

A topographic map of the Amicalola Falls area in Georgia. A blue 'X' is drawn across the map, with one line running from the top left towards the bottom right, and the other running from the top right towards the bottom left. A black arrow points from the left towards the word 'T-Hunting'.

T-Hunting

A Radio Direction Finding Presentation

By Jim Sorenson KA4IIA

Agenda

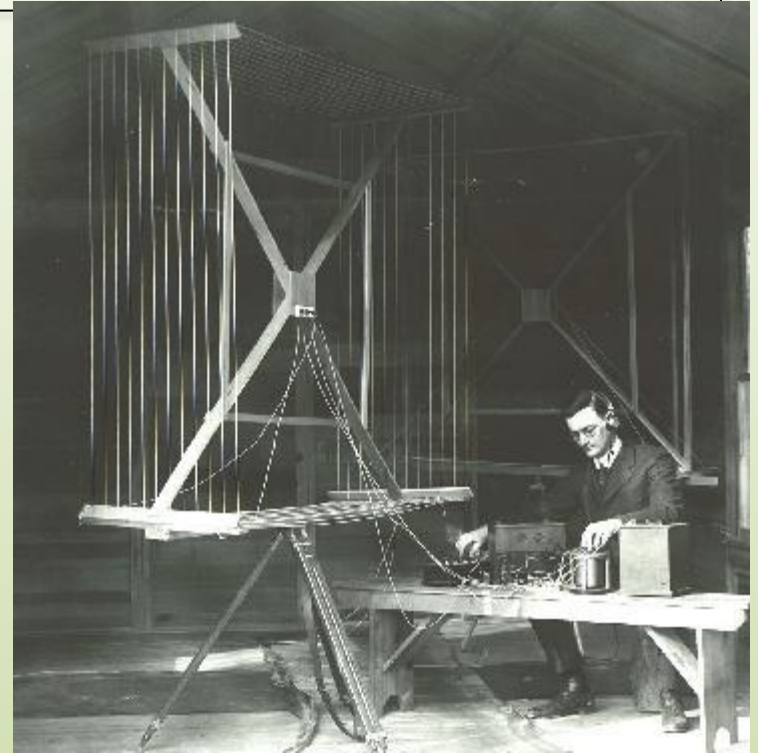


- Introduction
- History of T-Hunting
- Applications
- T-Hunting Equipment
- Advanced T-Hunting Equipment
- T-Hunting Software
- Phases of a T-Hunt
- T-Hunting Tips
- Questions & Answers

History of T-Hunting

https://en.wikipedia.org/wiki/File:Wade_performing_RDF.jpg

- Radio direction finding started with the beginning of radio
- John Stone granted patent in 1902 ¹



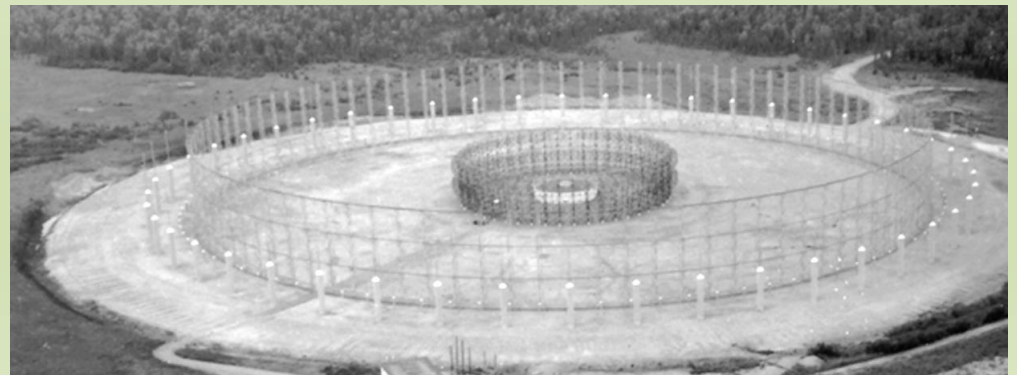
W.G. Wade of the National Bureau of Standards uses a large multi-loop antenna to perform RDF in this 1919 photo.

History of T-Hunting (Cont.)

- Military History
 - Used to locate ships during WWI and WWII
 - Helped limit German U-Boat attacks later in WWII
 - Cold War - "Wullenweber" antenna array (*AN/FLR-9*)



British Post Office RDF lorry from 1927 for finding unlicensed amateur radio transmitters.



T-Hunting Radio Direction Finding
Presentation by Jim Sorenson KA4IIA

T-Hunting Applications



- Military
 - Troop Communication/Movement
 - Radar
- Maritime
 - Navigation - Beacons
 - Distressed Ship Location
- Aircraft
 - Navigation - Automatic direction finder (ADF)
 - Downed Aircraft – Emergency Location TX (ELT)

T-Hunting Applications (Cont.)

- LoJack
 - 173.075 MHz Signal to locate stolen vehicles
- Wild Life tracking
 - Developed in the 1970's, VHF telemetry, triangulation
- Personal Safety
 - Emergency position-indicating radio-beacon station (EPLIRBs) - 406 MHz,
 - Cospas - Sarsat in 1982

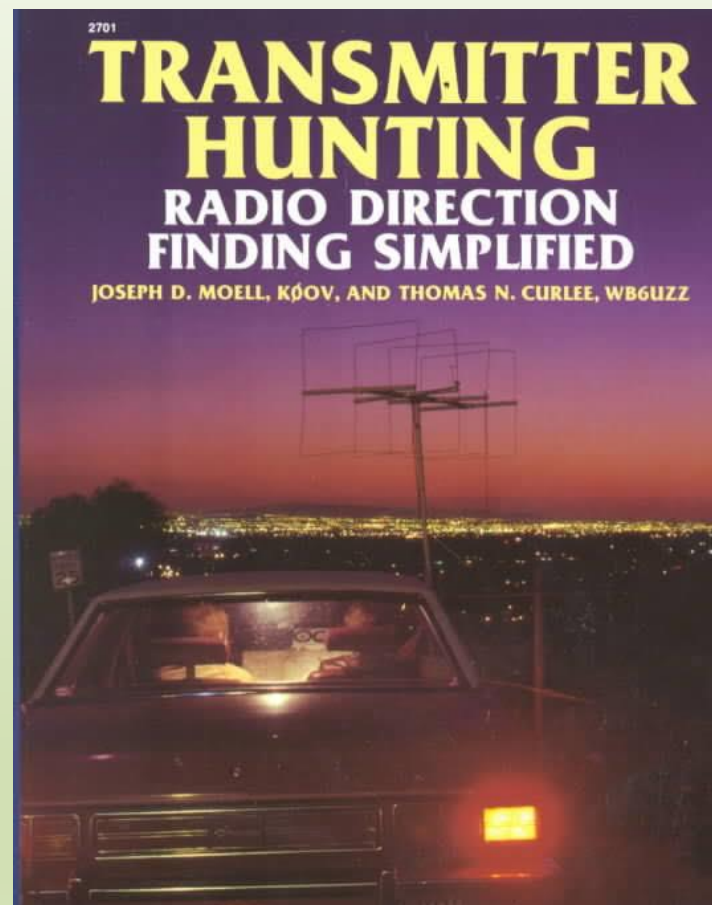


T-Hunting Equipment

- Transmitter Hunting: Radio Direction Finding Simplified

By Joseph Moell and Thomas N. Curlee

- The best T-Hunting guide for Amateur Radio!!!
- <http://www.homingin.com/>
- Available on Amazon's website



T-Hunting Equipment (Cont.)



