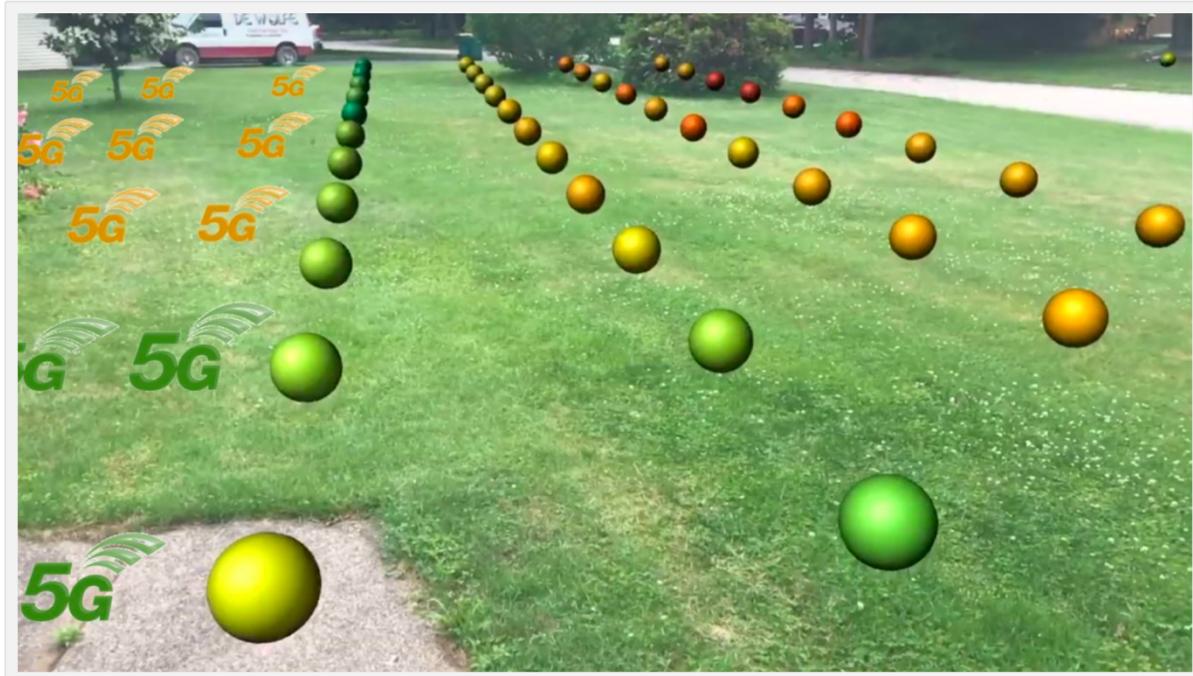


Proof of Concept: Augmented Reality - Signal Strength Visualization for Wifi / LTE & 5G (Drone Survey/AR Viz)



M Watson Studio

Project Skittles is exciting, because it demonstrates the value of:
MAKING VISIBILE THAT WHICH IS INVISIBLE - which extends beyond RF...

https://youtu.be/IDFRuG_D3lo

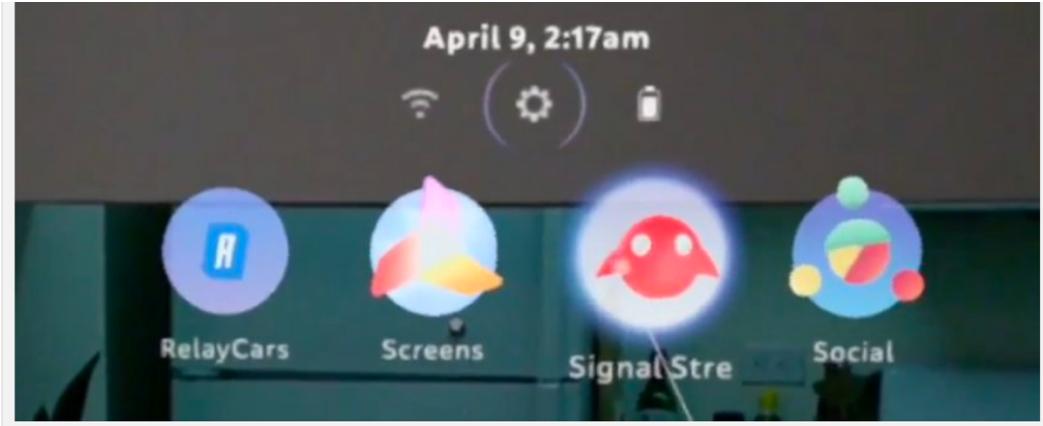
Drone Surveys WIFI Signal Strength and AR Visualize

