QinetiQ Young Engineers' Scheme 2017-18

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Introduction

QINETIQ

- We were given a problem and had to create a logical solution
- Electronic device had to:
  - deploy rapidly
  - autonomously report the target position
  - be relatively inexpensive

Project Aims

- Portable device that uses radio signals to report the target device's position
- Design a fully functional end product
- Planning, user requirements, research, and creating a solution
- Functional prototype created

Requirements

- Deploy rapidly
- Shows position of the target
- Cheap as possible
- Lightweight and portable
- Locates target as quickly as possible
- Sturdy and Robust

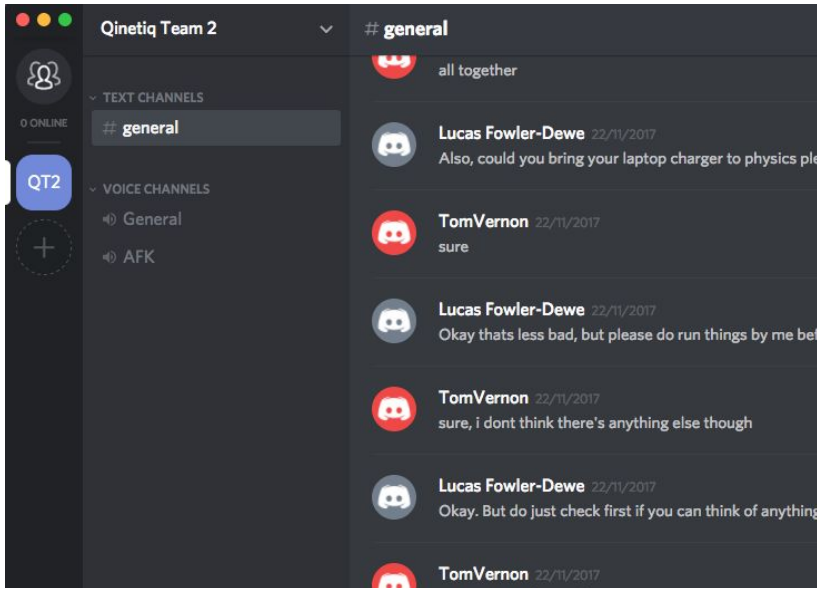
Job allocation

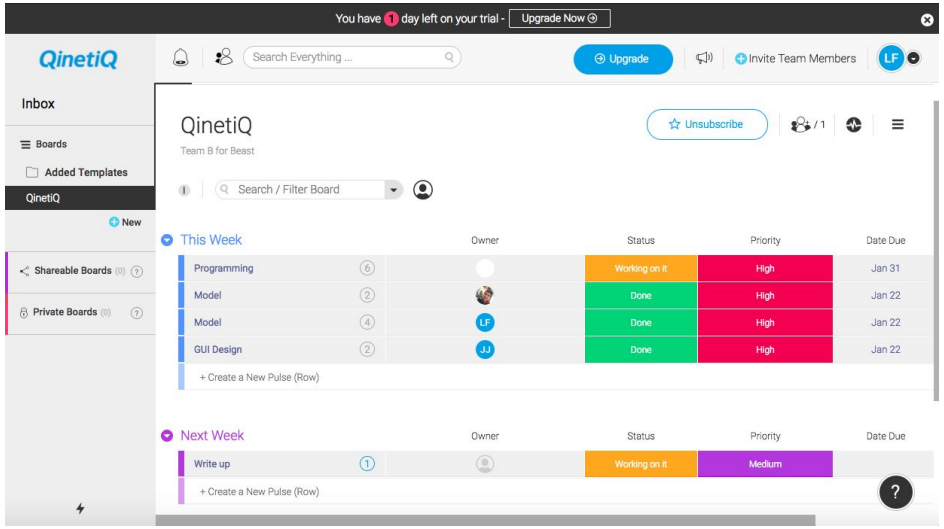
Jasmine - Research and Planning.

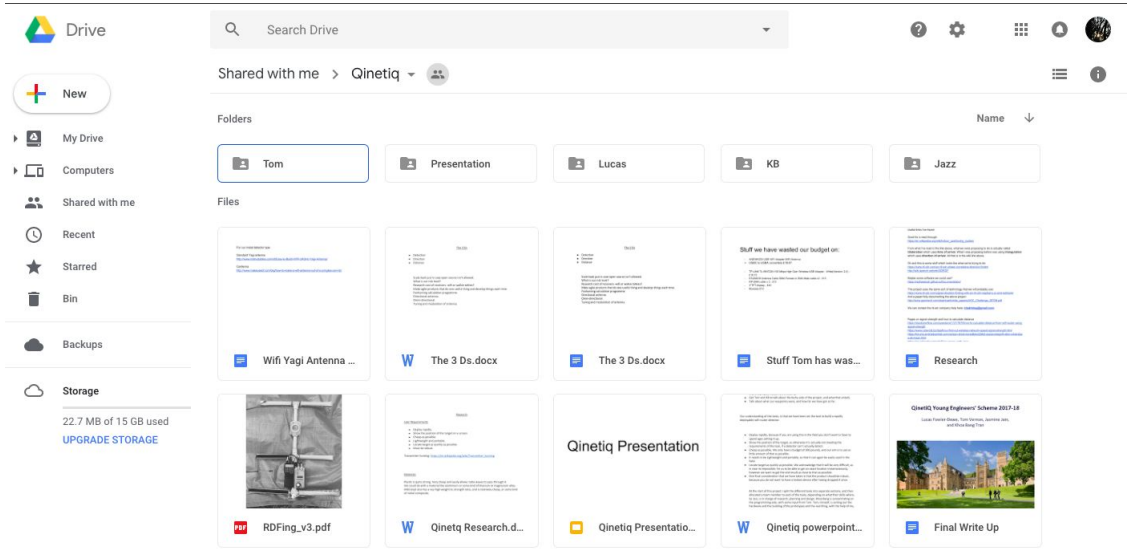
Khoa Bang - Programming.

Tom - Hardware and Prototyping.

Lucas - Design, Prototyping and Planning.



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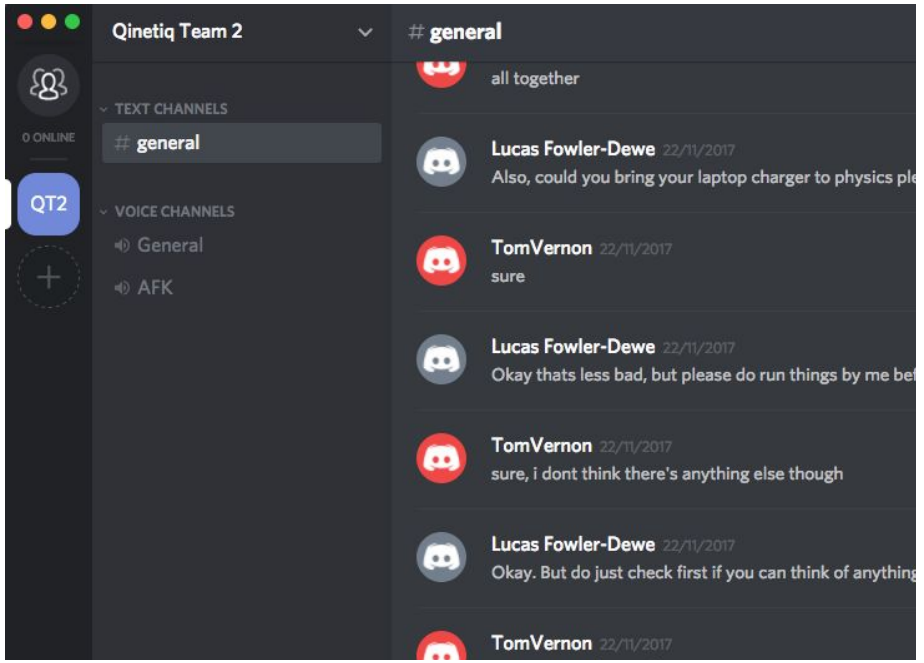
Final Write Up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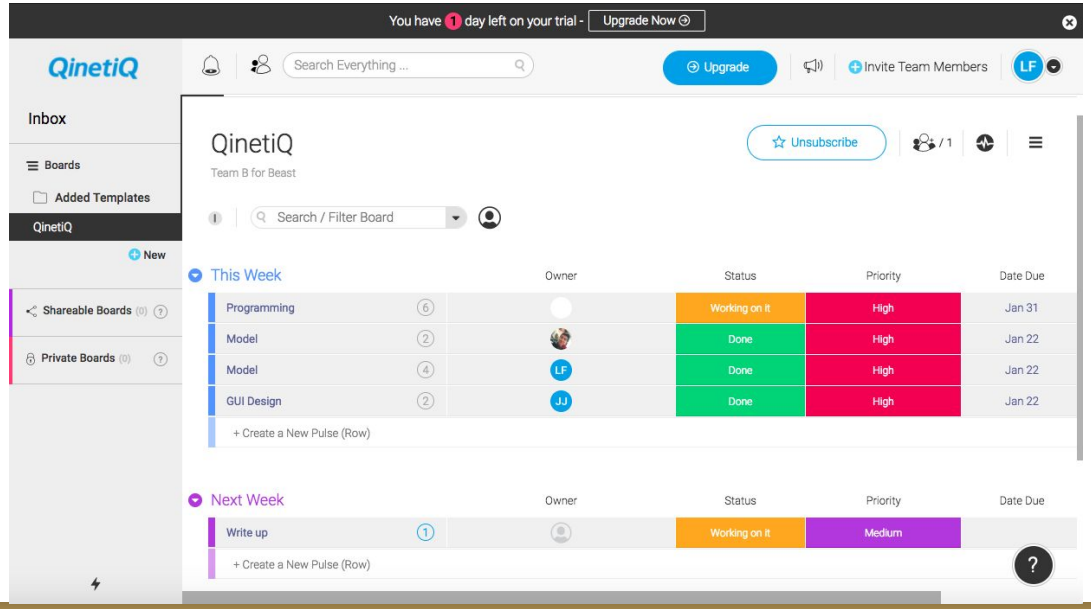
all together
Lucas Fowler-Dewe 22/11/2017
Also, could you bring your laptop charger to physics pl
TomVernon 22/11/2017
sure
Lucas Fowler-Dewe 22/11/2017
Okay thats less bad, but please do run things by me be
TomVernon 22/11/2017
sure, i dont think there's anything else though
Lucas Fowler-Dewe 22/11/2017
Okay. But do just check first if you can think of anything
TomVernon 22/11/2017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QinetiQ
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Date Due
Programming
Working on it
High
Jan 31
Model
Done
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Jan 22
Model
Done
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Jan 22
GUI Design
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High
Jan 22
+ Create a New Pulse (Row)
Next Week
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Date Due
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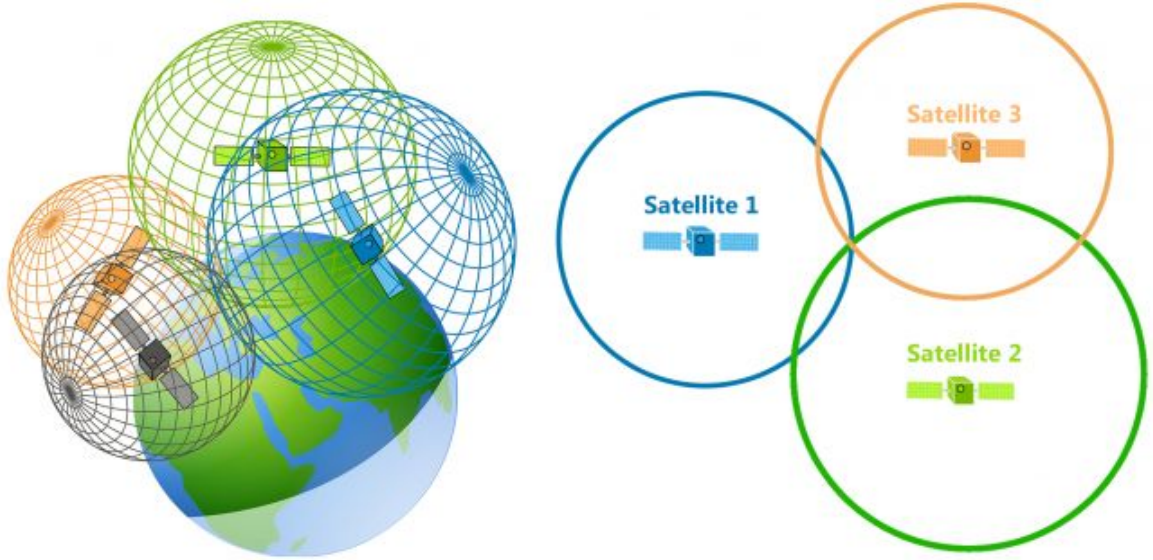
Working on it
Medium
+ Create a New Pulse (Row)

