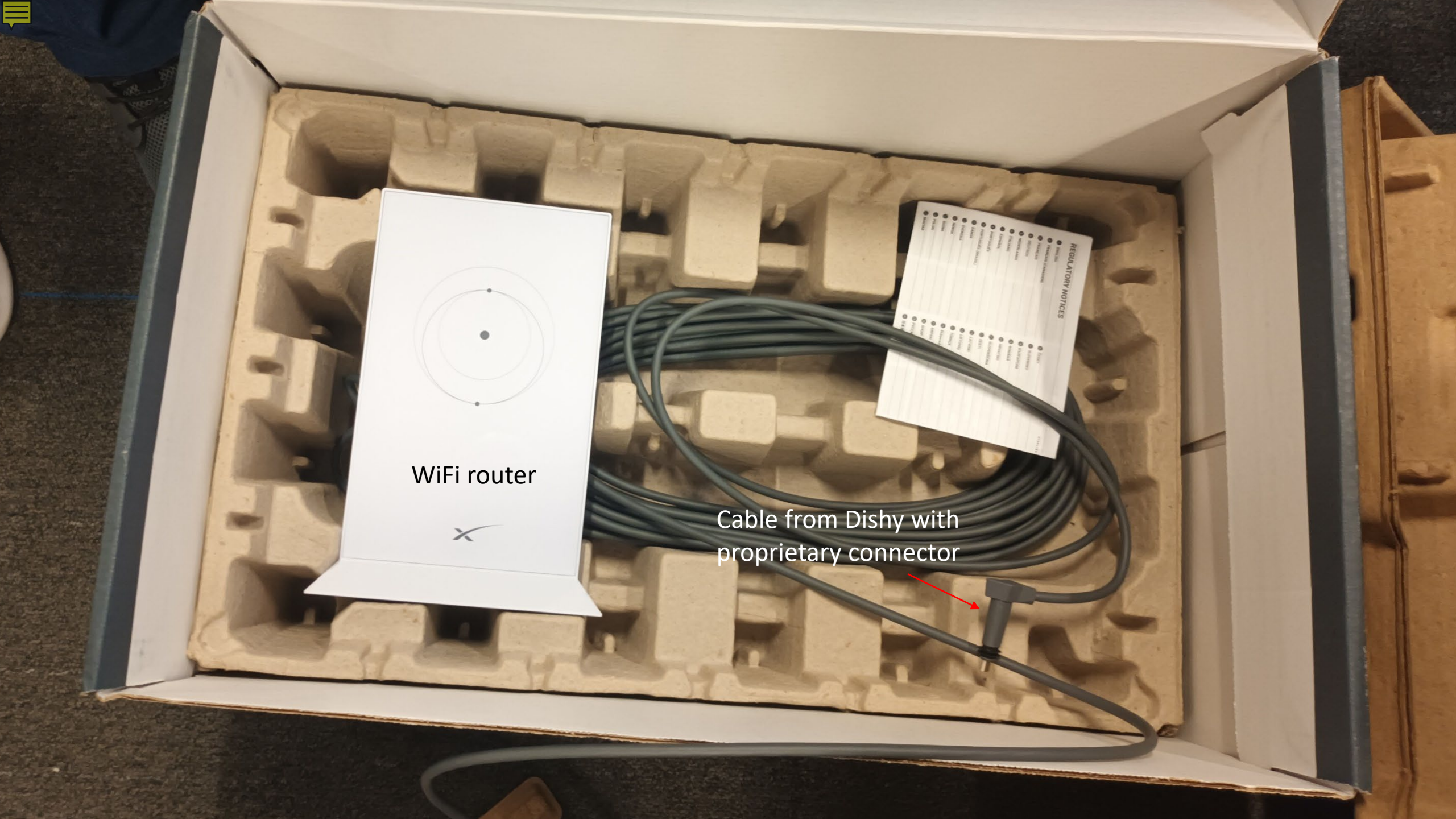