- Receivers
- Antennas
 - Loop
 - Yagi
 - Quad
- Attenuators
- Sniffers
- Pre-amplifier

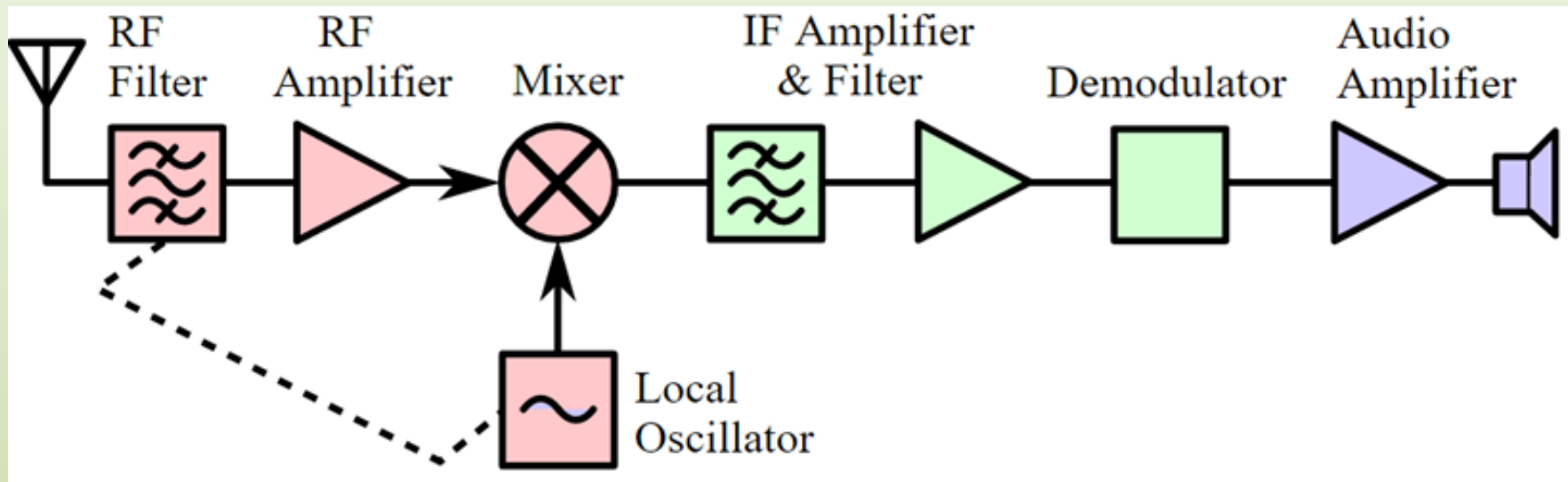
T-Hunting Equipment



- Receivers
 - Can make or break your hunt!
 - Sensitivity – weak signal detection & signal to noise ratio (SNR)
 - Selectivity – adjacent channel interference
 - Generally receiver cost is directly related to better sensitivity and selectivity
 - Broad-band receivers like scanners will have poorer sensitivity and selectivity performance

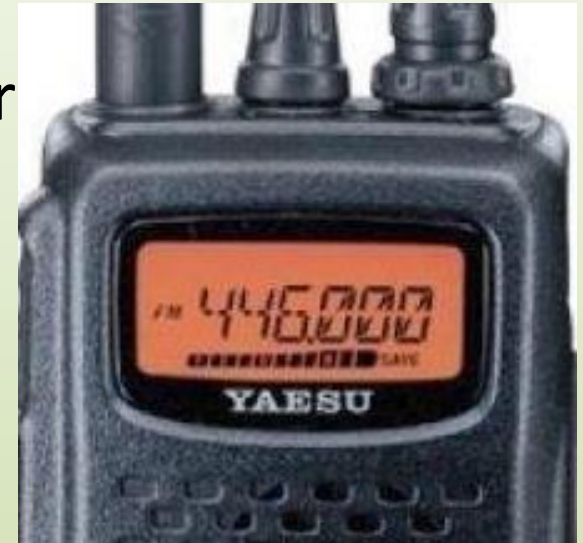
T-Hunting Equipment (Cont.)

- Receivers (Cont.)



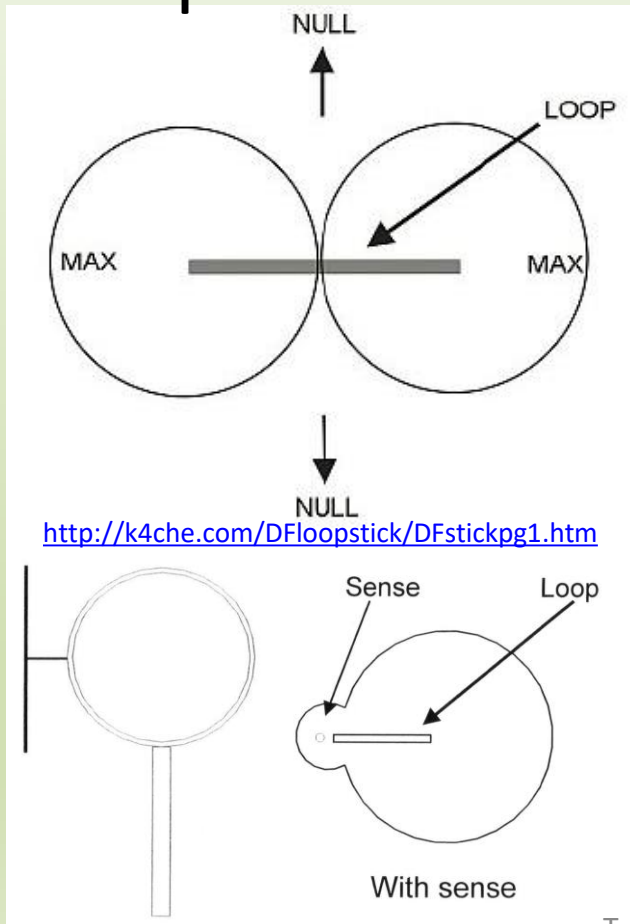
T-Hunting Equipment (Cont.)

