Practical Foxhunting 101

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DEFCON 25

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Overview

- About me
- About Foxhunting
- Equipment Overview & Selection
- Preparation
- Techniques

Who Am I?

- More than 15 years professional experience as a software & systems engineer
- Most of my career has been spent working on wireless communications & emitter geolocation systems
- Last year's winner of the Hide & Seek and Foxhunt events in the Wireless Pentathlon

What is Foxhunting?

- Finding the physical location of wireless emitters and/or their users, by measuring received power from different locations
- Foxhunting is between the "last mile" and the “last feet”; for greater or lesser distances, other techniques are more appropriate
  - Wet-work ninjas finding the correct bedroom in the house of the South American populist government official
  - Tracking the Corporate Exec whose iPhone you've trojaned into an access point, as part of a Red Team penetration test
  - DEFCON 22 Wireless CTF
- Techniques are applicable to all RF emitters, like mobiles phones, WiFi APs, heart monitors, etc.

What Equipment's Involved?

- Antennas
  - Omnidirectional and directional, for different purposes
- Radios
  - Capable of receiving the signal-of-interest
  - Software-defined radios are finally becoming affordable
- Visualization Software
  - Most important feature is viewing received power over time

Gear Selection:

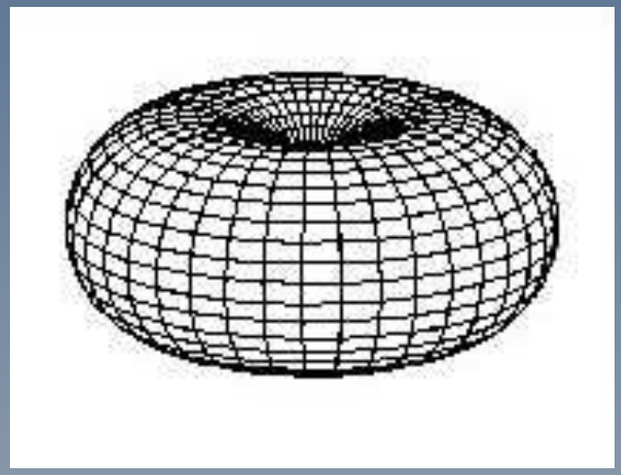
Antennas

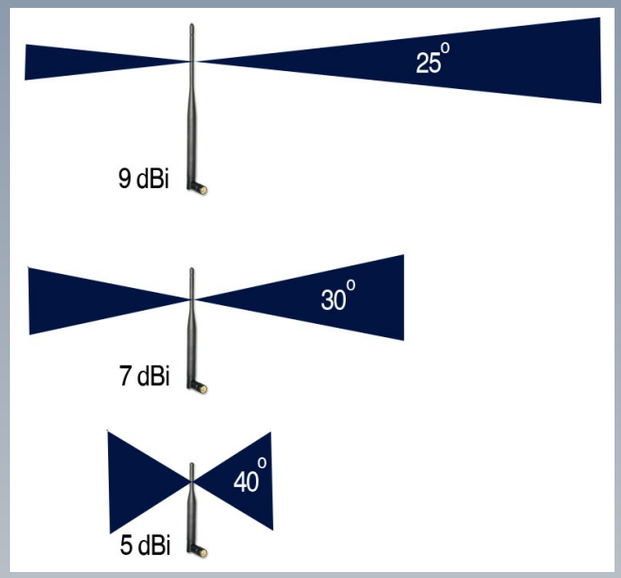
Aperture Versus Gain

- As a rule, the more sensitive the antenna, the more focused (directional) its reception pattern
- Too much gain can be a bad thing
  - High gain requires accurate pointing
  - Power curve follows the Inverse-Square Law
  - Unless you can attenuate your gain, you lose range discrimination when you're close to an emitter