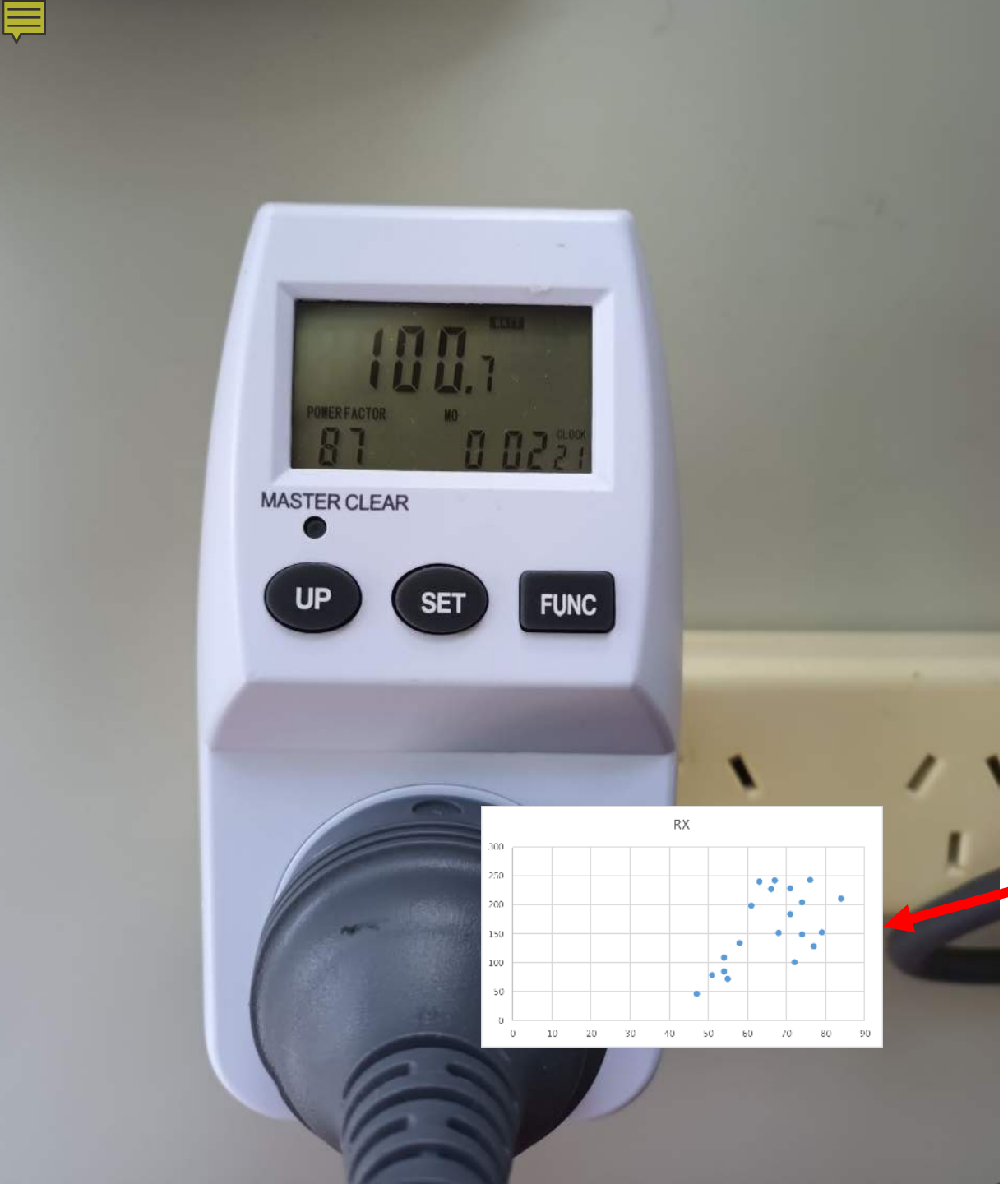
office@cs.auckland.ac.nz