Research

- Trilateration
  - Time of arrival
- Triangulation
  - Angle of arrival
- Doppler
  - Time of transmission and arrival
- Distance Signal strength
  - To inaccurate
- Examples on the internet

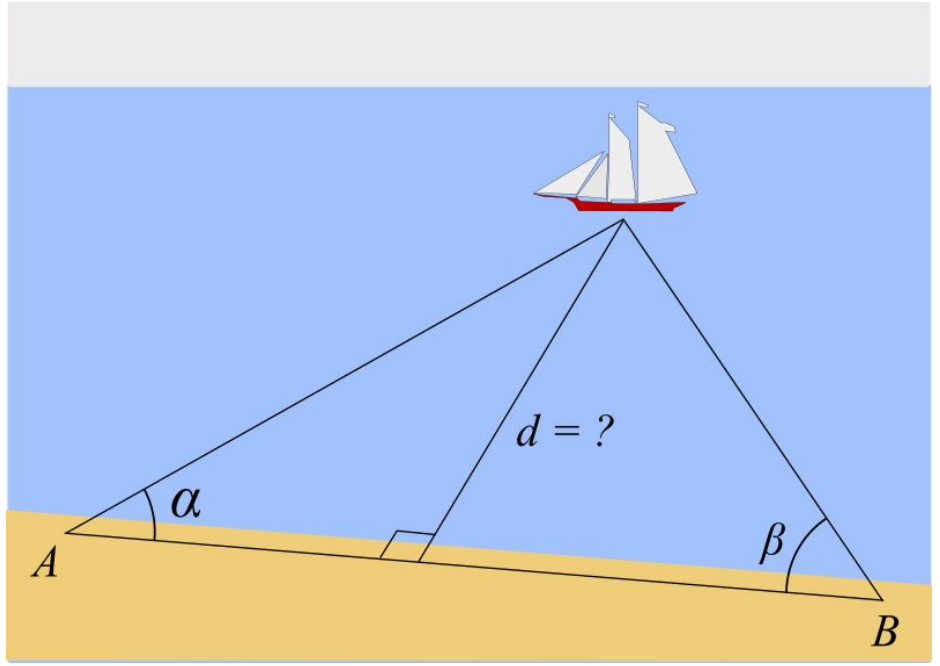
Trilateration

- Used to calculate location of an object on a map or grid
- Works using time of arrival of a signal across three known points
- GPS and Earthquake location use this method



Triangulation

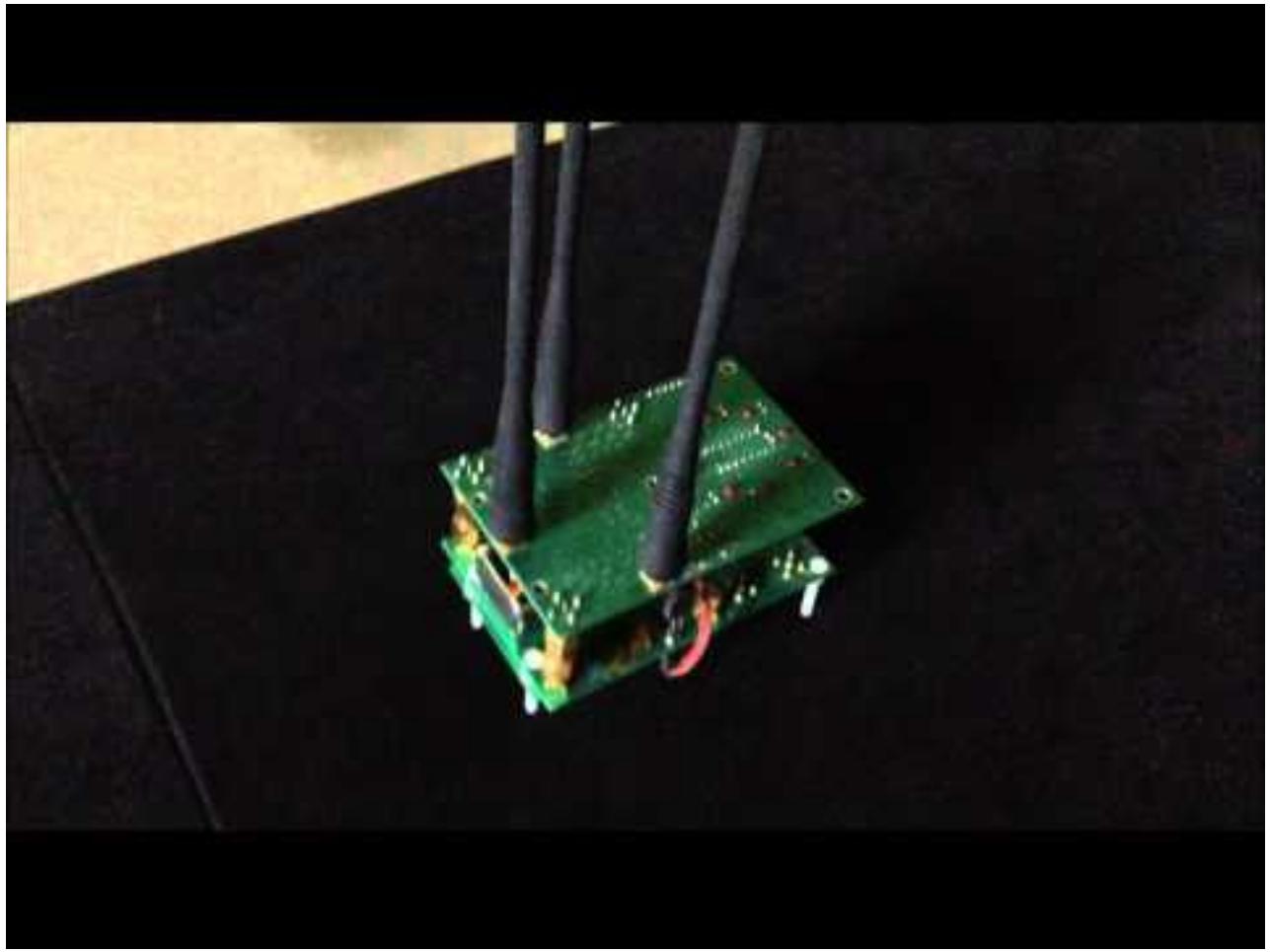
- Used to calculate the distance of an object from two known points.
- Cannot calculate direction by itself, requires rotation
- Uses simple trigonometry
- Fox hunting