JUNE 21 2019 Test

<https://youtu.be/8RCgh8jv3xM>

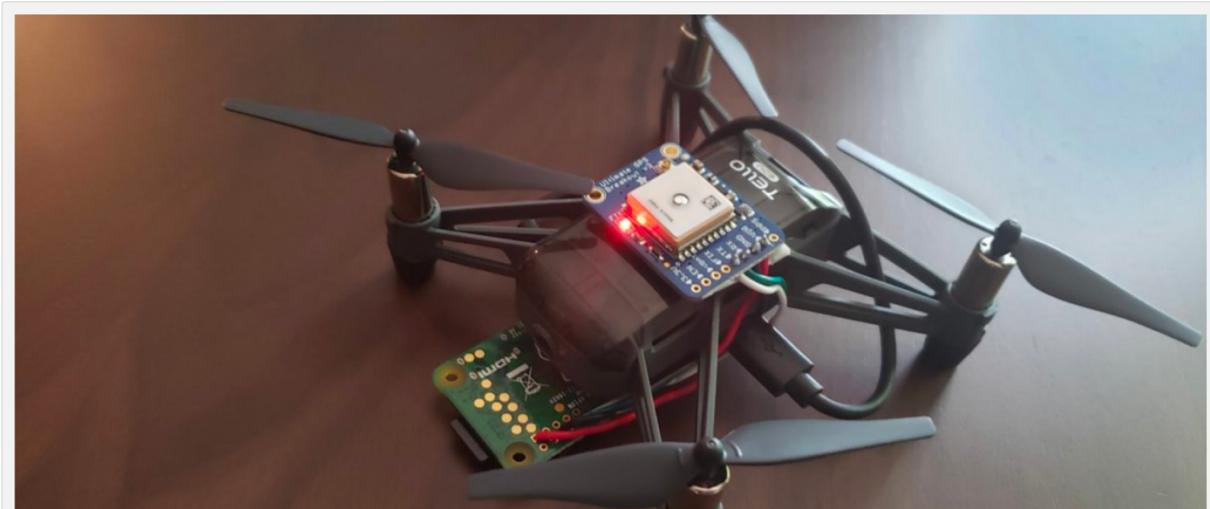
<LINK> Magic Leap POC

<https://drive.google.com/file/d/1anMDbpGhPwmJgdW0g9LFMvxkqqKu8vUb/view>



<LINK> Magic Leap POC

SurveyCopter (Photo Credit Jay Griffin)