Omnidirectional Antennas

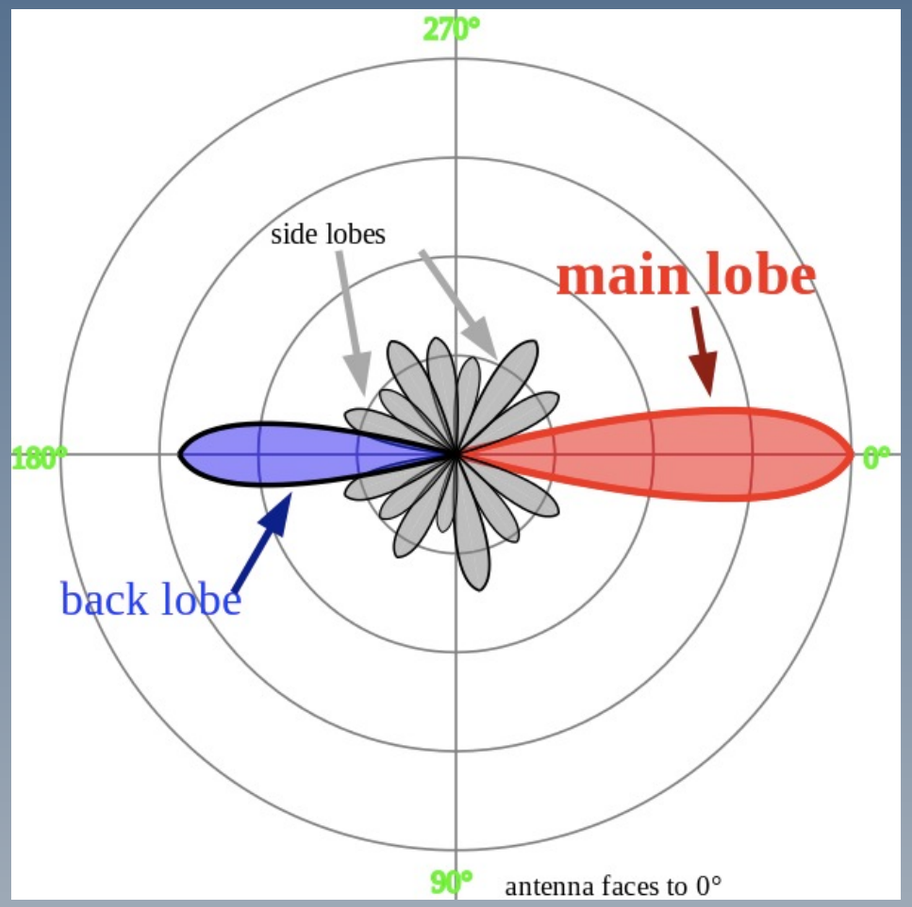
- Typically have a toroidal radiation pattern
- Gain varies inversely with z-axis directionality
- For foxhunting, high gain is good
  - Provides greater detection distance
  - Allows some degree of attenuation by varying orientation





Directional Antennas

- There are only two good choices, based on availability:
  - Yagi: High gain, narrow aperture, narrow bandwidth
  - Panel: Refers to several varieties of antennas that are flat perpendicular to their boresight, therefore performance varies
- Log-periodic antennas are also available, but are less common
- If you're on a budget, it's easy to make your own Cantenna or WokFi
- Choose your antenna based on performance and form factor



Directional Antenna Pattern

Beware of back lobes & side lobes when hunting

Multi-antenna Arrays

- Generally proprietary (Read: expensive)
- Require custom software
- Tricky to configure and use correctly
- But awesome when you have one!
- Challenge: Create a HackRF-based DF array

Gear Selection:

Radios

Cost Versus Performance

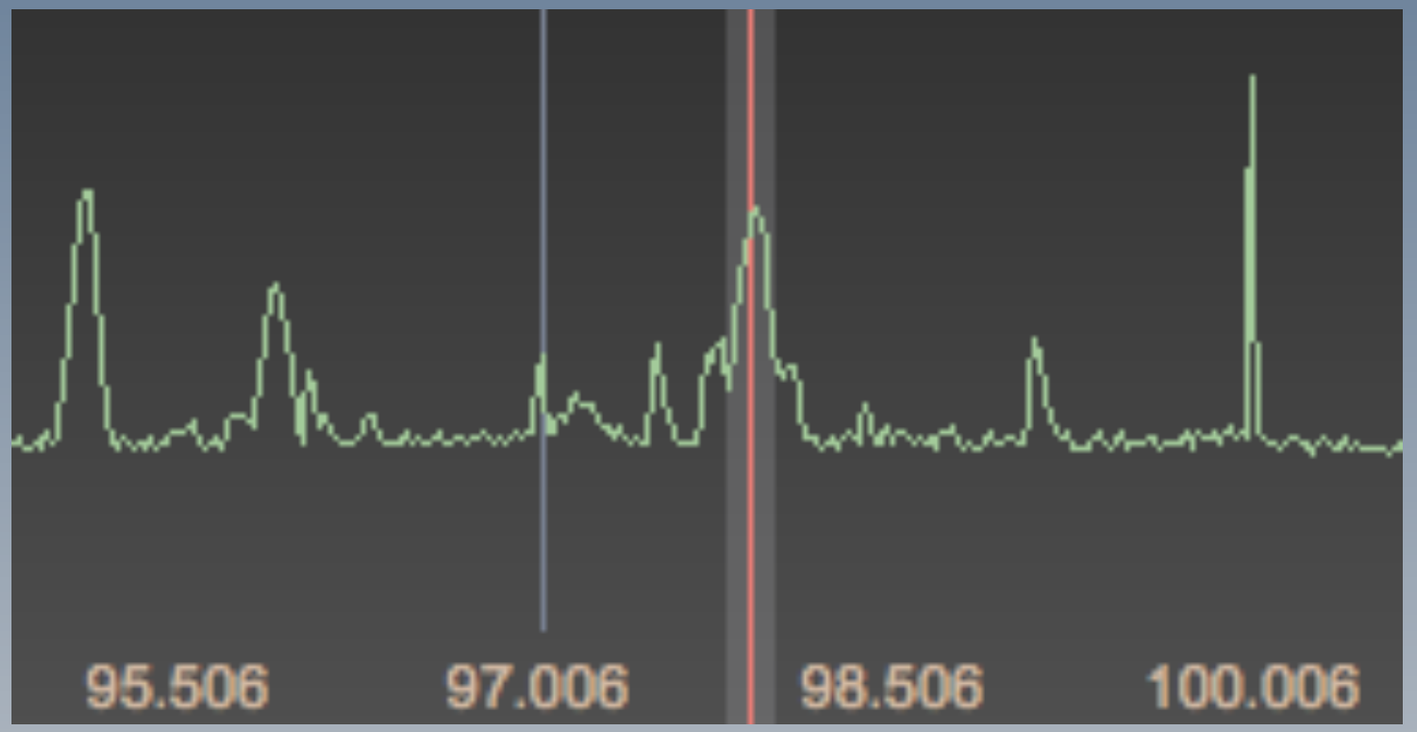
- RF equipment can get expensive quickly
- Broadband radios and software-defined radios are more expensive than their application-specific counterparts, but are more flexible
- Low-cost SDR is starting to become a reality
- WiFi radios are particularly inexpensive; perfect for beginners: Alfa 1, Alfa N & TL-WN722N

Variable Attenuators

- Used to reduce the strength of the received signal
- Allow you to use a very high-gain antenna, even at close ranges
- Not strictly necessary, but add versatility
- Many types are available, but they usually aren't cheap; check eBay
- Old-fashioned variable attenuator: rotate your antenna