Foot
Mast
“Dishy”
Insight #1: Dishy swivels and pivots around its mast. In most positions, it will not fit back in the box. To get Dishy back into the box after an outing, DO NOT UNPLUG FROM POWER. Use the Starlink app on your phone to “stow” Dishy.


WiFi router
REGULATORY NOTICES
Cable from Dishy with
proprietary connector

Optional extra: Ethernet adapter



Powering up…

SpaceX quote:

Standard (Rectangular) power specifications:

- Average: 50-75W
- Idle: 20W
- Peak: 100-240V~ 2.0A 50-60Hz

Now “Peak” is a voltage here, not a power?

Seen here: about 100W – well after boot and with WiFi idle

Actually seen in operation:

- Typically 80-100W, sometimes up to 100W
- Since 16/2: typically between 38 and 75W

Power use appears to correlate with **download** data rate

Running this on an inverter off a car cigarette lighter socket could blow the fuse!

Caveat:

I am using a Southern Hemisphere perspective

If you live north of the Equator,
swap “north” and “south” in my talk

Observations were made in Auckland at ~37°S

Moves to “coffee table” position

rotates

rotates

Still in “coffee table” position but with different orientations

rotates

tilts

Final position is **always** exactly south-facing and stationary

2:13
92%
UOASTARLINK
ONLINE
OBSTRUCTED
Expect an interruption every 2 minutes
STATISTICS
NETWORK
2 devices
OBSTRUCTIONS
SPEED TEST
SETTINGS

12:14
92%
SETTINGS
WIFI CONFIGURATION
uoastarlink
ADVANCED
SAVE
SNOW MELT
OFF
Never use extra power to melt snow.
AUTOMATIC
Automatically detect snow and heat up when needed.
PRE-HEAT
Keep warm to better resist snow build-up. This option may increase power consumption.
SAVE

12:15
92%
SETTINGS
SAVE
STOW STARLINK
Stowing will tilt your Starlink for storage or shipping. This will interrupt your service until you unstow it.
STOW
FACTORY RESET WIFI
Factory reset will clear your WiFi network name, password, and other settings. This will interrupt your service until you set up again.
FACTORY RESET
SET UP ANOTHER STARLINK
ADVANCED

Partial obstruction is OK, **this** position actually works!

With partial obstructions, expect intermittent outages

Frequency and maximum length of outages increases with degree of obstruction.

