Direction Finding Workshop

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Agenda

- Basic Techniques
  - Body Blocking
  - Directional Antennas
  - Passive and Active Attenuators
  - Triangulation
- Advanced Techniques
  - Doppler and TDOA
  - KN2C
  - Kraken
  - Doppler Systems
- Outdoor Demonstration

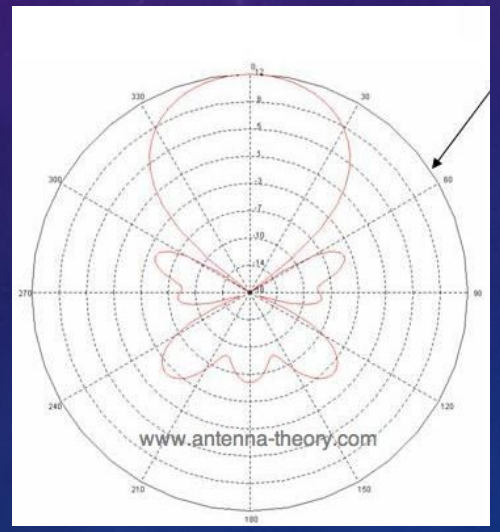
Basic Techniques

Body Blocking

- All it takes is an HT!
- Hold close to your chest and turn around
- Weakest signal indicates when you're facing away
- Use your body as an attenuator

Directional Antenna

- Antennas with directional gain
- Yagi and Log-Periodic

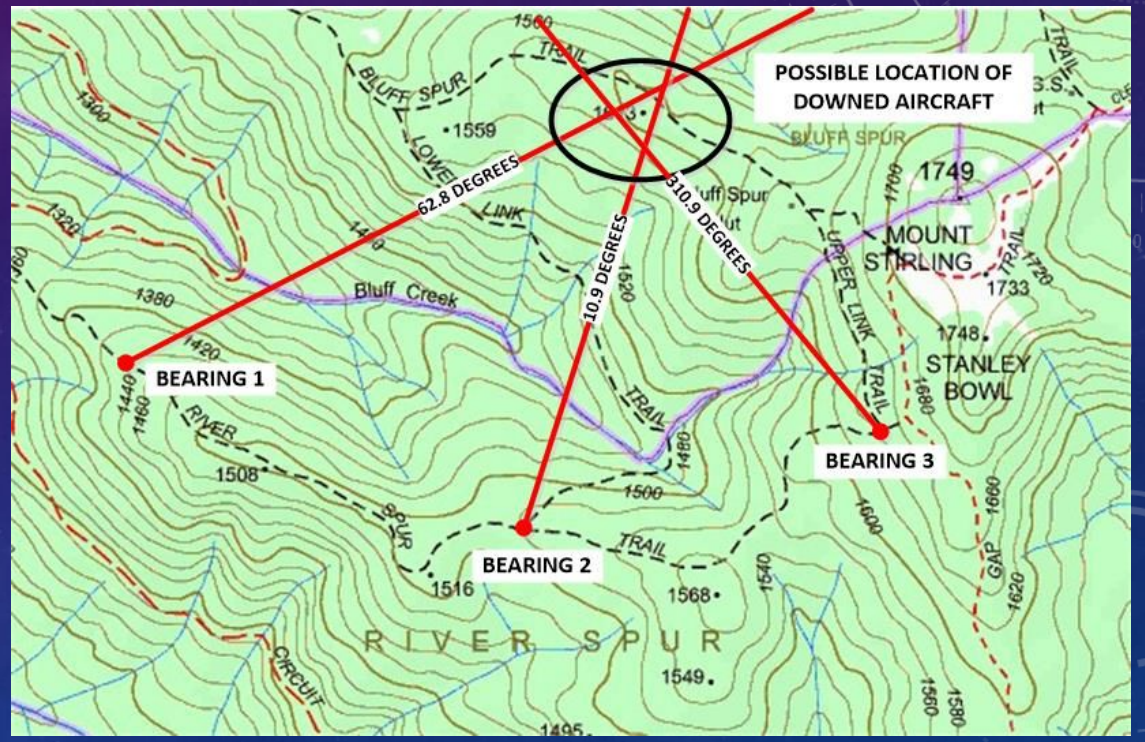


Attenuator

- Once close to the transmitter, even directional antennas can get swamped
- Attenuation can “turn down the volume” on the signal
- Passive vs Active Attenuation

Triangulation / LOP

- Once you know which direction the transmitter is, do you go directly toward it?
- Move in the oblique direction and take another bearing 2-3 times
- Avoids overshooting the transmitter, and helps identify bouncing
- Lines of Position (LOP) - thx Brad!