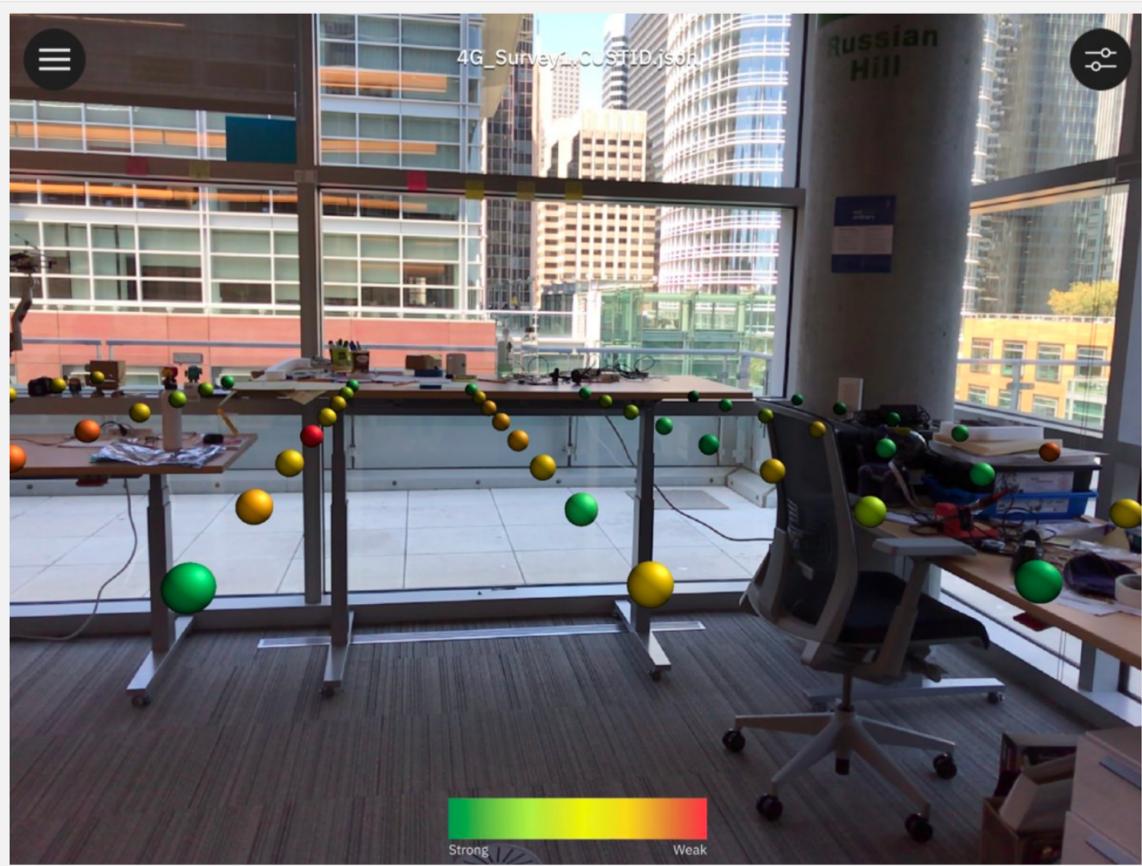
SurveyCopter (Photo Credit Jay Griffin)

Loaded Drone with Gear - Test Flight #1

<https://youtu.be/hOexOQfU9gw>

POC at IBM Watson West (LTE Data)

POC at IBM Watson West (LTE Data)



Demonstration / Value

Show that AR Tech can be applied to visualize and remedy weak points in evolving 5G networks (better antenna placements)

Especially valuable given the gnarly physics of 5G - e.g.

<https://www.forbes.com/sites/annatobin/2018/05/25/could-5g-have-trouble-penetrating-buildings/#242c229f9f97>

Visualization:

Point cloud , anchored to physical location

Data Sources (Real world)

WIFI Signal Strength Level

LTE Signal Strength Level

Ping Test

X Y Z coordinates (For above)

Attenuation in Weather? (explore & visualize) - fog, rain and drizzle

source: <https://www.sciencedirect.com/topics/engineering/atmospheric-attenuation>

https://youtu.be/rnQF_XWvmEs

Mapping Options:

Manual (MAC)