Doppler

- Uses time between emission of a signal, and receival of the reflected signal to calculate distance.
- Direction is calculated typically by the antenna constantly rotating
- Used typically in nautical and aeronautical navigation

Examples on the Internet

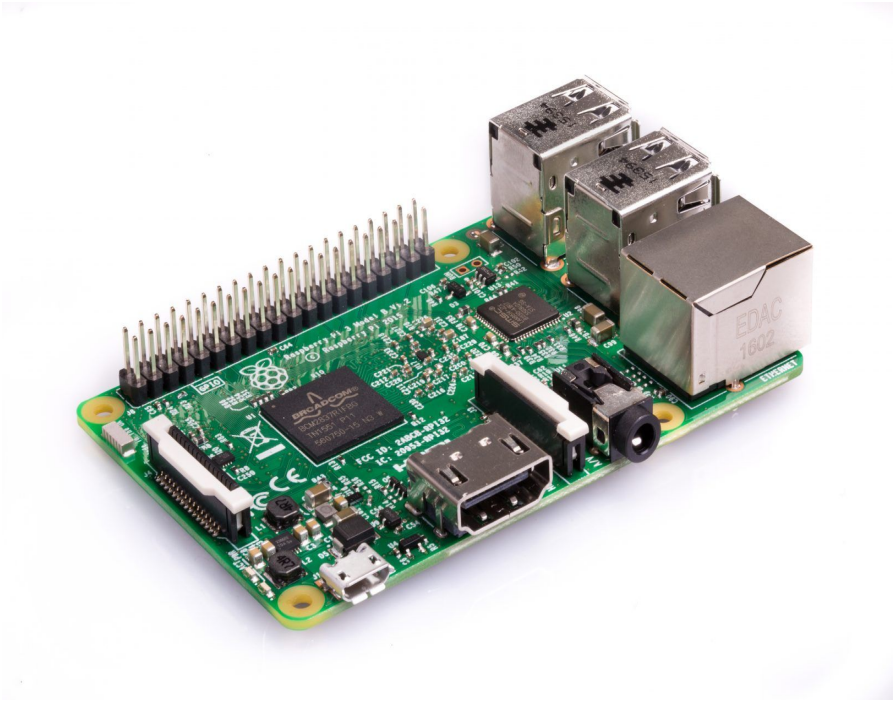


- Very similar device to our own project
- Very Compact
- Triangulation
- No instructions/links/help in video for us to carry forward our research

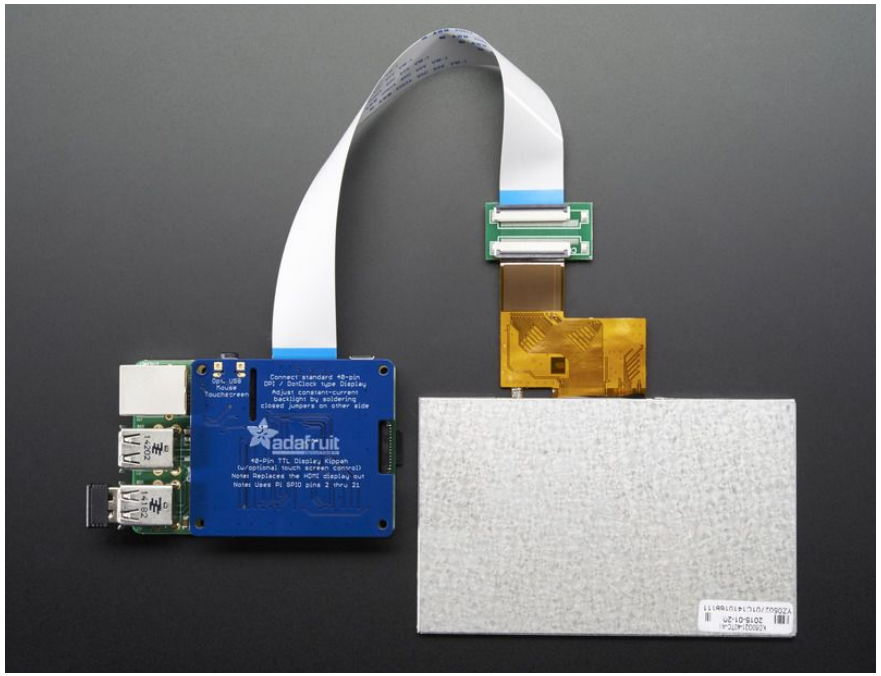
Hardware

Electronics

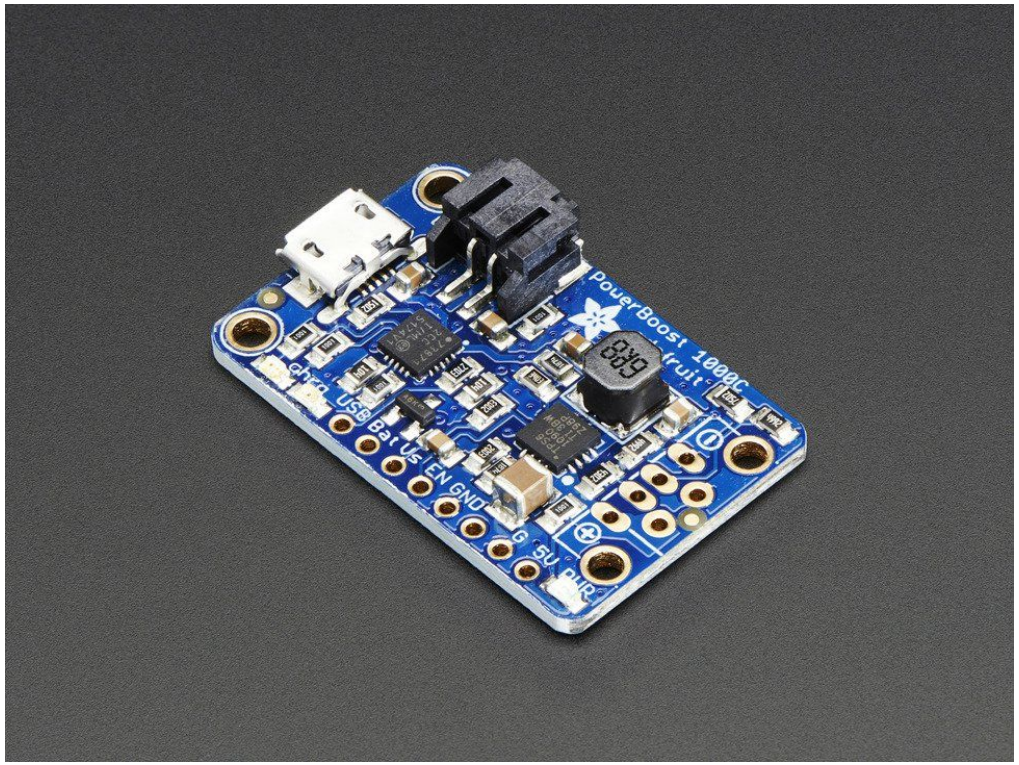
- Raspberry Pi
  - Cheap - £30
  - Compact - size of a thick wallet
  - Popular - **should** have lots of online support and good compatibility
  - Easy to use - works like a normal desktop computer
  - Tom had one



- **Display**
  - Running directly off GPIO pins to make power management easier
  - Removes need for 2 power supplies
  - Touch screen to remove need for external mouse
  - Initially a generic 7” TFT display with a DPI display kippah (stopped working)
  - Hyperpixel 5” TFT display hat



- **Power**
  - 4400mAh Battery - plenty of battery life
  - Powerboost 1000 battery charger (stopped working)