Super Tangent Time

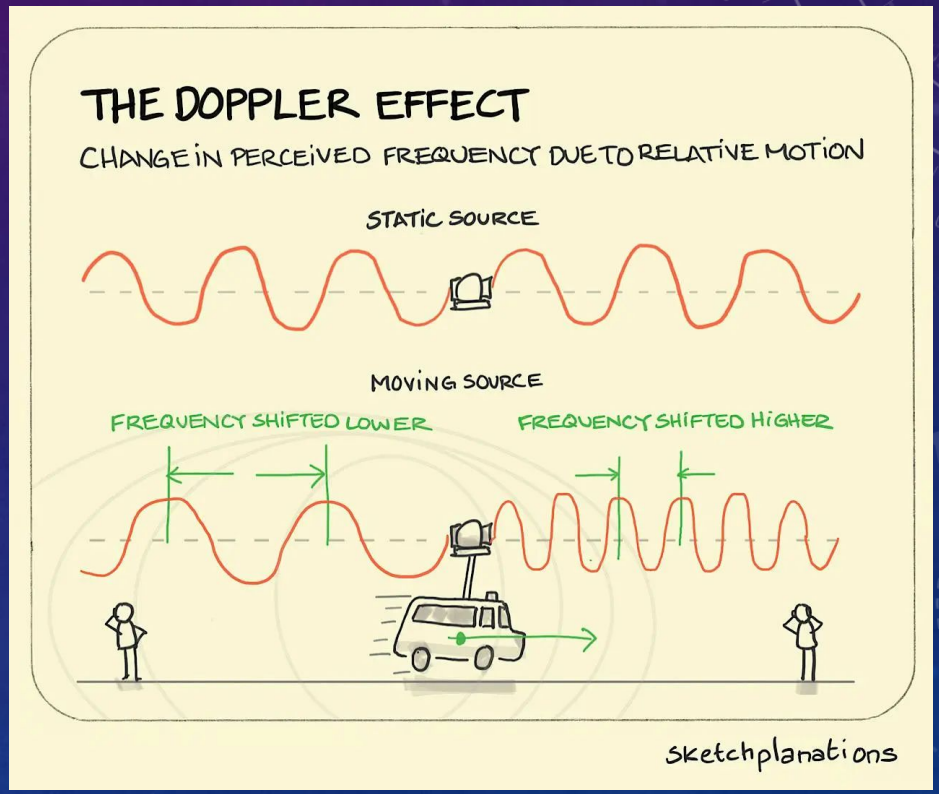
- Call Of Duty - Black Ops (2010) had a numbers station as a Macguffin 😁
- Sleeper agents could hear broadcast in their head 😕
- Impossible to figure out where the signal was coming from? 😞