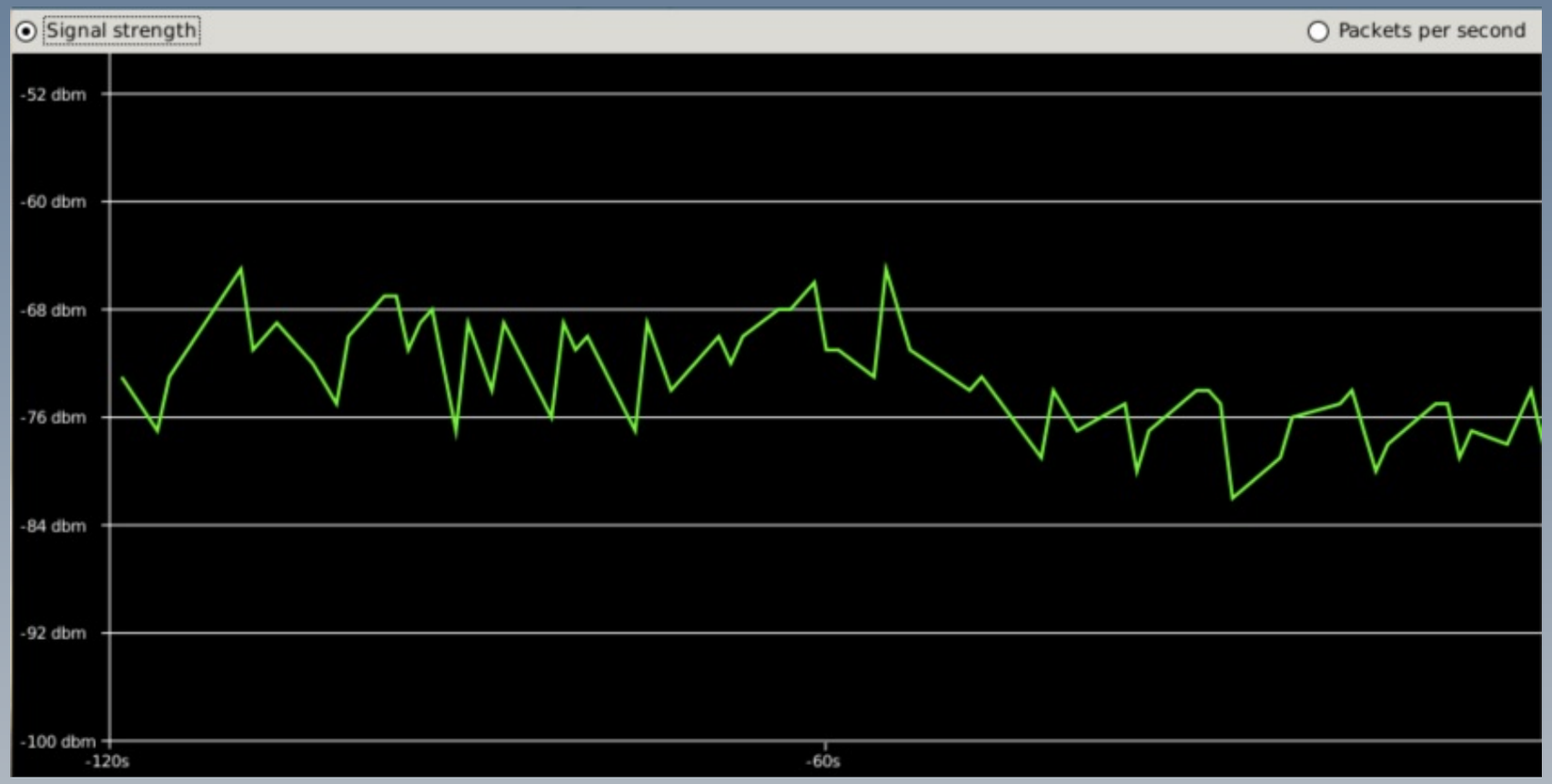
Signal Displays

Power Spectral Display



- Helps locate your target in the RF spectrum
- Not always needed, if you have other ways of tuning