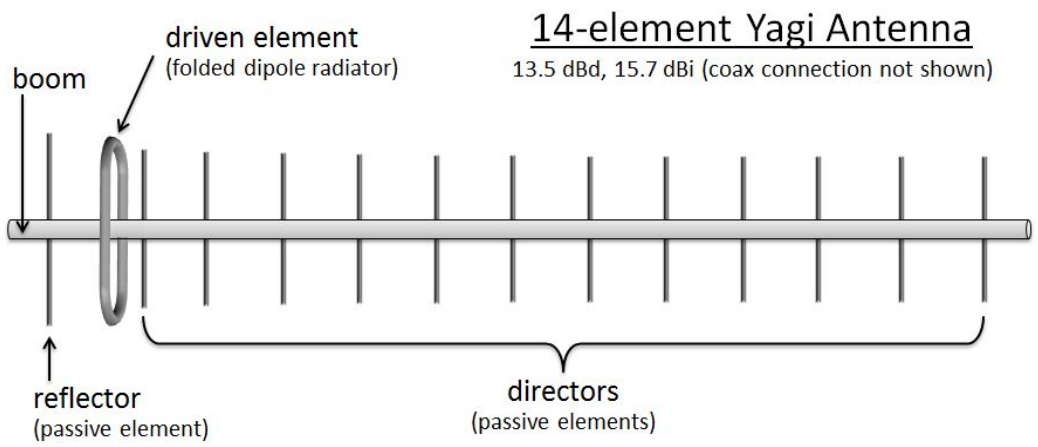
Directional Antennas

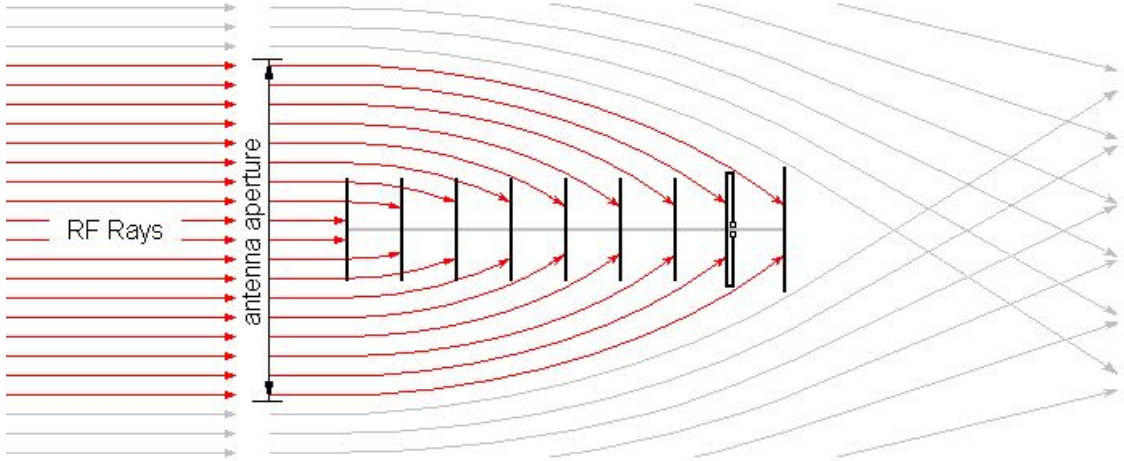
- 3 main viable types of directional antennas:
- The Uda Yagi antenna
- The "Cantenna"
- The Parabolic antenna

- Looked into Yagi Antenna first
- Fox Hunting!
- Only uses detection and direction.
- Null finding

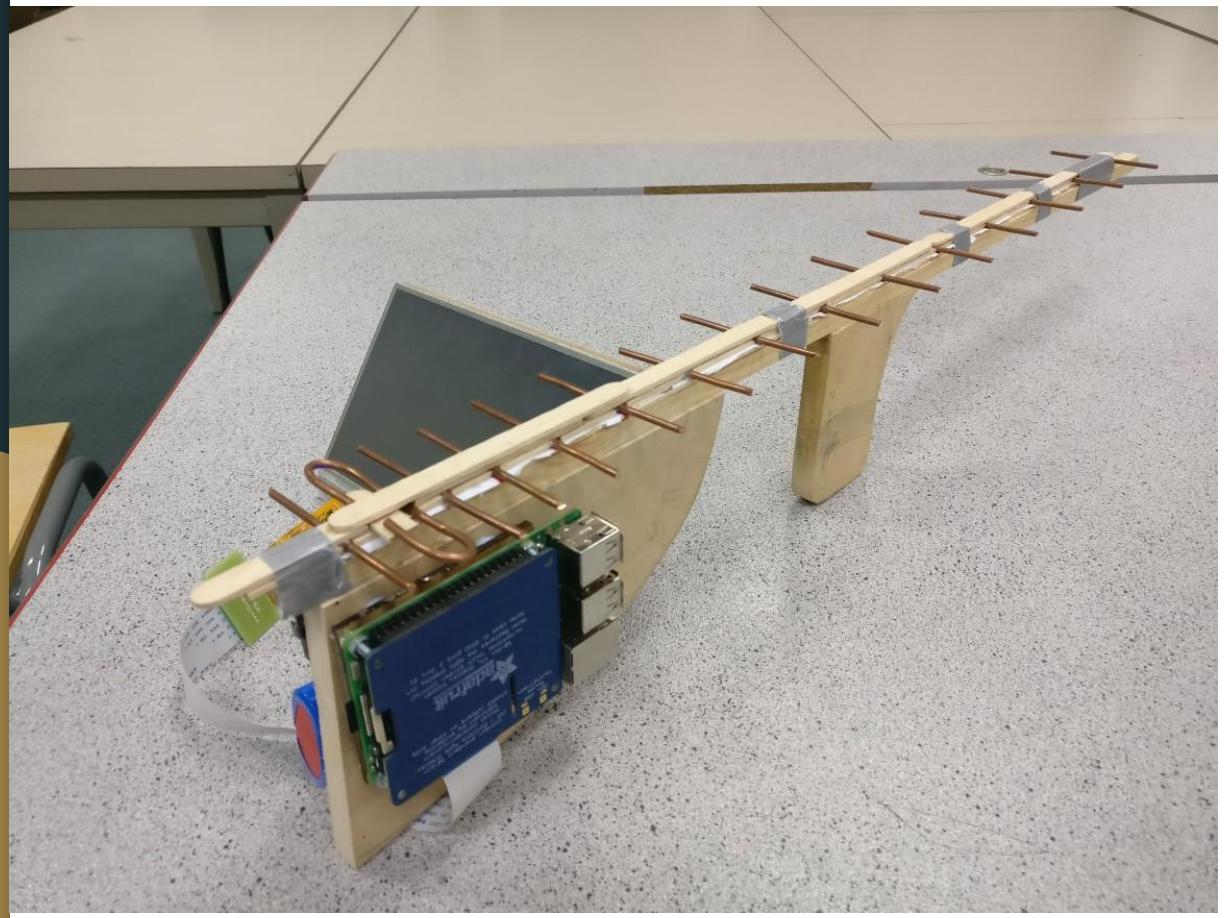
How does a Yagi antenna work?

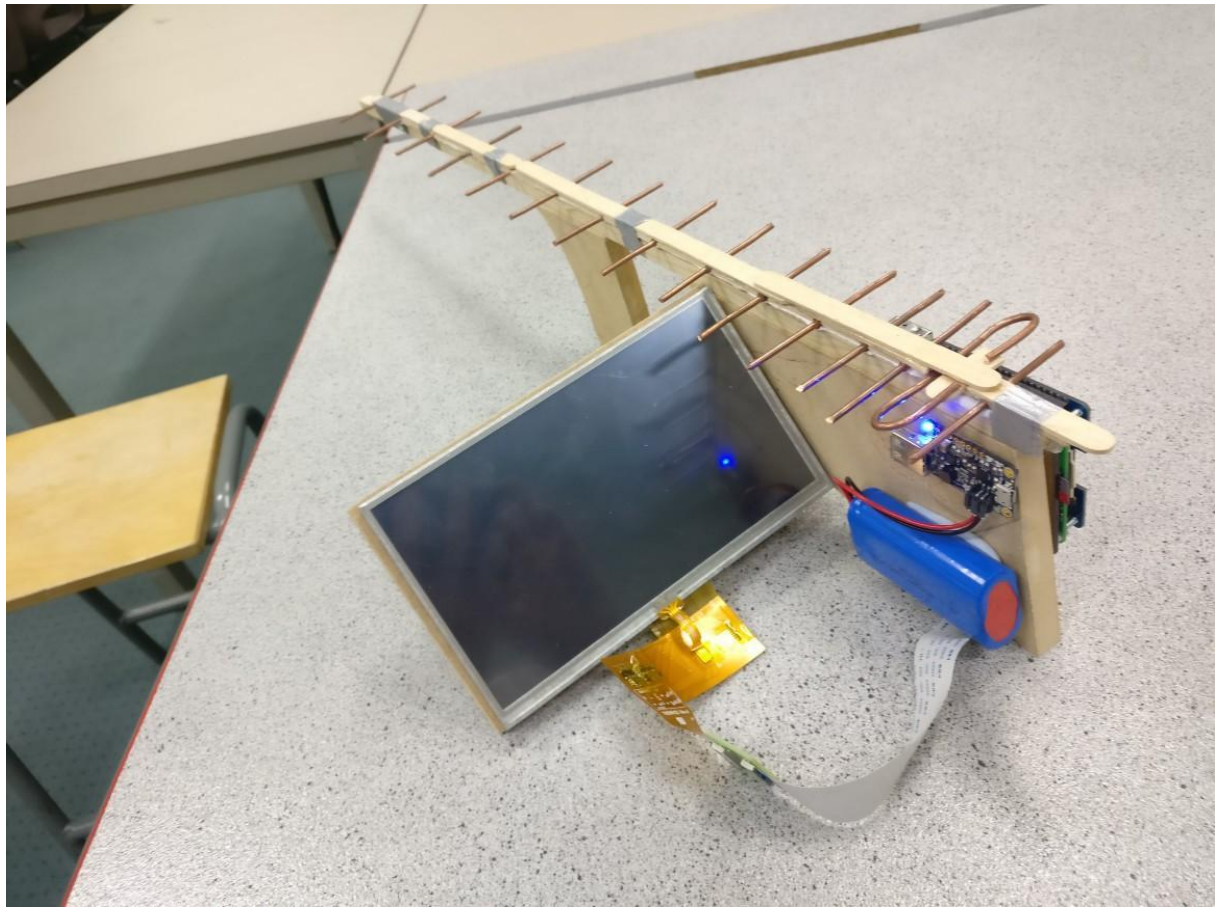
- It's directional
- Spacings between "elements" are specific to the frequency
- “Director” elements focus signal towards “driven” element
- “Reflector” element reflects back signal that missed driven element