- Receivers (Cont.)
 - A receive signal strength indicator (RSSI) is a MUST!!
 - Cheaper receivers often don't have one (i.e Baofeng HTs & scanners)
 - Helps determine distance to transmitter
 - **Warning:** transceivers can potentially damage some direction finding gear during transmission:
 - Doppler RDF units & other electronically switched equipment



T-Hunting Equipment (Cont.)

- Loop Antenna



https://en.wikipedia.org/wiki/Loop_antenna

Pro's:

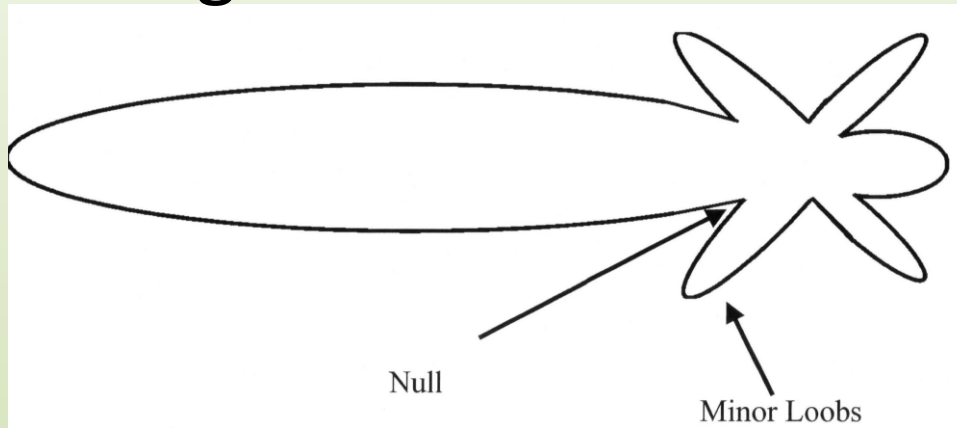
- Small, lightweight, Low Cost
- Can be used mobile

Con's:

- Ambiguous null & peak
- Must Rotate Manually
- Time to determine direction
- Low gain

T-Hunting Equipment (Cont.)

- Yagi Antenna



Pro's:

- Low Cost, High-gain
- Moderately Easy to Make
- Good for low-signal T-hunting

Con's:

- Large – hard to handle
- Must Rotate Manually
- Time to determine direction

T-Hunting Equipment (Cont.)

- Quad Antenna



<http://www.homingin.com/dualfeed.html>

Pro's:

- Low Cost, High-gain
- Good for low-signal T-hunting

Con's:

- Large – hard to handle
- Time to determine direction
- Must manually rotate

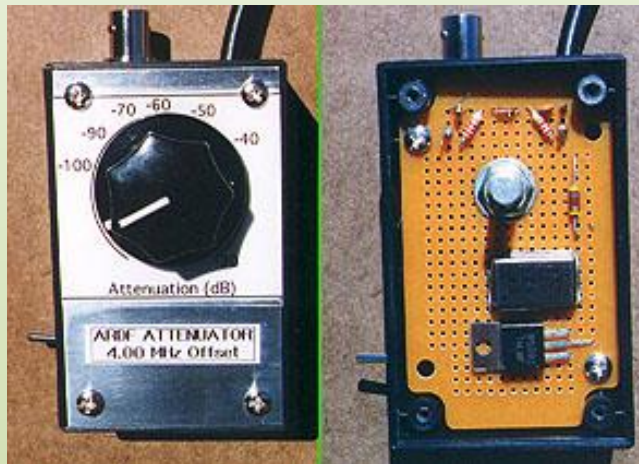
T-Hunting Equipment (Cont.)

- Attenuators
 - High sensitivity receivers are great for weak signals...what about strong signals?
 - Need to reduce signal for distance estimation
 - Add attenuation when RSSI is full scale

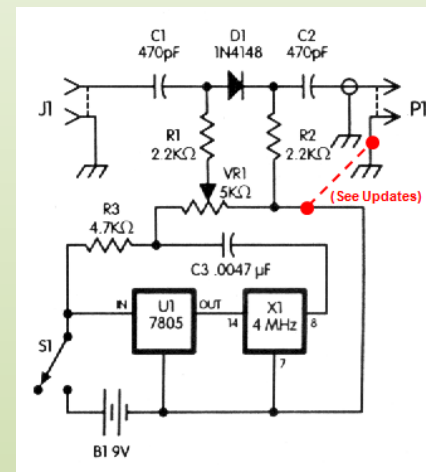


T-Hunting Equipment (Cont.)

- Offset Attenuator
 - Highly effective attenuating high-level signals that bypass receiver antenna input



<http://www.homingin.com/joek0ov/offatten.html>

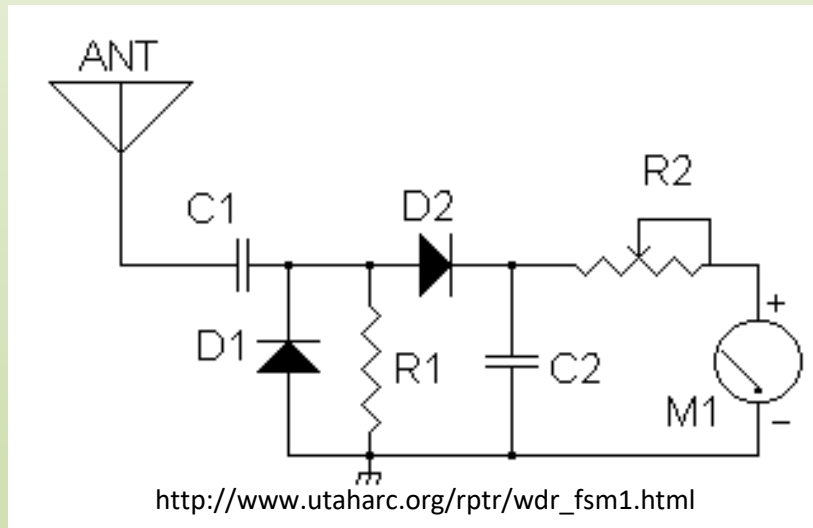


- Arrow Antenna model

<http://www.arrowantennas.com/main/4ofha.html>

T-Hunting Equipment (Cont.)