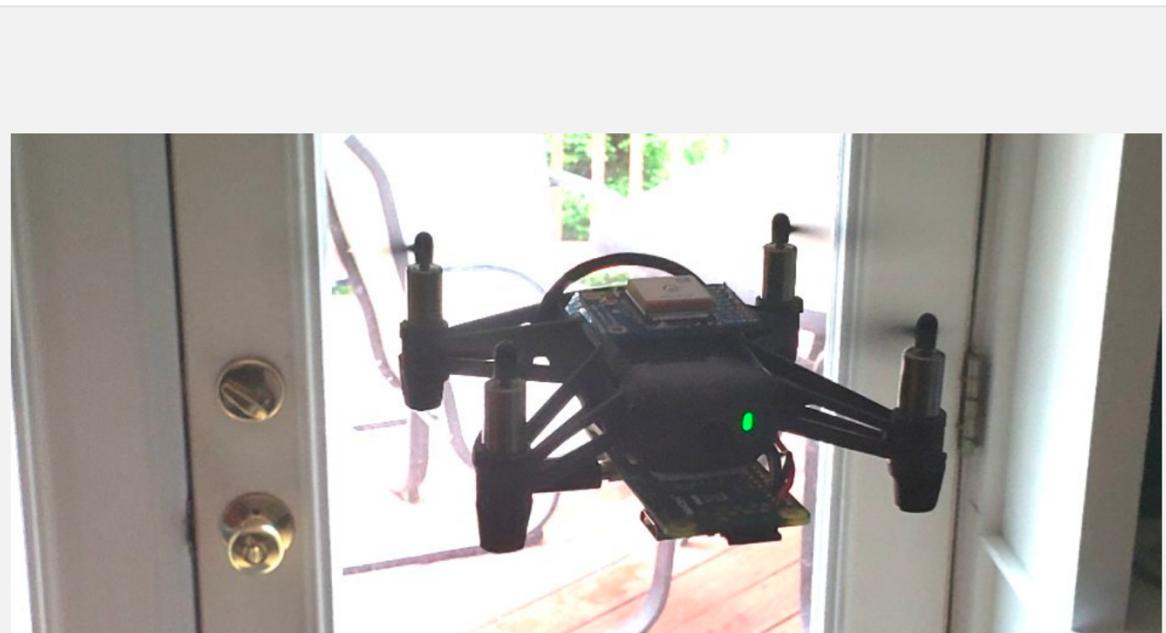
Manual (Raspberry PI with a button - and some 1m resolution locator - GPS or other localized data)

Drone - fly drone 8 X 8 X 3 (think about three chess boards) - taking measurements

				Filter							
1		137712	SCANNER_0	70/70	-38 dBm	DuyHoa	35.773125	-78.862951667	128.7	2019-06-22 20:25:19	
2		137713	SCANNER_0	70/70	-34 dBm	DuyHoa	35.773148333	-78.86293	128.7	2019-06-22 20:25:21	
3		137714	SCANNER_0	70/70	-38 dBm	DuyHoa	35.773171667	-78.862898333	128.7	2019-06-22 20:25:27	
4		137715	SCANNER_0	70/70	-34 dBm	DuyHoa	35.77316	-78.862903333	129	2019-06-22 20:25:33	
5		137716	SCANNER_0	70/70	-34 dBm	DuyHoa	35.773146667	-78.862906667	129.1	2019-06-22 20:25:39	
6		137717	SCANNER_0	70/70	-36 dBm	DuyHoa	35.77317	-78.862858333	129.2	2019-06-22 20:25:46	
7		137718	SCANNER_0	70/70	-33 dBm	DuyHoa	35.773175	-78.862836667	128.7	2019-06-22 20:25:54	
8		137900	SCANNER_0	51/70	-59 dBm	DuyHoa	0	0	0	2019-06-22 21:34:25	
9		137901	SCANNER_0	54/70	-56 dBm	DuyHoa	0	0	0	2019-06-22 21:34:30	
10		137902	SCANNER_0	52/70	-58 dBm	DuyHoa	0	0	0	2019-06-22 21:34:35	
11		137903	SCANNER_0	54/70	-56 dBm	DuyHoa	0	0	0	2019-06-22 21:34:40	
12		137904	SCANNER_0	56/70	-54 dBm	DuyHoa	0	0	0	2019-06-22 21:34:48	
13		137905	SCANNER_0	55/70	-55 dBm	DuyHoa	0	0	0	2019-06-22 21:34:56	
14		137906	SCANNER_0	55/70	-55 dBm	DuyHoa	0	0	0	2019-06-22 21:34:58	
15		137907	SCANNER_0	55/70	-55 dBm	DuyHoa	0	0	0	2019-06-22 21:35:06	
16		137908	SCANNER_0	53/70	-57 dBm	DuyHoa	35.773441667	-78.863238333	182.9	2019-06-22 21:35:10	
17		137909	SCANNER_0	56/70	-54 dBm	DuyHoa	35.773461667	-78.863266667	182.9	2019-06-22 21:35:16	
18		137910	SCANNER_0	51/70	-59 dBm	DuyHoa	35.773458333	-78.863251667	182.9	2019-06-22 21:35:22	
19		137911	SCANNER_0	54/70	-56 dBm	DuyHoa	35.773416667	-78.863248333	182.9	2019-06-22 21:35:28	