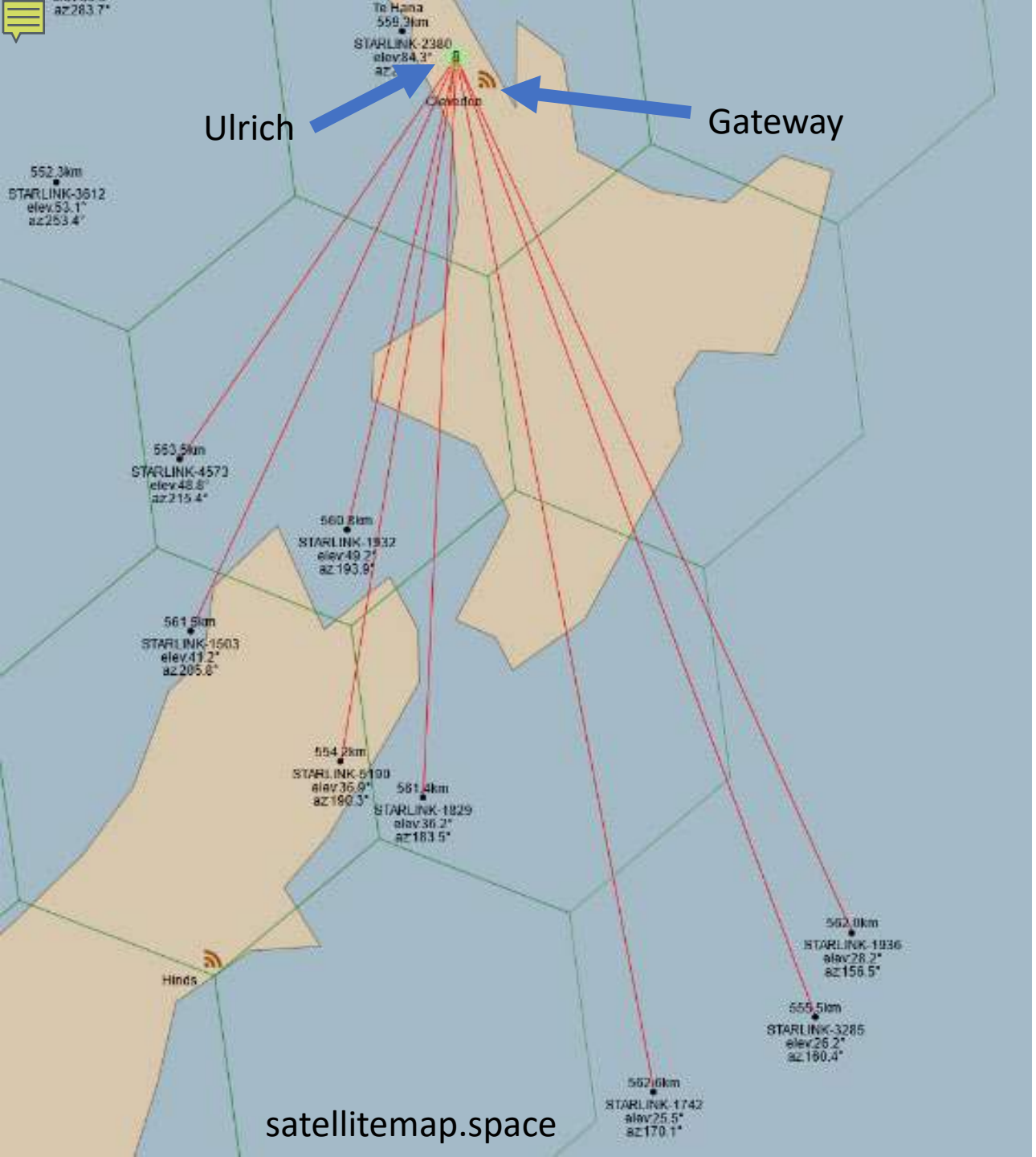
This position doesn't work, despite relatively few obstructions in a northerly direction

Dishy always wants to point south!

This may be different:

- In the Northern Hemisphere (mirrored behaviour)
- At latitudes close to or beyond 53°

Why? The main current Starlink constellations operate with 53° inclination, meaning satellite density is highest just short of the northern and southern 53rd parallel.