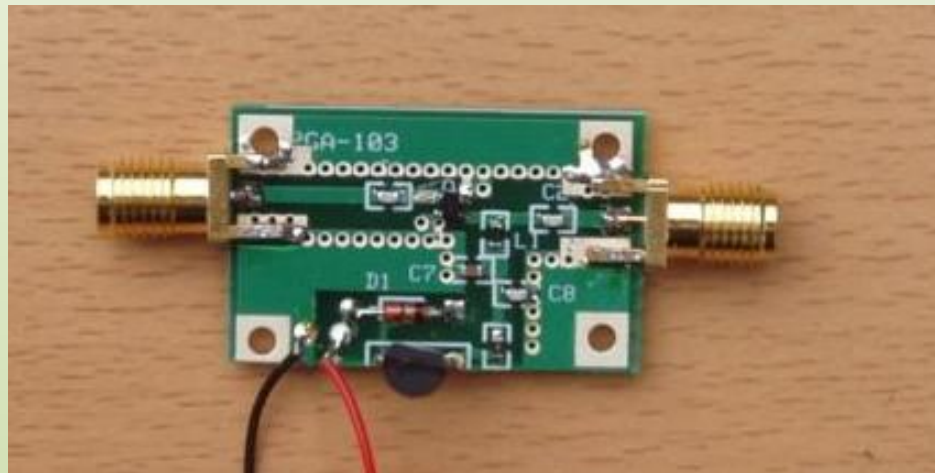
- Sniffer (Signal strength meter)
 - Help find source of RF source without a RX



<http://www.olderadiostuff.com/mf-j-801-2m-440-field-strength-meter>

T-Hunting Equipment (Cont.)

- Receiver Pre-amplifier
 - Used with high-gain antenna for weak signals



SPF-5043z LNA low noise amplifier kit, VHF - UHF

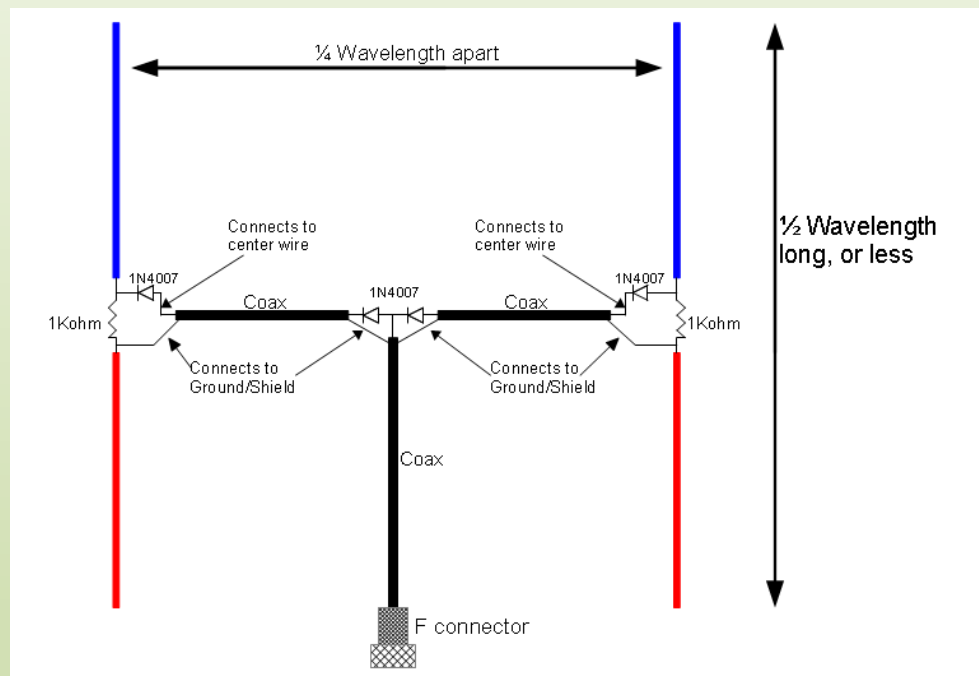
Advanced T-Hunting Equipment



- Time Difference of Arrival (TDOA) – Low Tech
- Little L-Per
- Doppler Direction Finders
- Phase Interferometry
- TDOA – High Tech
- Commercial Location Equipment

Advanced T-Hunting Equipment (Cont.)

- Time Difference of Arrival (TDOA) – Low Tech



<http://robowarner.com/portfolio/radio-homing-robot-diy/>

Pro's:

Low Cost

Small – can be used mobile

Con's:

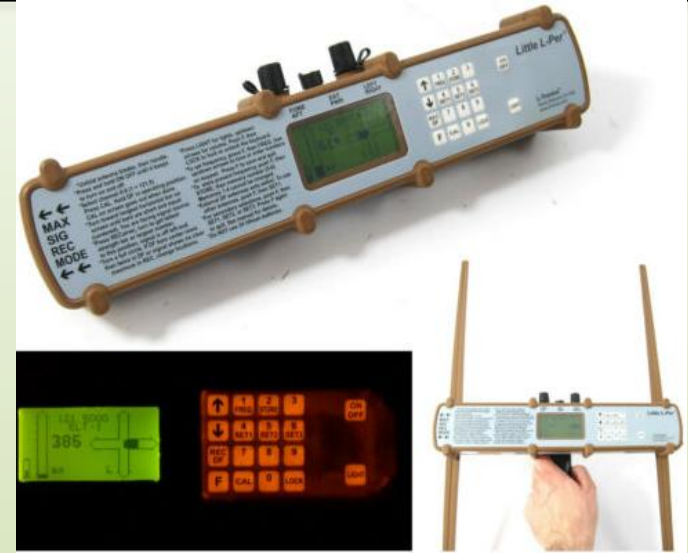
Ambiguous direction

Time to determine direction

Degrades RX performance

Advanced T-Hunting Equipment (Cont.)

- Little L-Per® (L-Tronics®)
 - Specifically designed for Emergency Location transmitters (ELTs), aircraft



Pro's:

- Small – control unit
- can fit into small spaces

Con's:

- Fixed frequency RX
- Ambiguous direction
- Cost – commercial equipment

Advanced T-Hunting Equipment (Cont.)

- Doppler Direction Finders



Pro's:

- Continuous bearings (360°)
- Very mobile

Con's:

- Cost
- Degrades RX performance
- Should be used while mobile
- Multipath
- Narrow band only

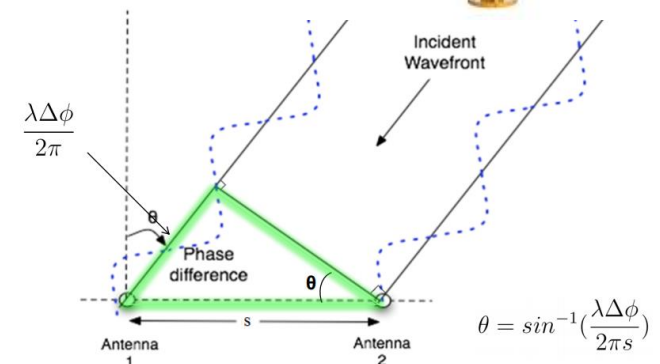
Advanced T-Hunting Equipment (Cont.)