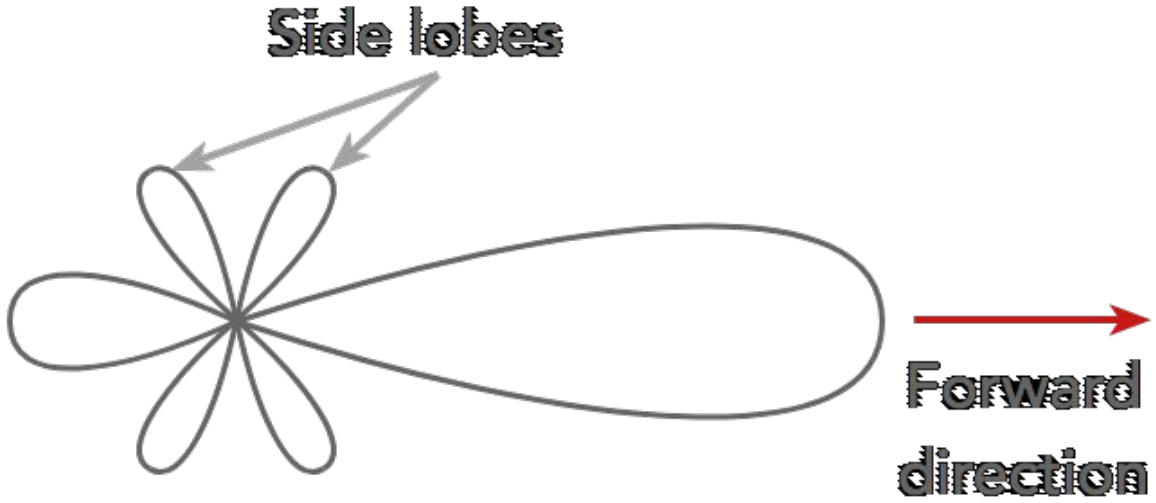
The Yagi antenna prototype (of the prototype?)





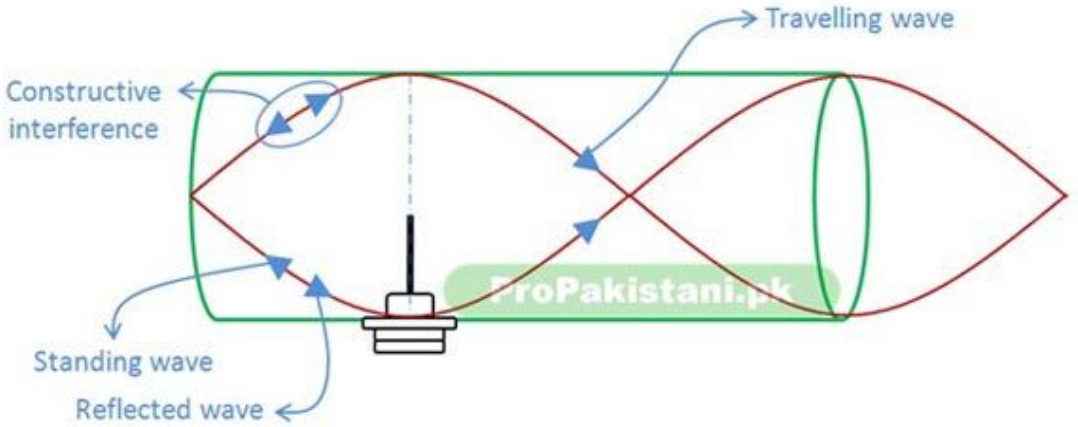
What went wrong? (and what did we learn?)

- Yagi antennas aren’t fully directional.
- At close proximity, difficult to tell apart side lobes to the main lobe.
- Measurements may not have been accurate enough to be effective



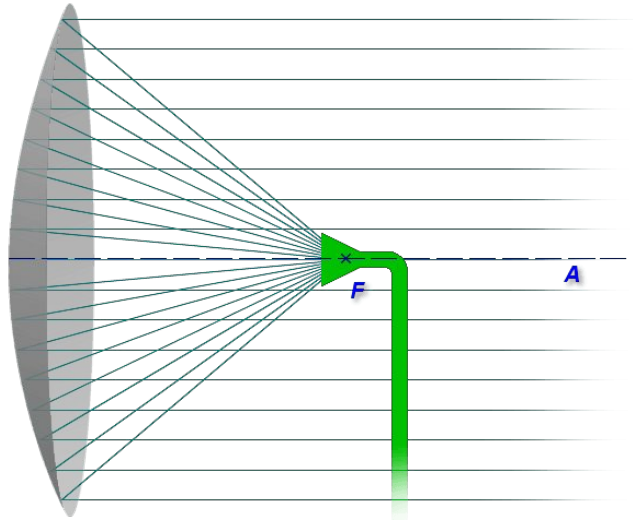
So... What Next?

- We decided to look into other antennas
- Cantenna
  - works by lining up phase of signal coming into antenna with the same signal reflected off the back
  - Creates constructive interference -> increases amplitude, therefore gain
  - Used for short range directional internet access eg: to a garden shed, linking 2 buildings.

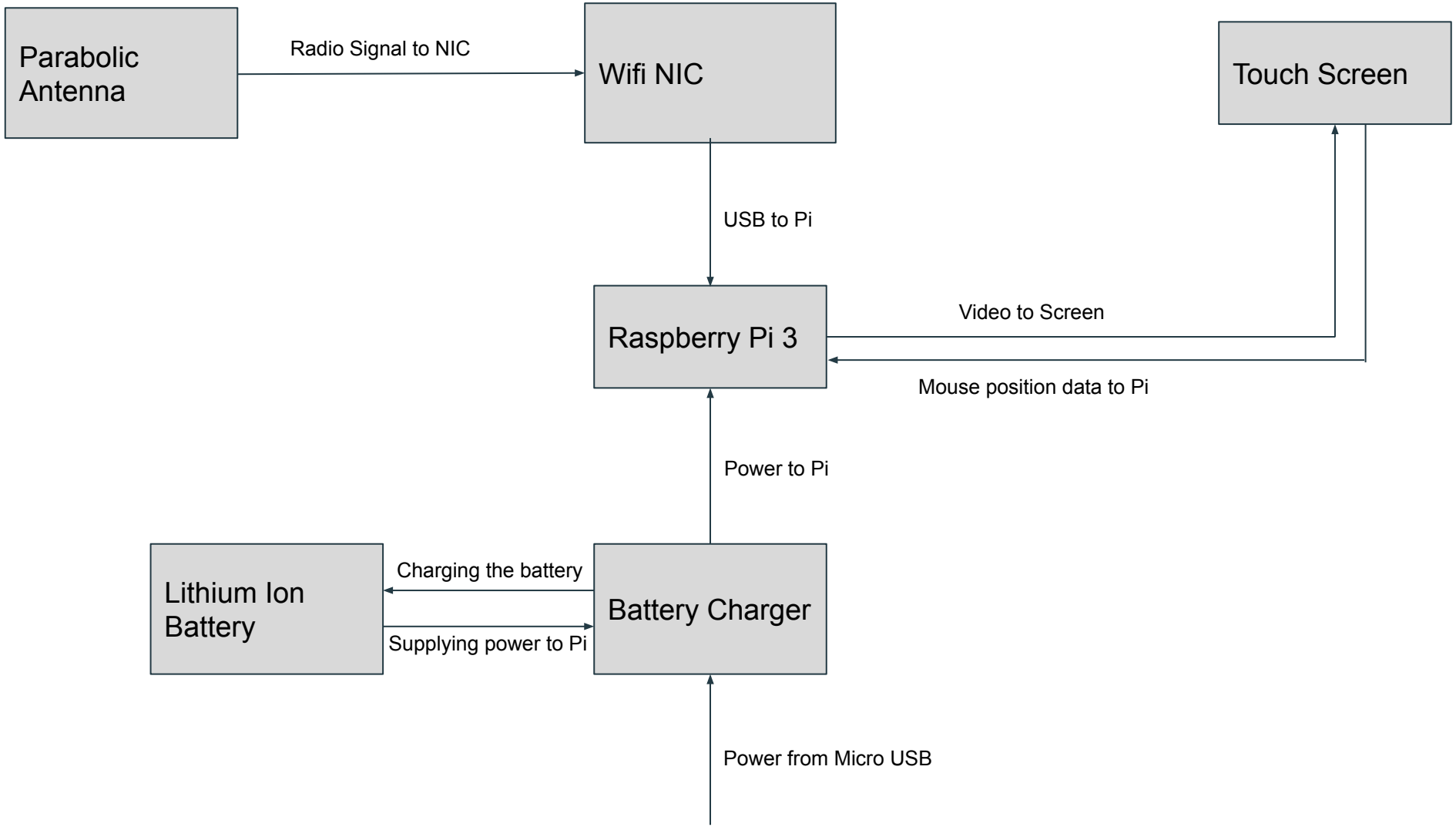


Parabolic Antenna

- Decided to go for this antenna
- Highest gain of all types
- Works by reflecting signal off a parabolically shaped dish to a receiver/transmitter
- Extremely long range
- Much smaller lobes than other designs, better direction distinction
- Used for:
  - Satellite communication (GPS, TV, etc)
  - long range WIFI WAPs
- TP-LINK TL-ANT2424B 2.4 GHz Grid Parabolic Antenna