My unfair advantages

#1: Gateway(s) in the neighbourhood

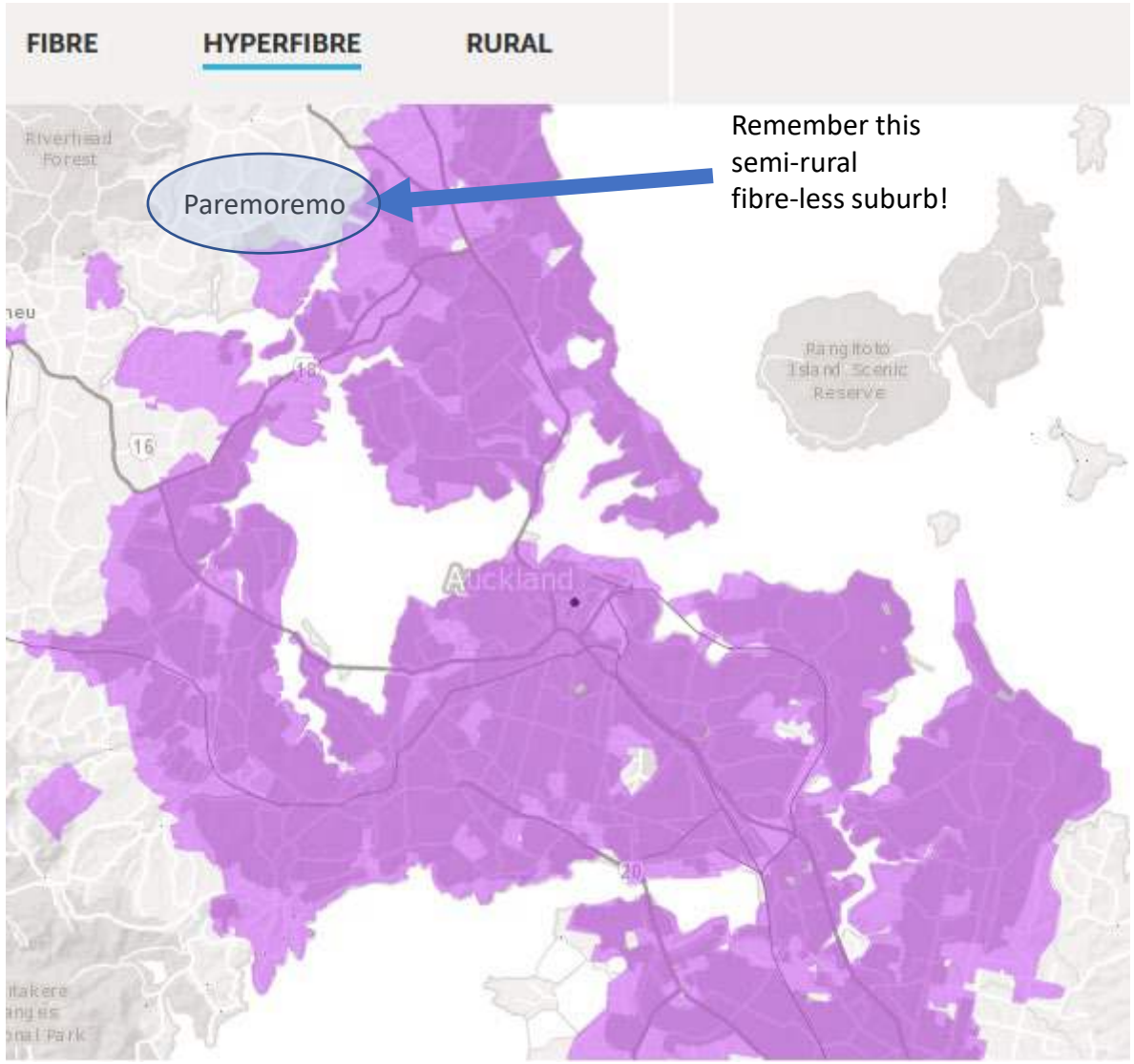
When looking south, my Dishy can see more or less the same set of satellites as Starlink's Clevedon gateway about 30 km away.

>>> Plenty of choice for bent pipe connections!

Caveat: If your closest gateway is further away, the set of satellites that both you and the gateway can see is on average smaller.

My unfair advantages

#2: Fibre in the neighbourhood



Metropolitan Auckland has gigabit fibre to the home almost everywhere – ~NZ$90/month for almost 1 Gb/s, average RTT < 10 ms to networks connected to APE.

Starlink's fixed connection package is NZ$159 for at most a few hundred Mb/s with average RTT > 30 ms.

Why would anyone in their right mind get Starlink in Auckland?

>>> No competition for Starlink capacity in my cell!