6.0	81.9	86.2	82.3	80.7	79.2	70.9	63.2	62.2	62.2	57.2	47.6	45.8	40.2	38.0	39.9	36.7	38.8
8.0	80.8	83.5	79.8	74.4	64.5	61.3	57.4	48.8	48.9	47.0	47.2	47.5	47.7	46.9	41.1	39.8	41.6
10.0	79.8	81.6	73.1	66.3	57.0	54.4	52.1	48.9	41.0	42.7	41.3	37.0	36.0	37.1	34.2	31.4	29.9
12.0	76.8	79.2	72.9	62.1	61.1	57.2	49.6	45.7	37.0	31.0	28.6	29.3	30.9	31.5	26.9	28.8	30.5
14.0	69.0	74.1	63.2	59.1	53.4	54.1	48.8	45.9	37.2	36.2	28.3	25.1	18.1	20.6	19.0	22.5	17.7
16.0	65.5	69.8	62.2	52.2	50.1	46.1	42.4	34.0	33.3	33.6	29.9	23.5	23.6	20.8	15.1	18.9	13.4
18.0	59.2	64.5	58.4	51.7	43.6	39.1	39.9	32.8	33.1	30.5	23.0	26.2	24.1	26.2	25.1	25.1	28.1
20.0	52.3	58.4	53.7	44.4	43.9	39.4	37.2	34.2	34.5	35.7	35.9	30.0	29.6	24.2	25.3	27.3	24.1
22.0	50.7	54.5	55.2	53.8	47.5	40.7	42.4	43.0	34.6	32.8	33.2	33.5	29.8	32.5	29.9	24.5	17.5
24.0	48.1	51.3	50.2	48.2	39.4	38.2	38.1	32.1	26.5	26.4	21.3	23.6	17.7	12.3	9.3	13.6	12.5
26.0	44.7	48.0	41.2	33.9	29.2	24.8	17.9	11.4	11.5	9.6	11.8	14.9	9.7	13.9	8.8	5.1	4.7
28.0	41.5	44.8	38.2	33.1	32.5	24.9	22.9	20.1	23.5	18.6	21.1	14.4	10.2	14.4	11.3	12.4	13.4
30.0	34.4	39.6	40.4	38.2	30.1	23.7	23.8	24.9	22.9	25.1	28.1	23.8	17.9	12.5	13.5	10.4	14.6
32.0	29.7	34.6	36.9	31.9	28.4	26.1	28.0	30.8	31.3	25.8	23.7	26.8	25.7	28.6	23.3	20.5	22.8
34.0	28.2	31.4	26.9	29.8	24.4	23.4	20.6	19.9	17.3	14.9	18.7	15.2	11.0	12.1	12.2	6.2	9.7
36.0	27.8	29.6	27.2	24.1	20.1	23.5	22.6	21.8	18.1	15.6	11.4	9.5	9.7	12.9	9.9	5.1	6.7
38.0	22.4	26.0	19.9	22.3	21.5	21.8	21.1	24.4	25.4	28.4	25.1	21.1	18.4	13.0	14.9	16.7	19.4
40.0	20.3	23.1	16.3	11.0	11.1	11.2	14.3	8.2	7.5	7.9	11.3	10.4	9.6	8.8	10.1	4.3	8.9

Make believe heat map...