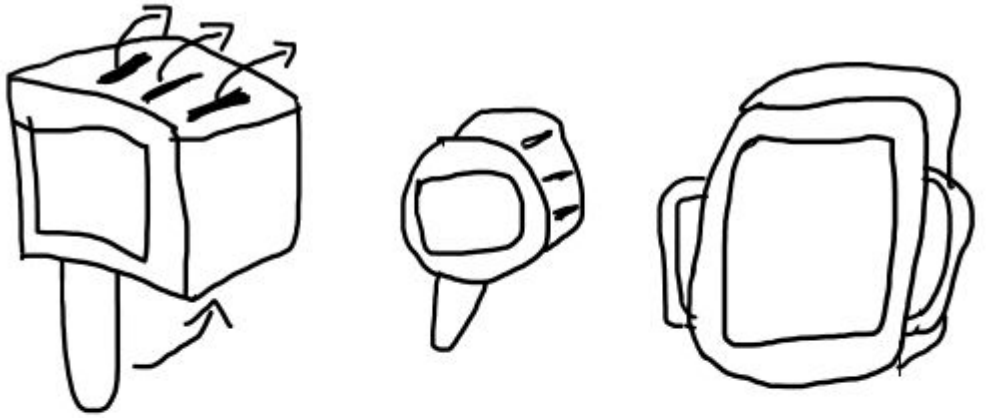
Hardware


Parabolic Antenna
Radio Signal to NIC
Wifi NIC
Touch Screen
USB to Pi
Raspberry Pi 3
Video to Screen
Mouse position data to Pi
Power to Pi
Lithium Ion Battery
Charging the battery
Supplying power to Pi
Battery Charger
Power from Micro USB

Design

Initial design

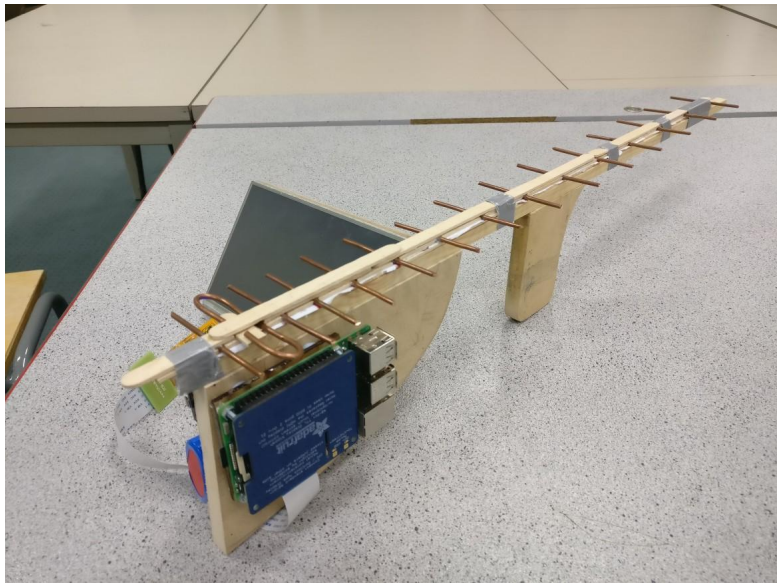
- Three antennae.
- Screen.
- Handle for support



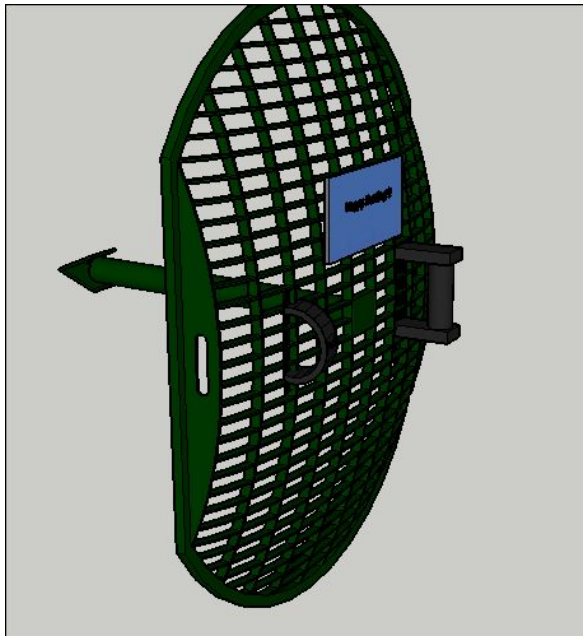
Design

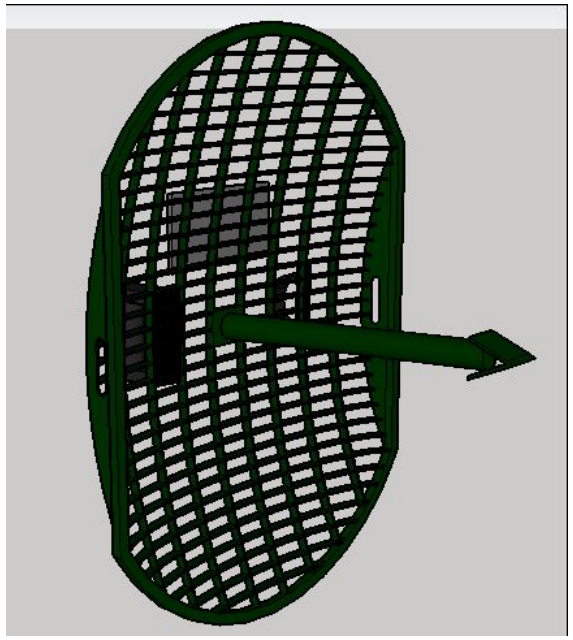
Military-Today.com

- Foldable for better transportation.
- Use more lightweight materials.
- Gun type features.
- Mounts.



Final Design





Pricing

Item	Price
Raspberry Pi 3	£32
4400mAh Lithium Ion Battery	£15
Battery Charger	£8
Parabolic Antenna	£60
Wifi NIC	£13
Touch Screen	£40

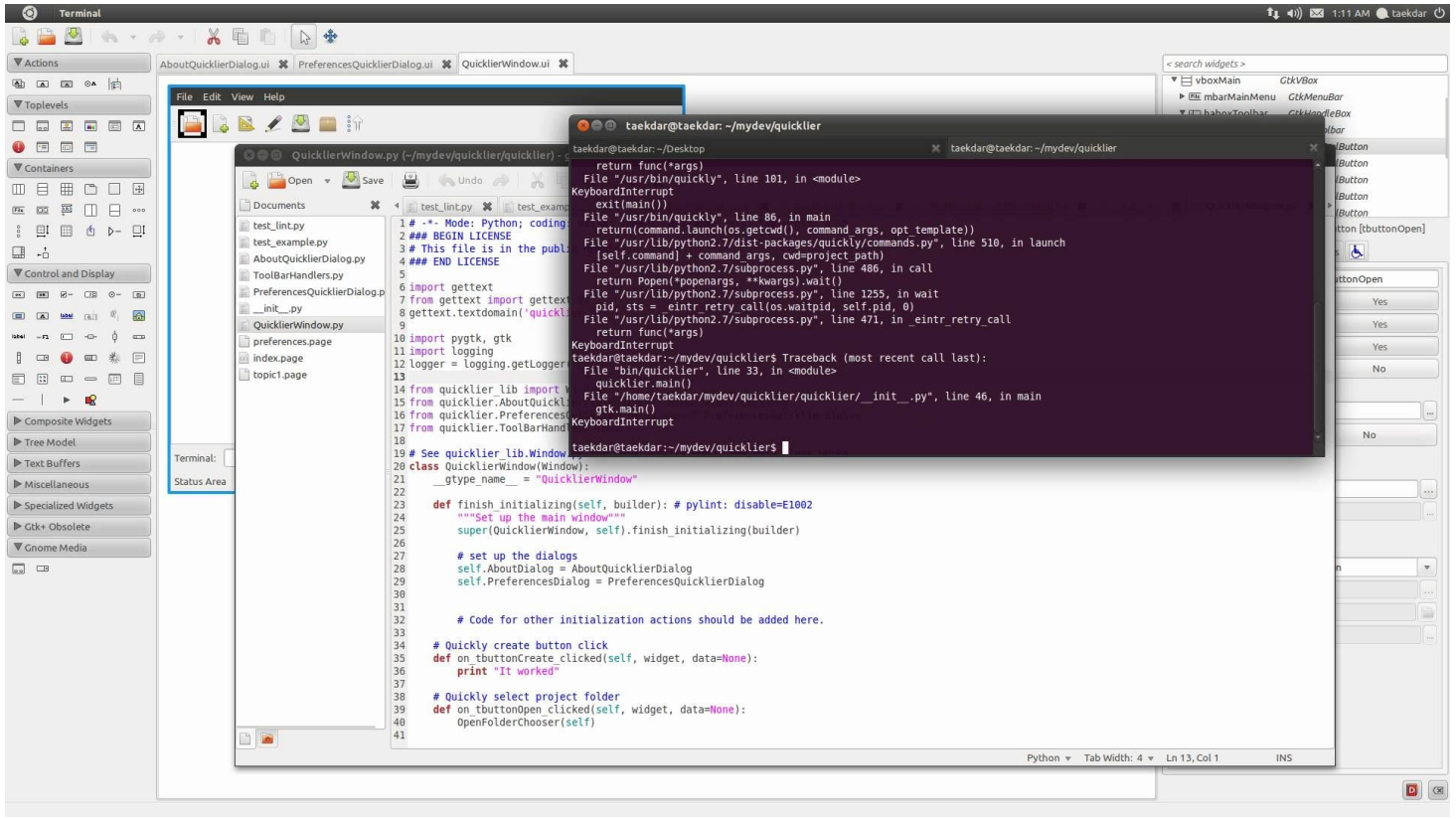
Total - £168

- Price is higher than we wanted
- Could maybe reduce costs on cheaper touch screen and smaller battery