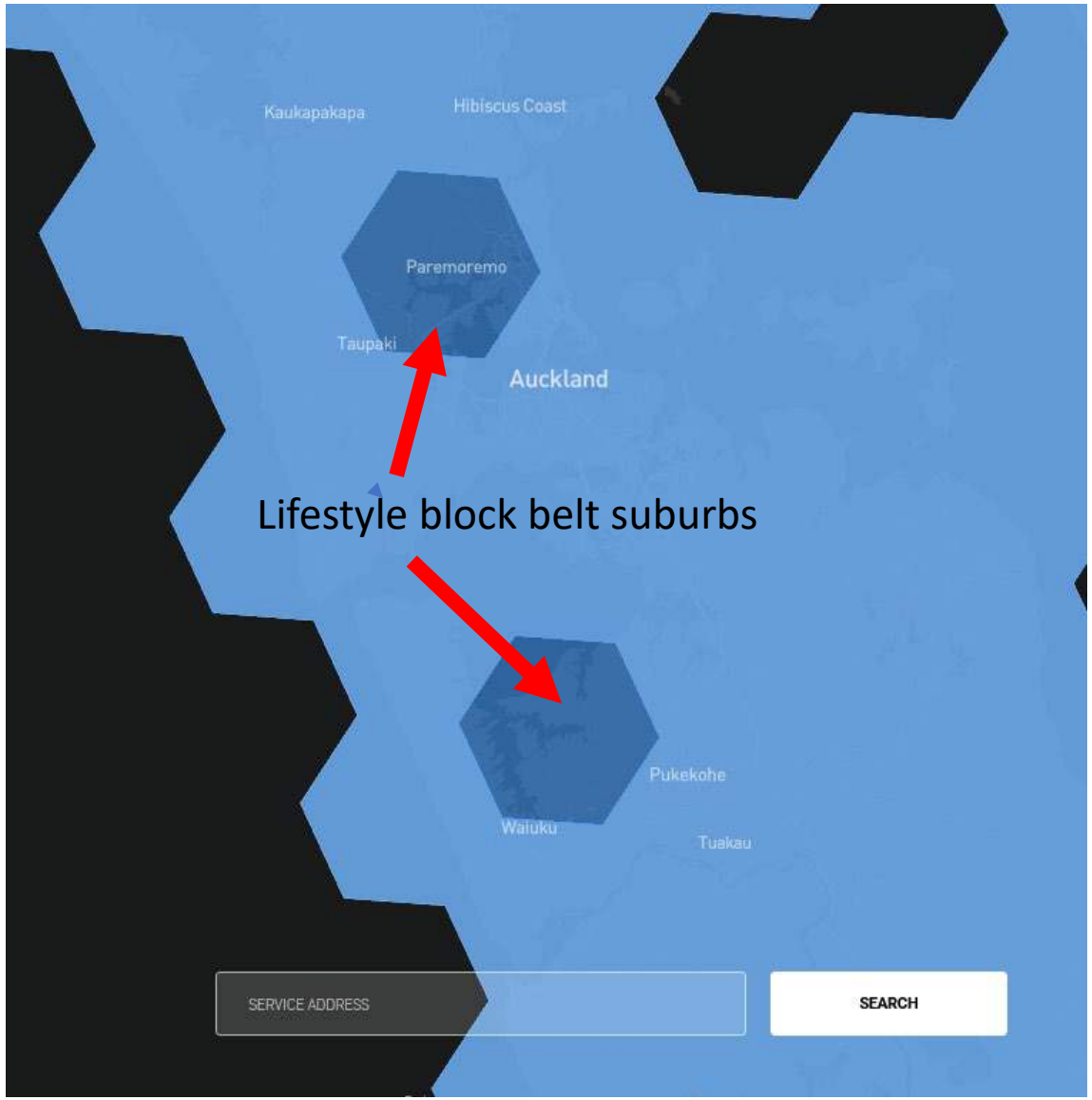
My unfair advantages

#3: Not much neighbourhood

Auckland sits on an isthmus on long peninsula with otherwise very little population.

NZ sits in a big ocean with the next large population density over 2000 km away (well over the horizon for Starlink)

>>> Not much competition for Starlink capacity from neighbouring areas either!