Advanced Techniques

Doppler and TDOA

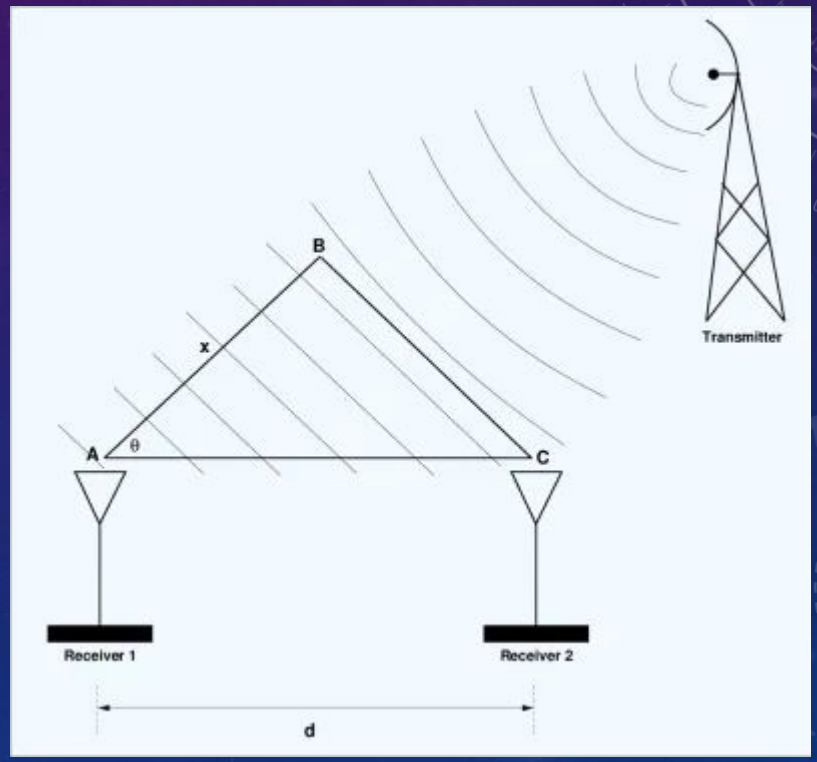
Doppler Concept of Operations

- Object emitting a wave at a certain frequency
  - Moving toward observer pushes the frequency higher
  - Moving away observer pulls the frequency lower
- Requires emitter to be moving relative to sensor - physically or virtually
- Can’t control the emitter? Move the sensor!
- Only requires one receiver with good frequency precision



TDOA Concept of Operations

- Time Difference of Arrival
- Given several receivers and antennas, detect the order a signal hits them
- Requires several independent receivers, but they don’t need to be particularly sensitive
- However, accurate timing, “phase coherence,” is critical

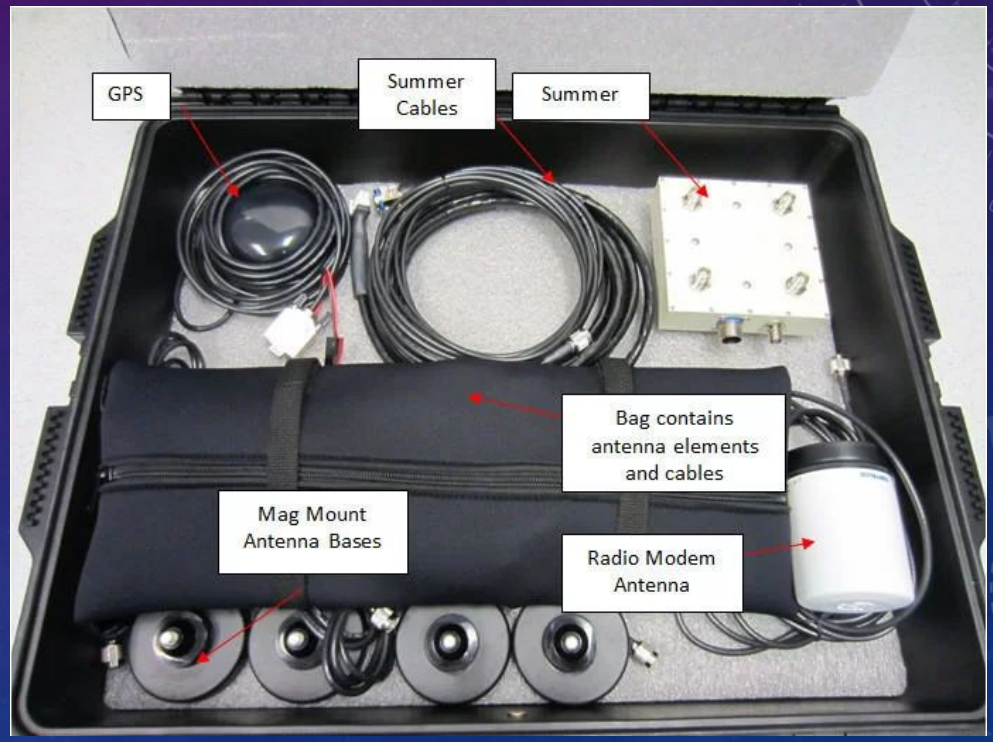


KN2C DF2020T Radio Direction Finder

- Doppler-based system
- Designed and sold by Gyo An KN2C in NY
- http://www.kn2c.us/