Software

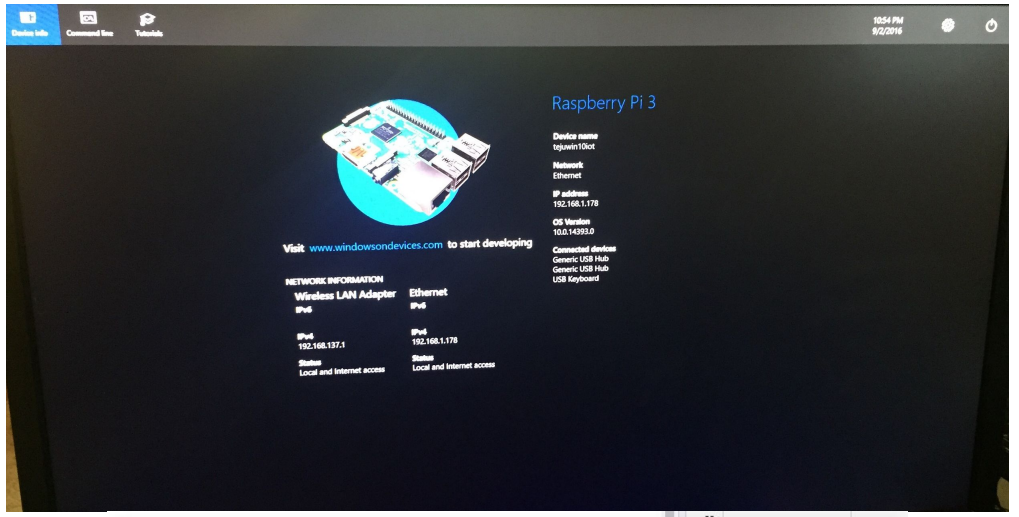
Linux

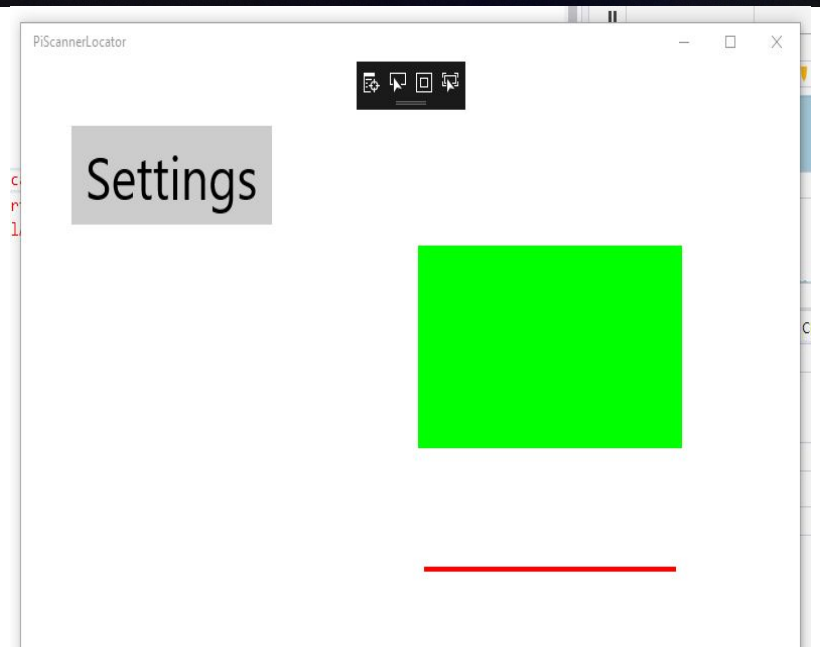
- Raspberry pi
- Ubuntu Mate
- Functionality
  - Detection
  - Strength
- Linux app:
  - Python 3
  - Modules
- Compatibility
  - WiFi NIC
  - Ubuntu



Windows

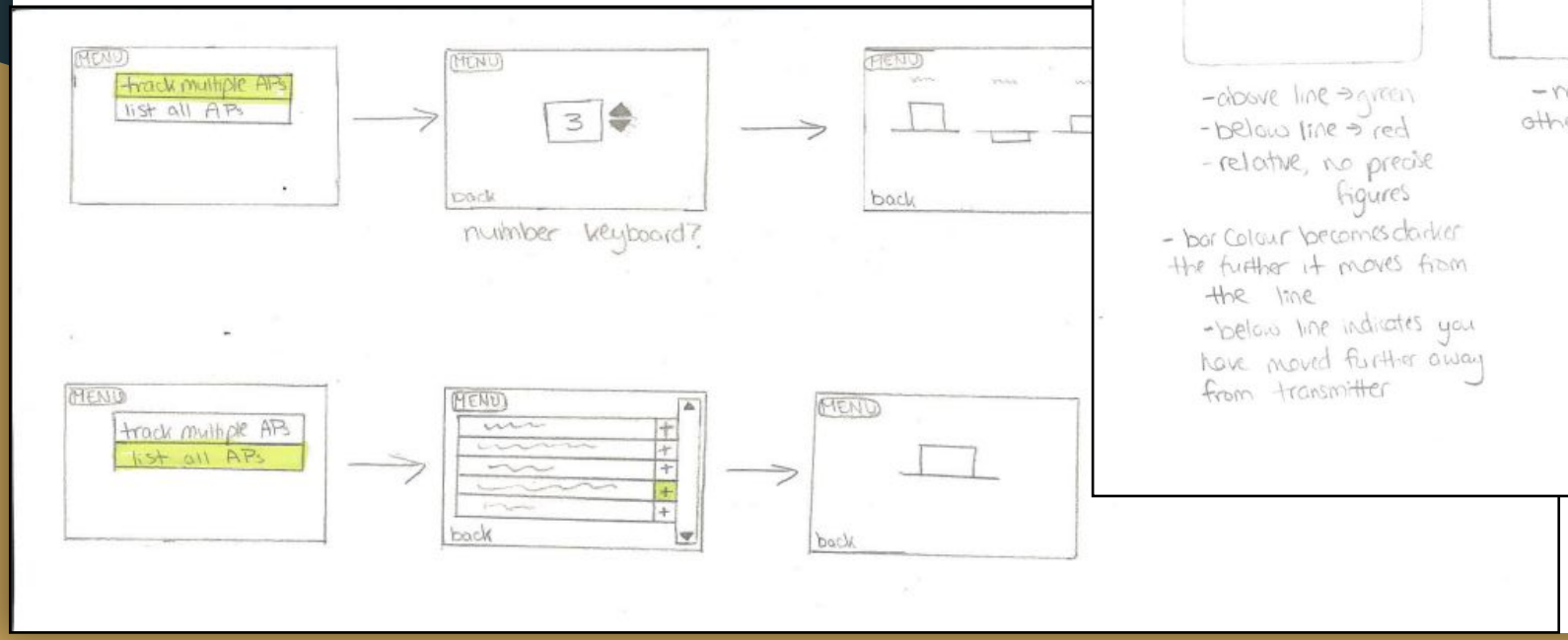
- Windows IoT Core
- Documentation
- Built in modules
- GUI support
- C#
- C#