Actionable Insights:

Adjust mesh antennas (rotate, relocate, or add more) to ensure sufficient coverage across physical space.

Modify Policies to ensure choke points are prioritizing network or compute that is priority

Post It Credit :) - Jenna G.

Trade Show WIFI Visualized - June 2019

Started with Dummy Data... then

https://github.com/rustyoldrake/Catchers_Mitt/blob/master/Signal%20Strength%20Basic%20Data%20Generator.csv

https://github.com/rustyoldrake/Catchers_Mitt/blob/master/Signal%20Strength%20Basic%20Data%20Generator.xlsx

Make believe heat map...

... Real Data - Mapping Signal Strength for Real

mac terminal >

```
while x=1; do  
/System/Library/PrivateFrameworks/Apple80211.framework/Versions/Current/Resources/airport -I | grep CtlRSSI; sleep 0.5; done
```

wifi RSSI - you can script, or just walk around your room and holler to your friend the coordinates and 'level'

Test Flight #2 (Jay Griffin) - Drone Programmed in Node Red to Survey and Get signal strength

Bill of Materials

1x Tello-EDU drone \$99

<https://store.dji.com/product/tello-edu?vid=47091>

* Be sure it is the "EDU" version of the drone. It allows for easier wireless connectivity for accessing the flight SDK

recommended accessories:

spare propellers \$4

<https://store.dji.com/product/tello-propellers>

spare battery \$19

<https://store.dji.com/product/tello-battery?from=compatibility>

battery charging hub \$25

<https://store.dji.com/product/tello-battery-charging-hub>

1x(3x) Raspberry PI Zero W \$10

<https://www.adafruit.com/product/3400>

for \$10 ea. spares are good

I got this kit for a bit more which covered most accessories \$60

<https://www.adafruit.com/product/3411>

1x GPS breakout card \$40

<https://www.adafruit.com/product/746>

Other items

wire spools (4 colors needed, 6 in the pack) \$16

<https://www.adafruit.com/product/1311>

Solder \$8

<https://www.adafruit.com/product/145>

iron \$22

<https://www.adafruit.com/product/180>

solder wick (recommended if soldering novice, mandatory if expert.... or so I'm told) \$3

<https://www.adafruit.com/product/149>

Really short usb cable: \$6 (important for weight and mounting balance)

https://www.amazon.com/CableCreation-Compatible-Kindle-Android-Tablet/dp/B01M5GZ3N0/ref=sr_1_1_sspa?keywords=CC0573-2&qid=1559593854&s=electronics&sr=1-1-spons&psc=1

total ~\$300 depending on replacement part insurance.

==

Prior Work (Pre-POC) - Proof of Concept (Magic Leap)

thanks Jake Madden!

Jake did a POC > he "created a test Magic Leap Unity project that reads in the csv file and creates colored spheres of sizes corresponding to the strength value and similar color scheme to the example table... captured a short video demonstrating on the ML1. It doesn't factor in walls for occlusion presently but could and demonstrates the idea."

Video Demo

The video is around 80mb:

<https://drive.google.com/file/d/1anMDbpGhPwmJgdW0g9LFMvxkqqKu8vUb/view?usp=sharing>

What Next 1?

Weather, Humidity, Pollutants, Altitude impact on propagation and models

https://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp25_mwt_and_5g_FINAL.pdf

What Next 2?