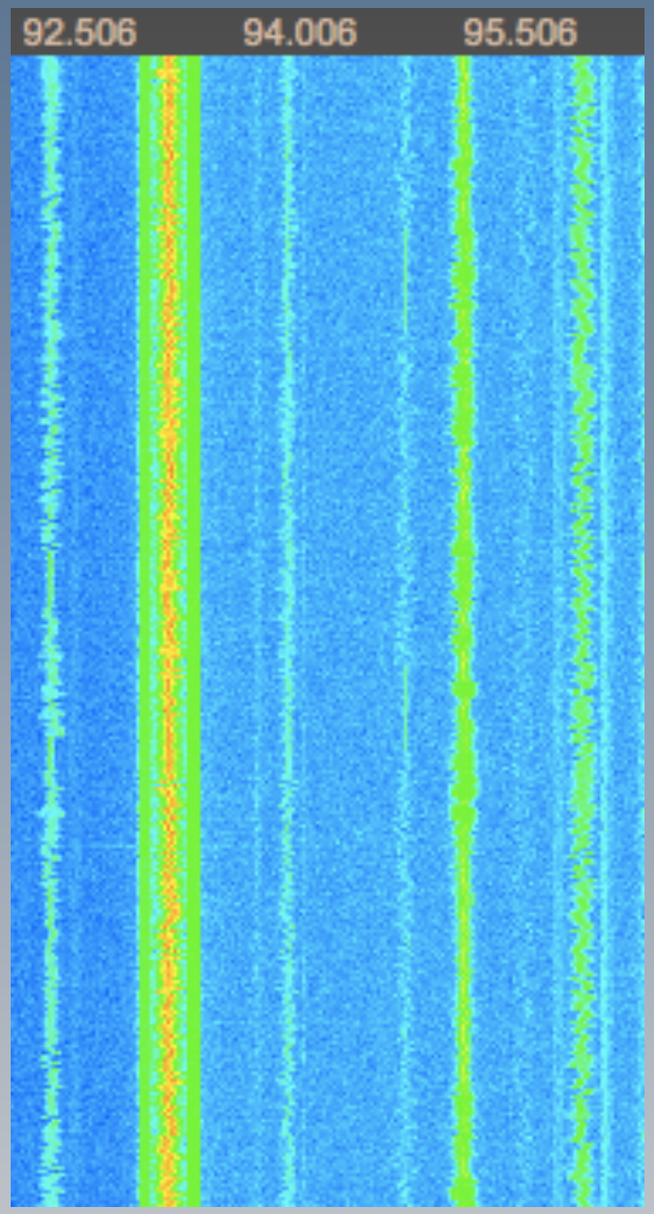
Power/Time Domain



- Used to track your target over time
- Foxhunting tool of choice

Spectrogram

- AKA Cumulative Spectral Decay / Waterfall
- PSD & PTD combined
- Can be used to track multiple emitters over time
- Information overload for simple foxhunting



Using Your Gear

Preparation

- Know and be comfortable with your equipment, especially how long your batteries will last
- Learn detection ranges for your particular setup; WiFi radios estimate signal strength inconsistently
- Know how sensitive your back/side lobes are
- Become fluent in the software you're using
- Practice

Inconspicuousness

- If you have a bunch of obvious equipment, people will be wary and avoid you
- Fly below the radar, or risk spooking your target

General Tips

- Be aggressive! Make an active effort to seek your target
- Be aware of your environment, and take an organized approach to your search area; don’t just wander randomly
- Keep a mental map of where you’ve been, and the observed signal levels along the way, for mental triangulation
- Heads Up! Don't glue your nose to the screen, or you might miss a chance to find your target based on secondary indicators

Multipath

- RF emanations will reflect off structures and objects
- Same signal will be received from different directions at different times (Phase Shift)
- Changes the SNR of the received signal (Multipath Fading)
- To mitigate multipath interference during a foxhunt, keep moving!

Using An Omni

- Used for proximity detection (Am I getting closer to the emitter?)
- Possible to successfully hunt with just an omni
  - Easier when dealing with stationary targets
  - Move around a lot to determine emitter proximity from various locations
  - Keep a good mental map, to perform on-the-fly triangulation

Using A Directional

- Steers you in the right direction, once you've determined proximity using the omni
- Helpful to have a variable attenuator between your directional antenna and the radio
  - Reduces the antenna's lobes (enhancing directionality)
  - Reduces your effective gain when you're getting closer, to give you more headroom against your radio's maximum input gain

Basic Strategy

- Tune your radios to the target emitter
- Walk a search pattern, watching the signal strength on a PTD plot
  - Use the omni to determine if you're getting closer
  - Use the directional, and your historical direction of travel, to determine in which direction to continue
  - If you start to peak your signal, add attenuation
- Don't go too fast, because received power will fluctuate
- Look around: The emitter may become obvious once you relate RF power to what you see in the environment

My WiFi Setup

- 5db Omnidirectional rubber duck
- 8db simpleWiFi mini panel
- HP 8495A Manual Step Attenuator
- Alfa USB NICs - Alfa 1 & Alfa N
  - Alfa N on the omni - it holds connections better
  - Alfa 1 on the panel - it’s more of a pure radio
- No good free software; Kismet/Kismon, WiFi Analyzer (Android), NetSurveyor (Windows), and Wireless Diagnostics (OS X) are OK