My unfair advantages

#4: Not all of my neighbourhood can get Starlink

Lifestyle block belt without fibre is reaching Starlink user density saturation

>>> Some of those who'd like to compete for Starlink capacity with me can't actually buy Starlink

How fast? “Speed” test from Bastion Point, Auckland (no obstructions) on 1/12/2022

All target servers in Auckland, rates in Mb/s, speedtest.net

Server	Test 1			Test 2			Test 3			Average		
	up	down	ping	up	down	ping	up	down	ping	up	down	ping
Spark	**15.13**	76.01	38	4.18	74.09	4.18	11.52	75.39	**92**	10.28	75.16	44.73
Vocusgroup	9.74	64.85	54	**1.4**	76.56	**31**	12.27	**54.42**	36	7.80	65.28	40.33
MyRepublic	6.74	**176.1**	33	10.99	129.3	63	11.98	110.6	40	9.90	138.68	45.33
Kordia	3.01	124.1	43	14.29	150.3	32	2.39	85	63	6.56	119.82	46.00
Average:	8.66	110.27	42.00	7.72	107.58	32.55	9.54	81.36	57.75	8.64	99.74	44.10

Take-home insights: A lot of variation even from a prime spot! Small sample…

Note: Tests conducted via WiFi

How fast? “Speed” test from my deck, Auckland (mild obstructions) early January 2023

All target servers in Auckland, rates in Mb/s, speedtest.net

Server	Test 1			Test 2			Test 3			Test 4			Average		
	up	down	ping	up	down	ping	up	down	ping	up	down	ping	up	down	ping
Spark	10.93	36.16	35	4.84	27.89	40	9.84	29.83	31	**17.59**	80.3	42	10.80	43.55	37.00
Vocusgroup	**4.09**	79.01	31	12.34	155.4	28	11.92	36.08	**27**	10.45	51.45	36	9.70	80.48	30.50
MyRepublic	6.16	126.3	37	5.23	33.14	39	5.97	206.7	**125**	8.78	**198.3**	**48**	6.54	141.1	62.25
Kordia	15.6	160.1	38	4.45	18.29	31	4.99	**12.54**	60	10.03	18.32	29	8.77	52.31	39.50
Vodafone	8.3	73.77	29	9.07	21.12	27	9.33	28.15	55	11.25	42.31	30	9.49	41.34	35.25
Average:	9.20	100.4	35.25	6.72	58.67	34.50	8.18	71.28	60.75	11.71	87.09	38.75	8.95	79.35	42.31

Take-home insights: Still a lot of variation – a factor of 8 in downloads! Still a small sample…

Bufferbloat!