<https://youtu.be/nRN4vUECzRU>

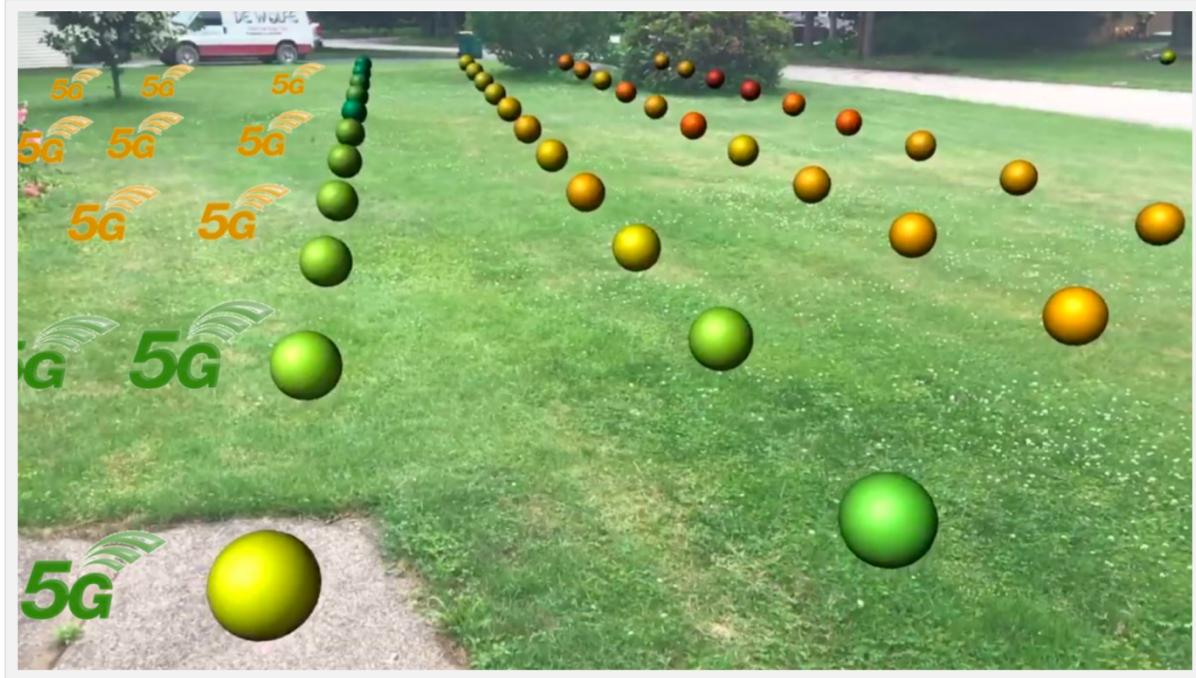
Mini-Project 1 - MANUAL MAP - Do some REAL WORLD signal strength mapping (hand hold a Mac, or phone) and manually create a (A) WIFI Strength ; (B) LTE / 4G Signal Strength

Mini-Project 2 - DRONE Survey - program a drone to SURVEY an area - 1 meter grid coordinates, measure, move , measure, move (could also be a ROOMBA)