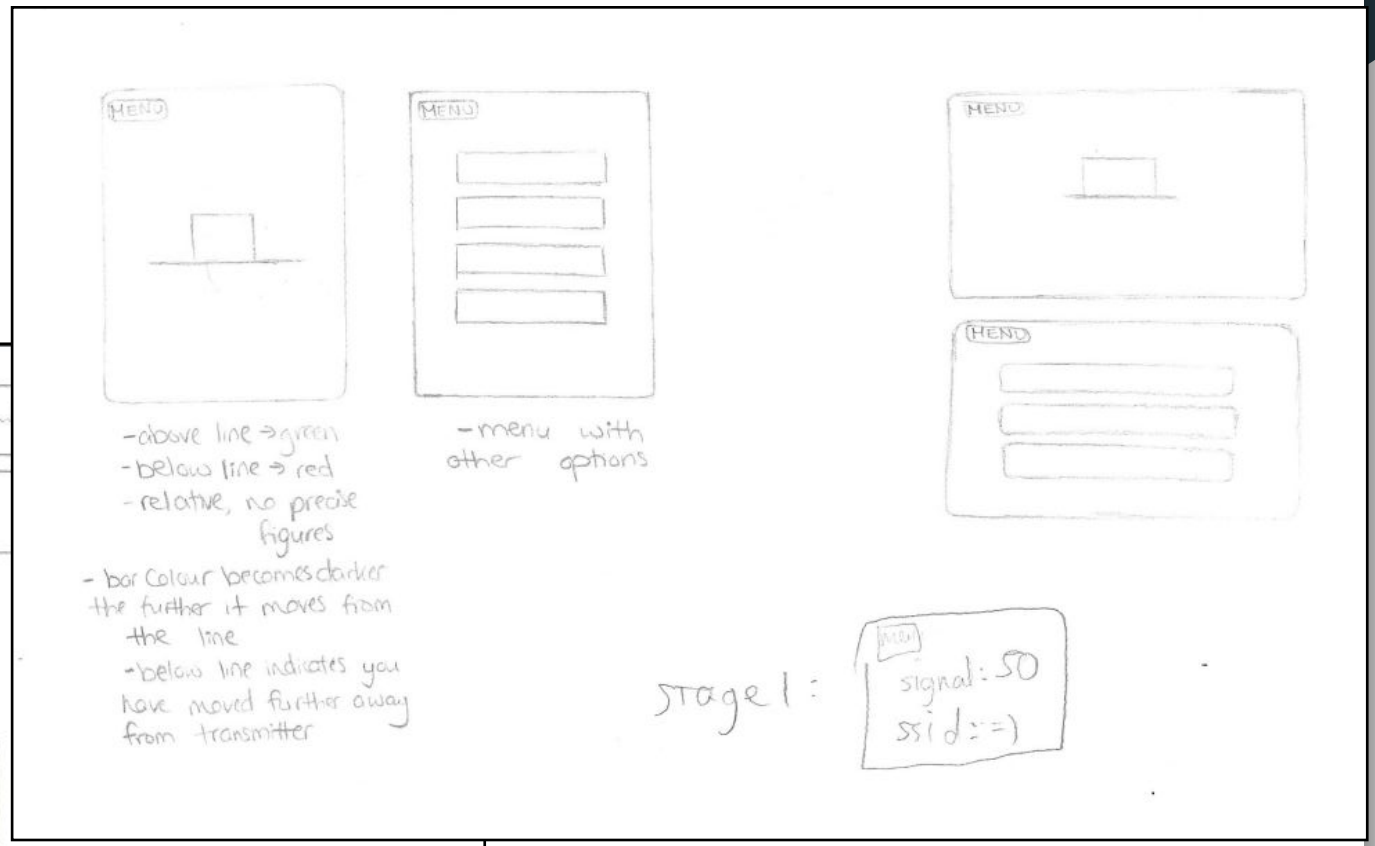




Meanwhile - User interface

- Mockups
- Easy to understand and use
- Simplicity

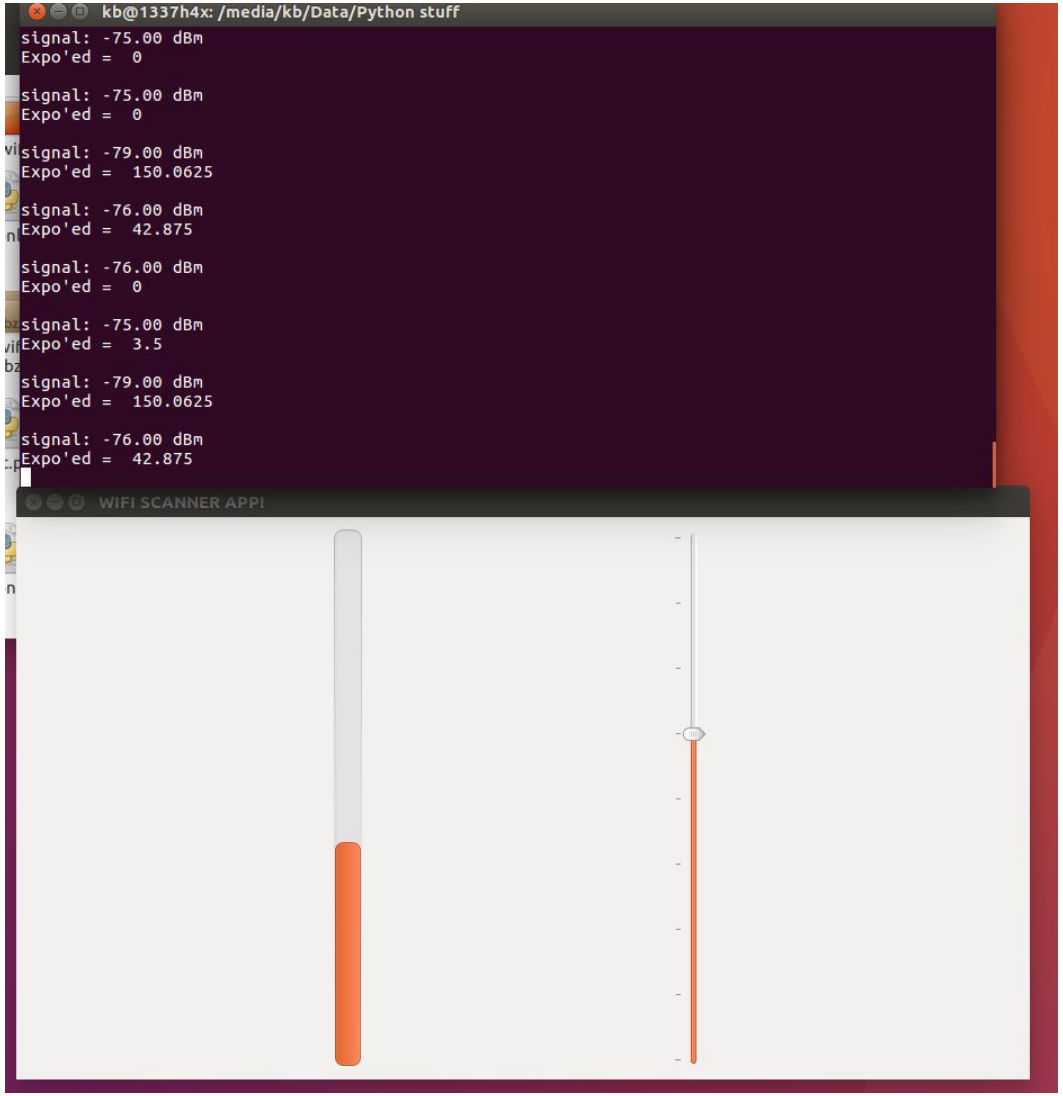




Windows stopped working

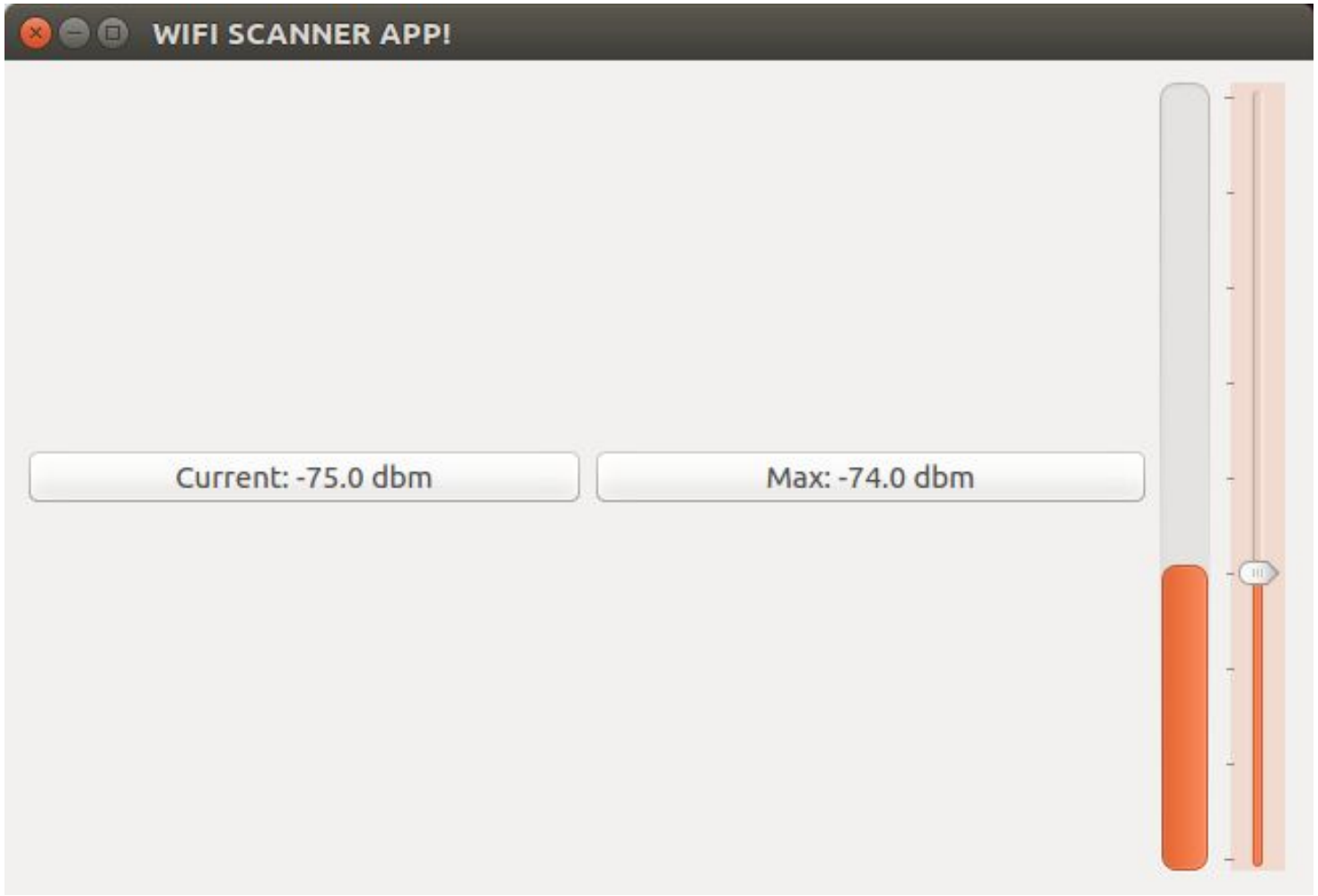
Back to Linux

- Too long to troubleshoot
- Windows for next revision
- Easily transferable
  - Math
  - Logic
- GUI - PyQt
- Minimalism



Final program

- Refresh rate limitation
- Current, max added
- Max reset button
- Chose adapter, mac address



- Using a standard phone charger as power
- Tom defined a boundary
- KB had to find the transmitter within the boundary
- A mouse and keyboard is still needed to run the script - no right click or enter on touch screen

Demonstration

WIFI SCANNER APP!

Current: -75.0 dbm

Max: -74.0 dbm

Did we meet the requirements?

- Deploy rapidly - Relatively, yes
- Shows position of the target - No, aids the user in finding the “target”
- Cheap as possible - Cheap components were used, but they could have been cheaper
- Lightweight and portable - to a certain extent
- Locates target as quickly as possible - As long as the user is using it correctly, yes
- Sturdy and Robust - The prototype, could easily be constructed from more robust materials

Questions?