- Doppler Direction Finders (Cont.)
 - Sample of current suppliers:
 - Doppler Systems (Commercial)
 - Pico-Doppler (Hobby – kit)
 - Ramsey (Hobby – kit)
 - DDF1
 - GLOBAL TSCM GROUP (Commercial/Hobby – not a kit)
 - KN2C DDF2020T

Advanced T-Hunting Equipment (Cont.)

- Phase Interferometry
 - Calculate AoA by measuring phase difference between antennas
 - First used in radio astronomy
 - Need three or more antennas to resolve ambiguity
 - High accuracy : $<1^\circ$
 - Less vulnerable to multipath
 - Rohde & Schwarz – military & commercial use

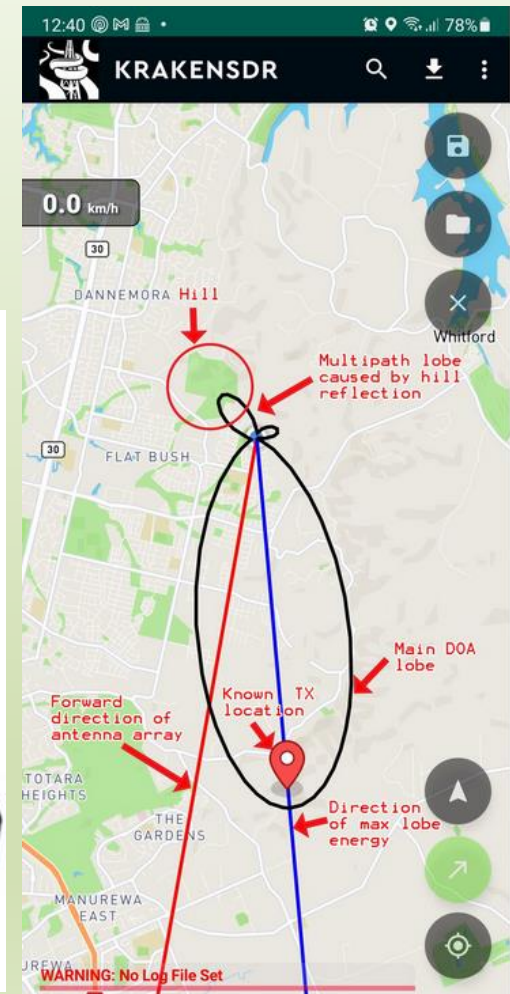


Direction Finding - 6
Group 108 1001/12

LINCOLN LABORATORY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Advanced T-Hunting Equipment (Cont.)

- Phase Interferometry AoA (cont)
 - KrakenSDR hardware and app
 - Correlative interferometry



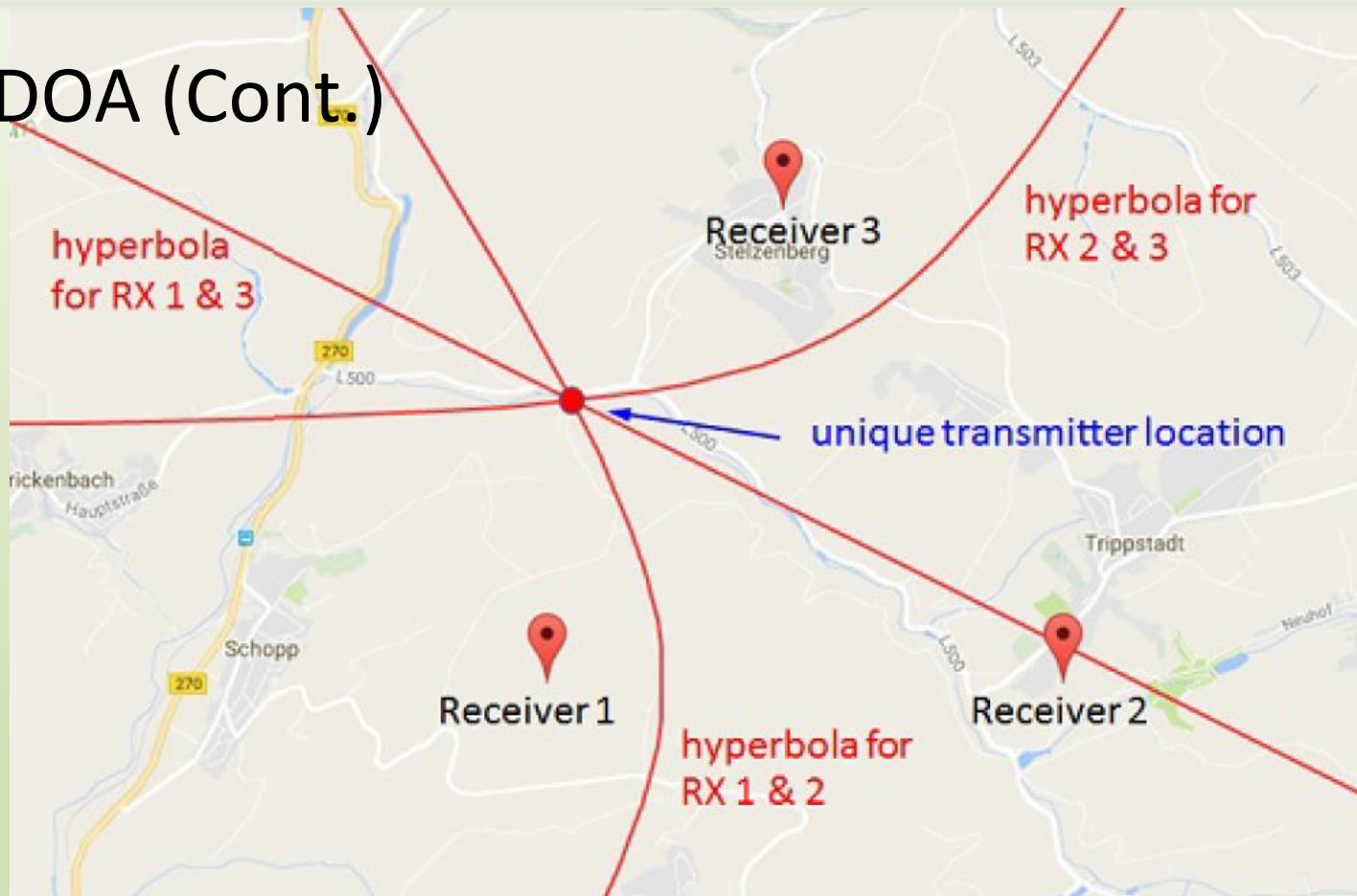
Advanced T-Hunting Equipment (Cont.)