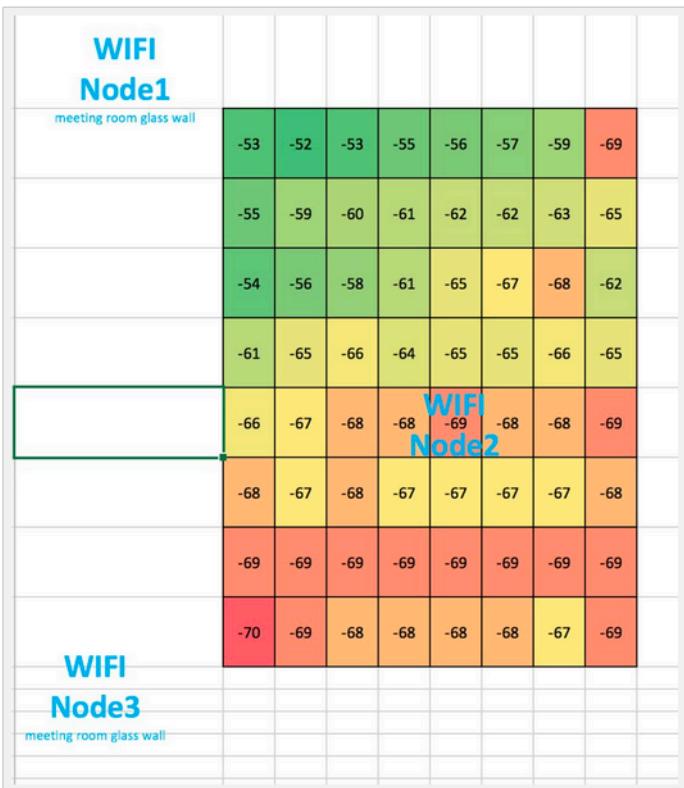
Mini-Project 3- Explore 3D mesh of Room / Environment (thanks Joe P!) <https://www.6d.ai/> APIs for Augmented Reality and the AR Cloud. With just a smartphone camera, 6D.ai's SDK creates a 3D mesh of the world around you. App developers can easily relocalize multiple cross-platform players into the same coordinate system. Objects remain persistent across sessions while respecting occlusion (JP > for "signal strength demo could be that you only see the spheres that are within your view")

Mini-Project 4 - GHOST Protocol - visualizing an after-image for security or perimeter monitoring

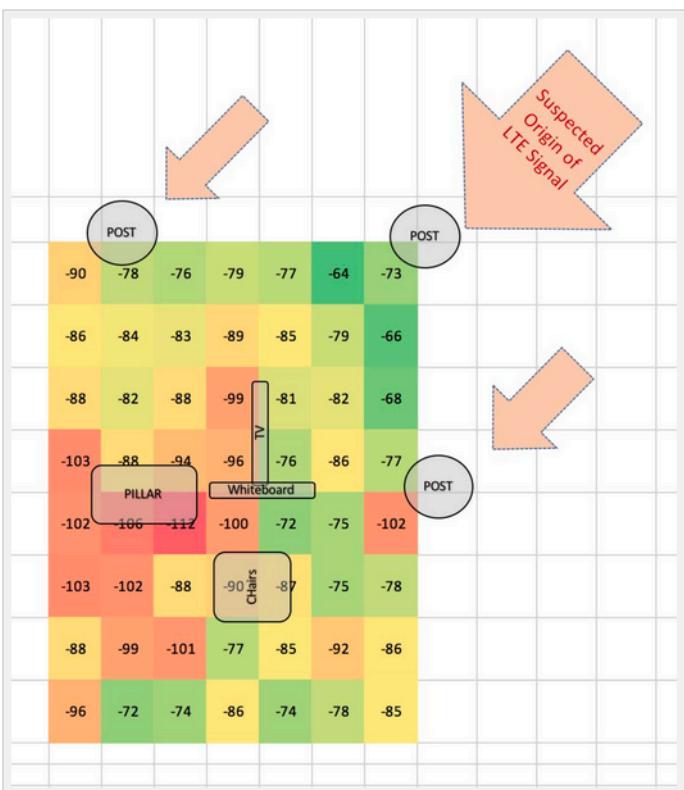
Mini-Project 5 - overlay multiple frequencies - e.g. 5G and LTE and WIFI on same viz (find juicy network in a stadium or event)



M Watson Studio



Guess which WiFi node our MAC was connected to? :-)



IBM Watson Studio

<https://www.ibm.com/cloud/watson-studio>

IBM Immersive Data:

https://www.youtube.com/watch?time_continue=111&v=6Nni5ywbEqo

For Later:

Dial and call "*3001#12345#" to enter iOS Field Test mode.

<https://medium.com/ibm-watson/visualize-high-dimensional-data-fast-watson-studio-ebad7e7e1b6a>

Guess which WIFI node our MAC was connected to? :)

OTHER LINKS

Finding Hidden Cells Phones in Prisons

<https://medium.com/@gwilymnewton/finding-hidden-cells-phones-in-prisons-16421352e039>