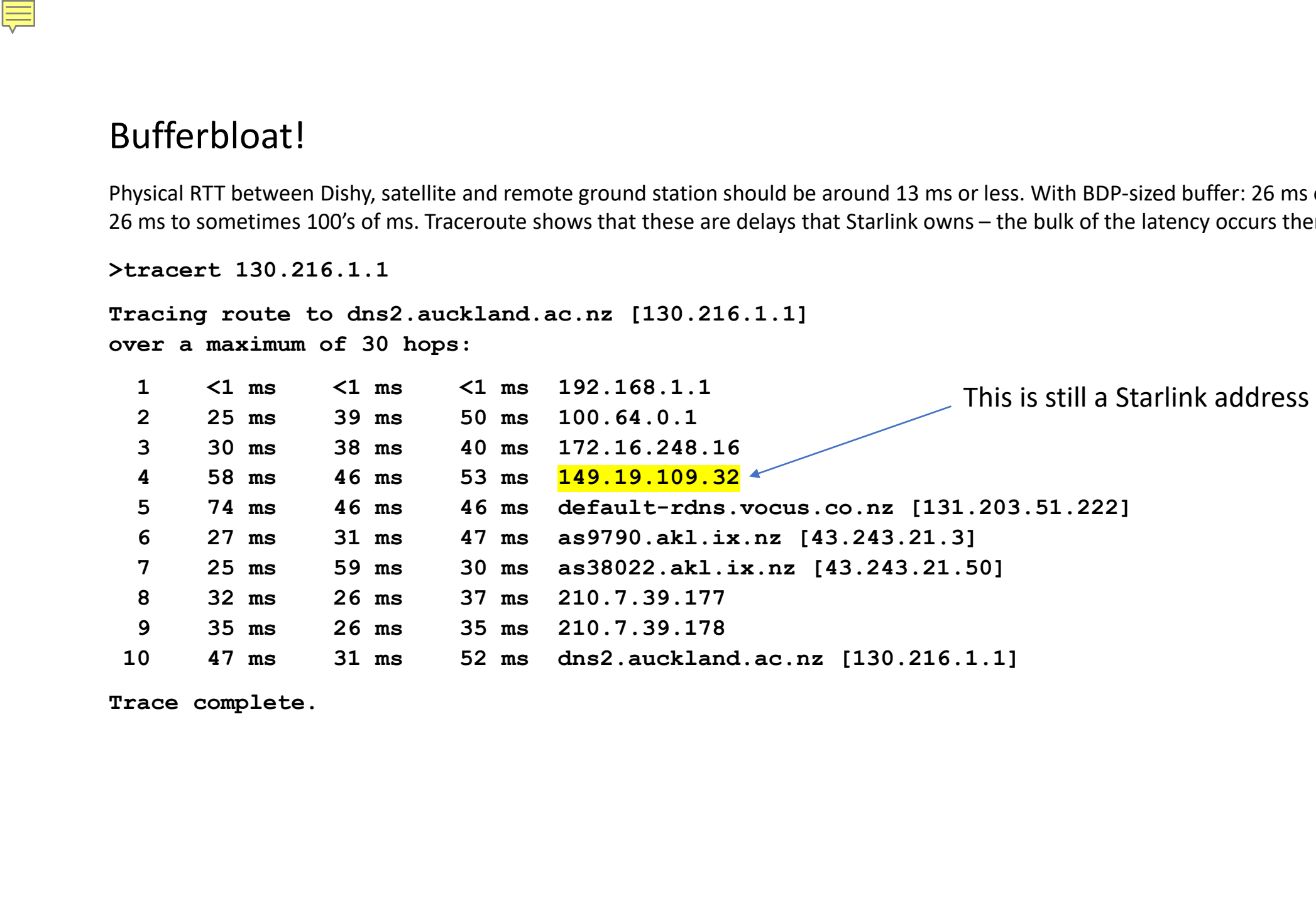
Physical RTT between Dishy, satellite and remote ground station should be around 13 ms or less. With BDP-sized buffer: 26 ms or less. We actually see 26 ms to sometimes 100's of ms. Traceroute shows that these are delays that Starlink owns – the bulk of the latency occurs there:

```
>tracert 130.216.1.1

Tracing route to dns2.auckland.ac.nz [130.216.1.1]
over a maximum of 30 hops:

  1    <1 ms    <1 ms    <1 ms  192.168.1.1
  2    25 ms    39 ms    50 ms  100.64.0.1
  3    30 ms    38 ms    40 ms  172.16.248.16
  4    58 ms    46 ms    53 ms  149.19.109.32
  5    74 ms    46 ms    46 ms  default-rdns.vocus.co.nz [131.203.51.222]
  6    27 ms    31 ms    47 ms  as9790.akl.ix.nz [43.243.21.3]
  7    25 ms    59 ms    30 ms  as38022.akl.ix.nz [43.243.21.50]
  8    32 ms    26 ms    37 ms  210.7.39.177
  9    35 ms    26 ms    35 ms  210.7.39.178
 10    47 ms    31 ms    52 ms  dns2.auckland.ac.nz [130.216.1.1]

Trace complete.
```



Conclusion

- It works, at least where we are
  - Even in cyclones
  - Moderate obstructions cause brief outages but no rate drops as such
- Performance varies enormously over time
  - Somewhere between DSL and entry level fibre
  - Strange things happen!
- Capacity constraints are biting now
- Starlink network has a lot of bloated buffers
  - Long RTT needlessly impairs performance!