- Time Difference of Arrival TDOA
 - Calculate and plot the difference in arrival between three or more receivers
 - Wide-band signals accuracy to within meters of TX!
 - Active Software Defined Radio (SDR) experimentation
 - Less vulnerable to multipath
 - Heavy military & commercial usage

Advanced T-Hunting Equipment (Cont.)

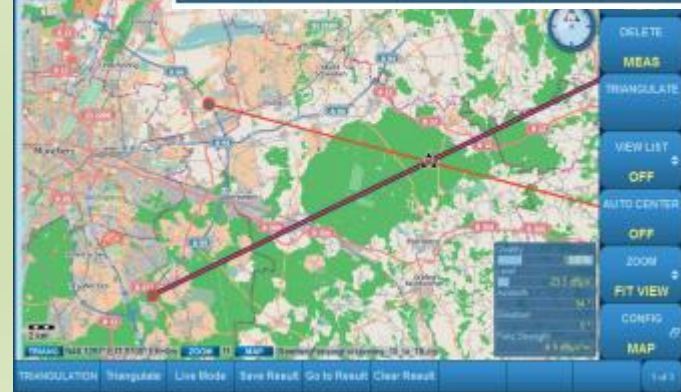
- TDOA (Cont.)



— Exact TDOA localization with 3 receivers and thus 3 hyperbolas from multilateration

Advanced T-Hunting Equipment (Cont.)

- Commercial Digital Direction Finders
 - 20 MHz to 8.2 GHz
 - Networkable



T-Hunting Software



- Automatic Packet Reporting System (APRS)
- GoogleHunt GPS / DF Display Program
- Smart Phone Apps
 - Foxhunt Pro – iPhone app only
 - SigTrax - iPhone and Android
 - Map-n-Compass iPhone app only

T-Hunting Software (Cont.)

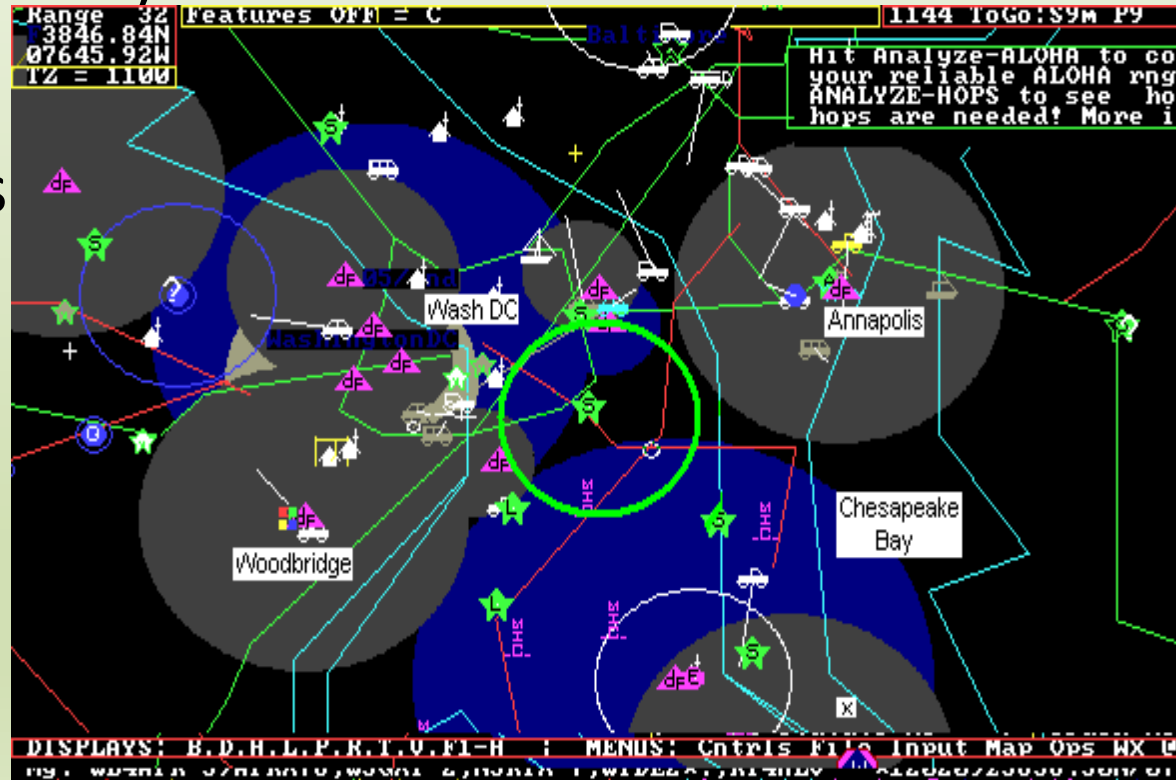
- Automatic Packet Reporting System (APRS)

- Free (many sources)

- Doppler plots

- Beam headings

- Fade Circles



T-Hunting Software (Cont.)

- GoogleHunt GPS / DF Display Program

- Aka Navi 2020

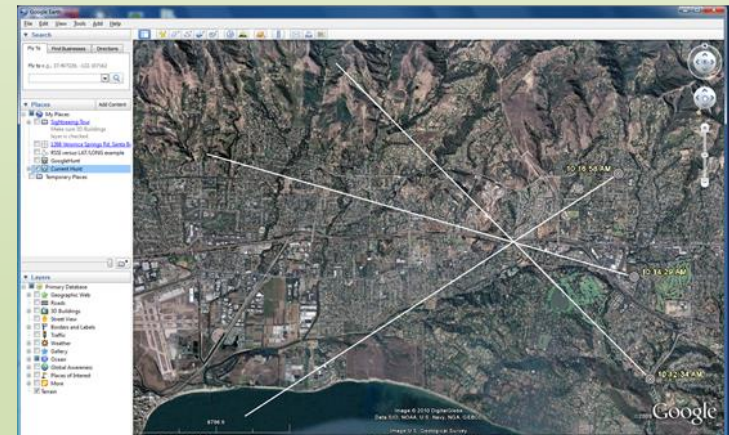
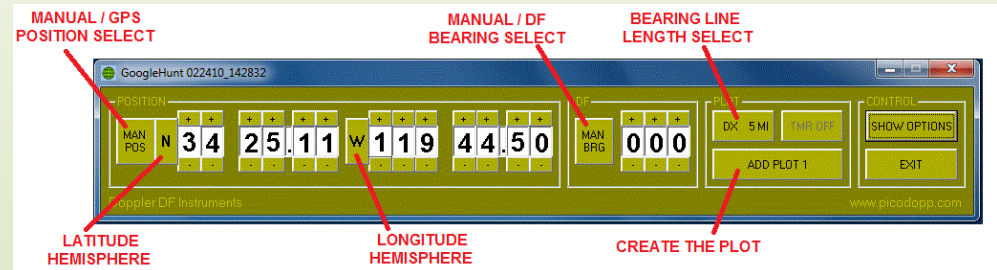
- Free:

- http://www.silcom.com/~pelican2/PicoDopp/GH_MORE.htm

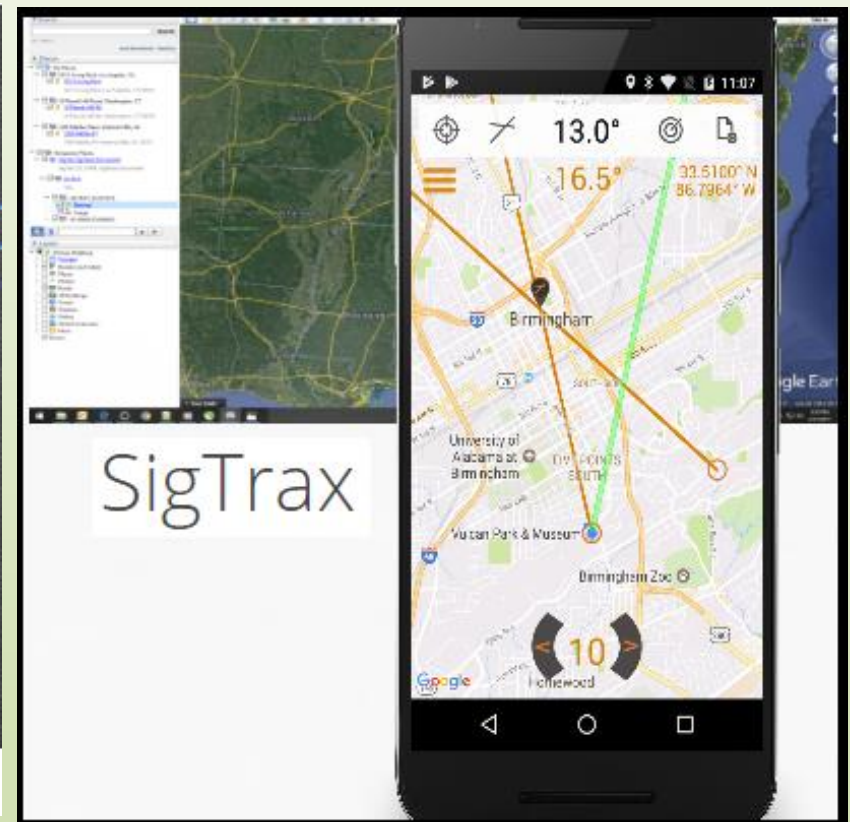
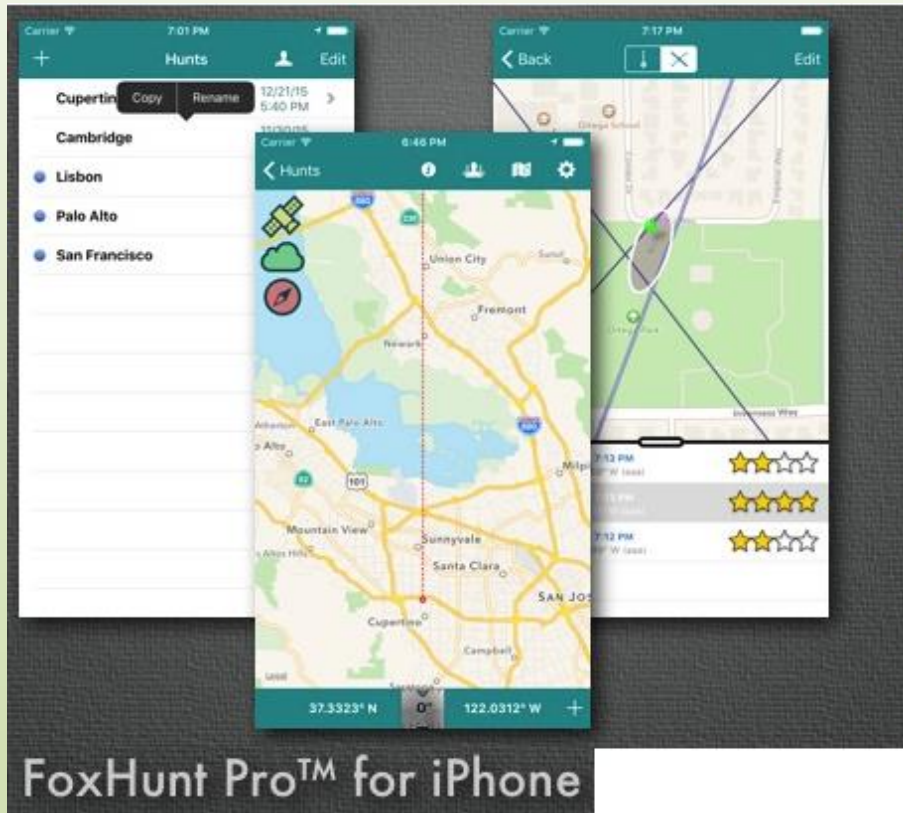
- Up to 100 plots

- Manual or Automatic (Doppler)

- Archives data automatically



T-Hunting Software (Cont.)



https://foxhunt.rail.com/FoxHunt_Pro/Home.html


<http://www.amcept.com/sigtrax/>

Phases of a T-Hunt



- Pre-Hunt
- Finding the signal
- Hunting – mobile
- Locating transmitter – on foot?

Phases of a T-Hunt (Cont.)



- Pre-Hunt
 - Equipment checklist:
 - Appropriate receivers
 - Antennas - highest gain you can transport! to most rugged
 - Pre-amplifier
 - Attenuator/Offset Attenuator
 - Maps or mapping software
 - GPS
 - Optional advanced DF units (Doppler, KrackenSDR etc.)