Doppler Systems

- Commercial mobile doppler system
- “Doppler Doug”
- https://dopsys.com/

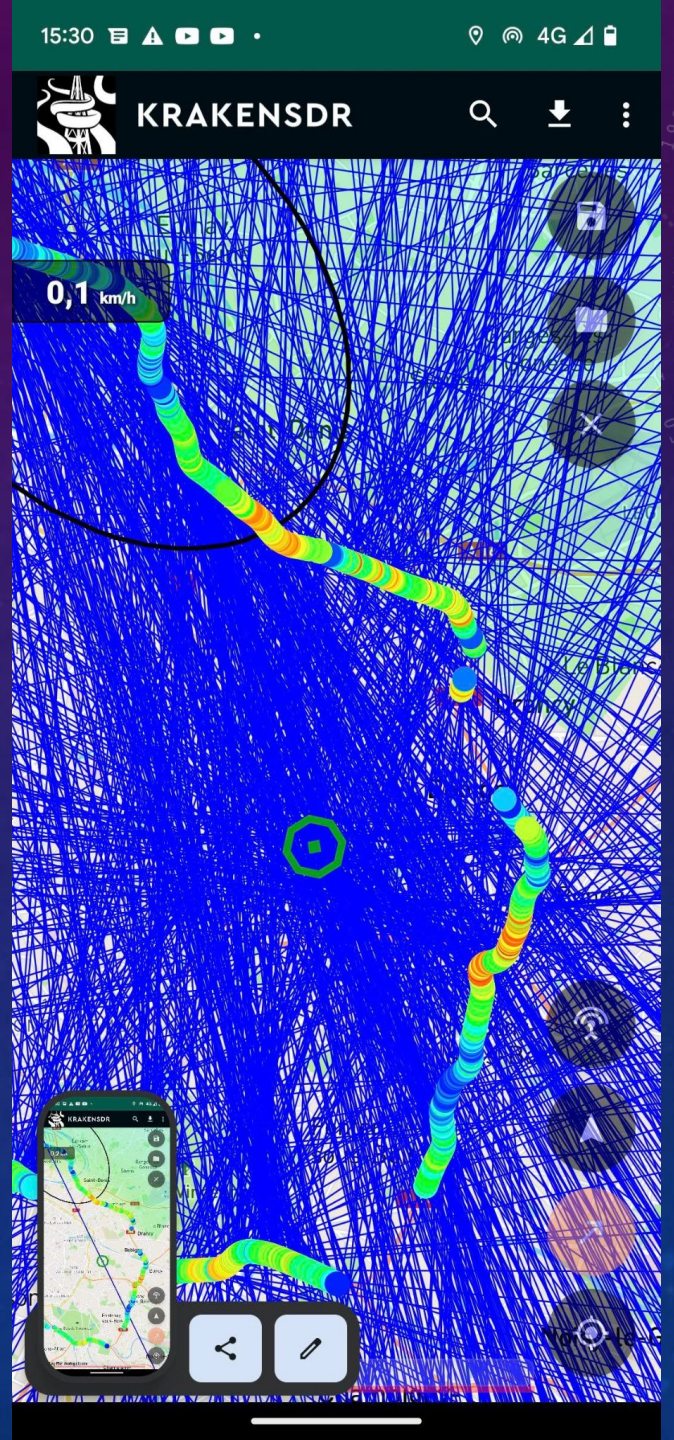


Kraken RF

- Kraken SDR includes TDOA-based DFing
- Not ham-specific, but covers 24 MHz to 1766 MHz
- Reprogrammable DAQ and DSP, including with GNU Radio!
- https://www.krakenrf.com/

Accuracy

- Are the “advanced” rigs more accurate?
- Not necessarily!
- Human precision with Yagi ~5° arc
- Kraken precision ~10-25° arc
- They just take more measurements and automatically integrate data



Accuracy

FREQUENCY TO ARRAY RADIUS

Instructions

1) Enter desired frequency.

2) Decide on an appropriate antenna array radius based on physical limitations and desired resolution.

Desired Freq (MHz)	*Wavelength Lambda (Meters)*
145	*2.068965517*

Spacing Multiplier	Interelement Spacing (cm)	Unit Radius	Max Radius (cm)	Est. Resolution (Degrees)
0.5	103.4482759	0.4253254042	88.00 cm	8.217337869
0.45	93.10344828	0.3827928638	79.20 cm	9.13037541
0.4	82.75862069	0.3402603233	70.40 cm	10.27167234
0.35	72.4137931	0.2977277829	61.60 cm	11.7390541
0.3	62.06896552	0.2551952425	52.80 cm	13.69556311
0.25	51.72413793	0.2126627021	44.00 cm	16.43467574
0.2	41.37931034	0.1701301617	35.20 cm	20.54334467
0.15	31.03448276	0.1275976213	26.40 cm	27.39112623
0.1	20.68965517	0.08506508084	17.60 cm	41.08668934

Array sizing must use a spacing multiplier less than 0.5 in order to avoid ambiguities.

However, a smaller radius has less resolving resolution. Ideally you want use a radius with a spacing multiplier close to 0.5. But physical size limitations may take priority.

E.G. If the Rayleigh Super-Resolution is 10 degrees, we can say that the signal source is somewhere within a 10 degree arc.

We consider a resolution of 0 - 25 degrees acceptable for direction finding.

Demonstration