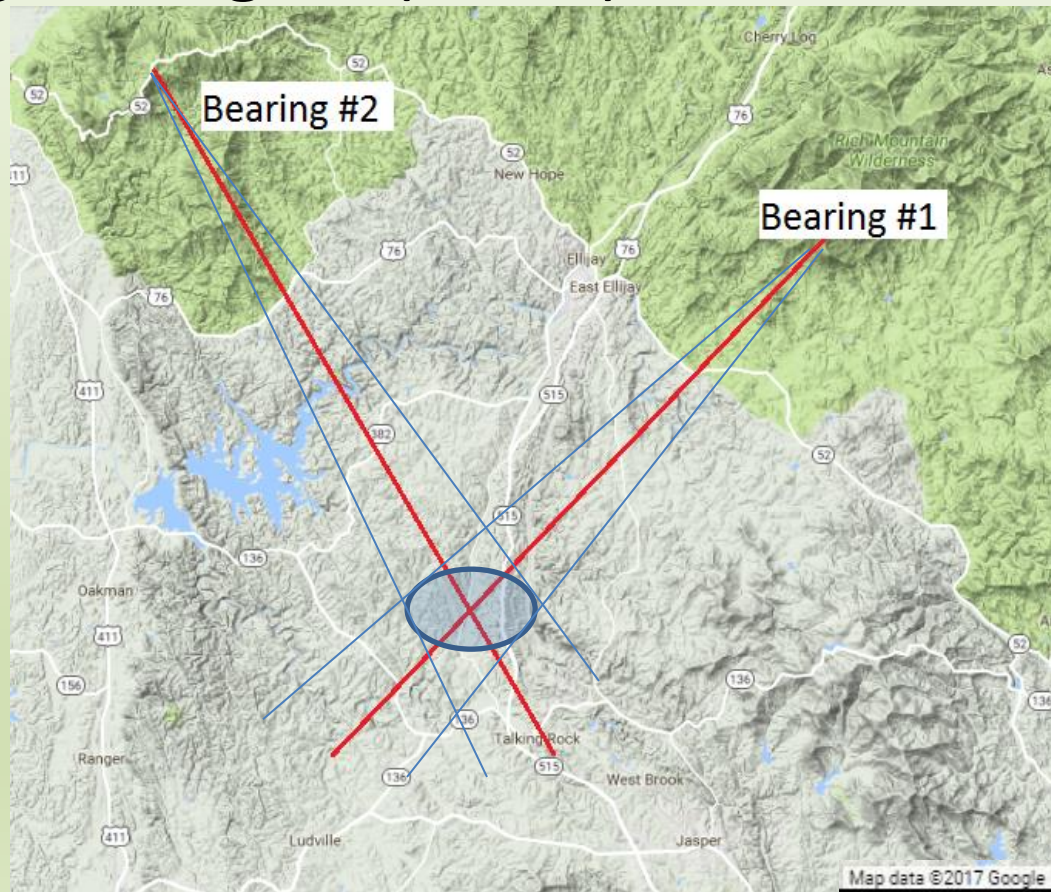
Phases of a T-Hunt (Cont.)

- Finding the signal
 - Often you don't receive the signal from starting point:
 - Move to the highest elevation
 - Use the lowest noise receiver
 - Preamp with high gain antenna




Phases of a T-Hunt (Cont.)

- Finding the signal (Cont.)



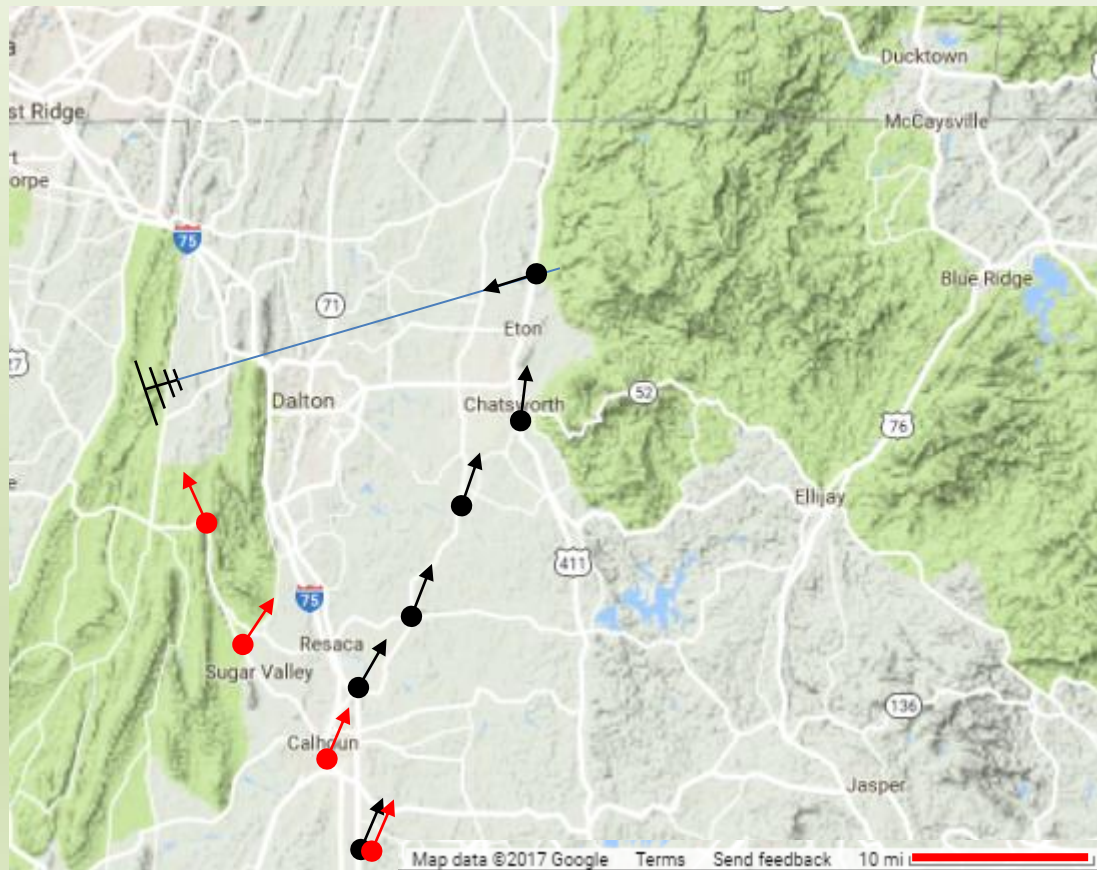
Phases of a T-Hunt (Cont.)



- Hunting – mobile
 - Remember: Altitude is king - Height is key to good bearings
 - Avoid large metal structures or power lines while taking bearings
 - Doppler DF – bearings are better while moving
 - Keep track of signal strength
 - Plot good bearings while you go
 - Beware of reflections (mountains etc.)

Phases of a T-Hunt (Cont.)

- Hunting – mobile (Cont.)



T-Hunting Radio Direction Finding
Presentation by Jim Sorenson KA4IIA

Phases of a T-Hunt (Cont.)

- Locating transmitter (Close in hunting)
 - Use RSSI and:
 - Remove antenna from HT ...body shield or...
 - Use attenuator or off-set attenuator with directional antenna



T-Hunting Tips



- Work in teams!!!
 - Use simplex or lesser known repeaters to share info among multiple hunters
 - Elect a non-mobile coordinator to plot bearings on Google Earth/GoogleHunt or other apps and collect signal reports
 - Enlist help from fixed stations with directional antennas for bearings
- Be safe – have a co-pilot to take bearings and watch signal strength etc...

Questions & Answers