Bonner County Amateur Radio Club

Meeting February 11, 2023

VFW Post

1325 Pine Street, Sandpoint, ID 83864

18:00 hrs. – Informal Discussions & Eyeball QSO’s

18:30 hrs. - Meeting

Why Are We Here? Per the Bylaws BCARC

1. *Facilitate communication and fellowship among amateur radio operators*
2. *Increase the number of licensed amateur radio operators through training and community awareness and promote active use of the hobby, and provide assistance to new operators to help them get on the air*

Introductions - Guests, New Members, Members

Current Membership
As of January 2023

Total	46
Extra	11
General	22
Technician	13
No Callsign	0

Three in One Presentation

Doug Forster, W6AXR, John Kludt, K7SYS

- Digital Recap
  - Which mode when?
  - FEC (Forward Error Correction)
- VHF/UHF Station Design
  - Link budgets
  - Antennas
  - Feedline
  - Etc.
- VHF UHF Propagation Beyond the Horizon

Digital Modes Recap

Clearing Up Confusion – Digital Modes

- WSJT-X Family of Programs (FEC)
  - FT8/FT4
  - JT65, Q65(A,B,C)
  - MSK144
  - WSPR
- Uses
  - Low SNR, low power, simple antennas
  - Contacts – Grid Squares
  - Contests – exchange dependent
  - Dxing sees heavy use (70% Q's in ClubLog)
- John K7SYS POC for help, questions

- "Chat" modes
  - PSK 31, 63, 125, 250 (no FEC)
  - MFSK 16, 32, 64, 128 (FEC)
  - Olivia, FeldHell, Domino, etc.
- Uses
  - Keyboard to keyboard chats
  - Extended messaging
  - Templated messaging (ARES)
  - Limited Dxing"
- John K7BSV POC for help, questions

Forward Error Correction -- FEC

- Adding data to a digital message to enable the receiver to process a received message with transmission errors and extract an error-free message
- A weak parallel is phonetic spelling
- Good codes have low computational requirements both to create the message and extract it
- Good codes have low overhead – typically add 10% to 30% to message length
- Powerful codes are one key to the various Joe Taylor weak signal modes
  - Low bandwidth also important
- Bit error rate improvement can be dramatic
  - A message with a raw error rate of 10E-2 can be improved to 10E-9
  - Without FEC, more transmit power and/or receive sensitivity would be required

VHF/UHF Station Design

Doug Forster

W6AXR

VHF/UHF radio system truths, on one slide

- A signal must be received with sufficient signal to noise ratio (SNR)
  - Modulation and coding determine how much SNR is sufficient
- Received SNR is limited by
  - Received power
  - System and environmental noise
- Received power is limited by
  - Power transmitted in the direction of the receiver
  - Distance
  - Obstacles between transmitter and receiver
    - VHF and UHF signals generally travel line of sight (LOS)
      - We'll talk about beyond-line-of-sight (BLOS) propagation later
    - Radio horizon can often be slightly beyond the visual horizon due to atmospheric refraction
  - Receive antenna system

Low noise amplifiers (LNA)

- Amplifiers with active components chosen to have low noise characteristics
- Surprisingly cheap these days -- $20 - $50
- Note that at many locations, the background noise is high

Placement of LNA matters a lot

- Goal is to increase SNR at receiver, not just signal strength
- Everything, including coax, above absolute zero temperature generates noise
  - Want to place LNA where it doesn’t amplify that noise
- If you put the LNA at the receiver, you amplify the coax noise contribution as well as any noise picked up by the antenna
- Place LNA as close to antenna as possible
  - Bias T power makes that convenient

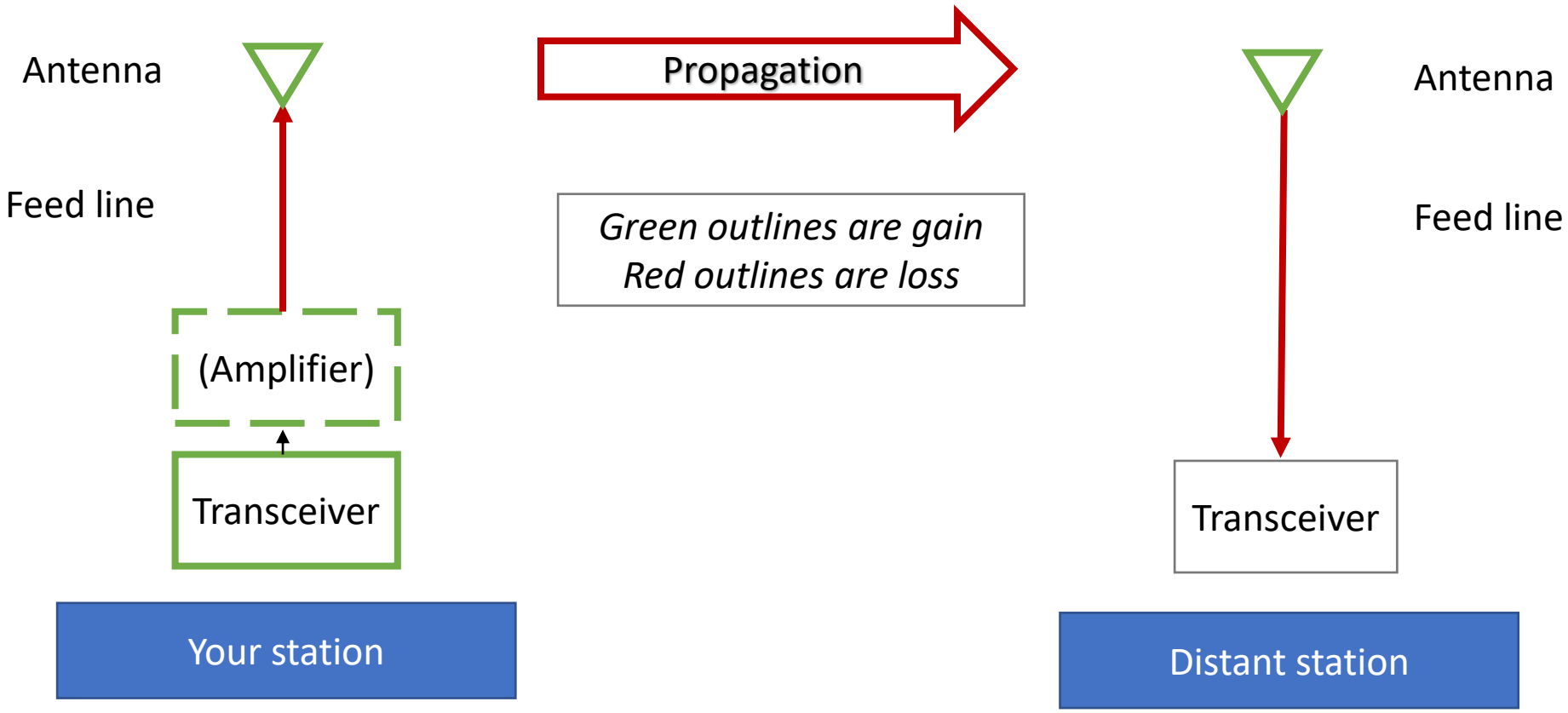
Semi-quantative analysis of LNA placement

- Rigorous calculation of noise and gain contributions in a system is difficult
  - I don’t really understand it, so I certainly could not explain it!
- A reasonable simplification is that cable noise figure (NF) is equal to its attenuation
  - Another reason to use low attenuation coax
  - You don’t want to amplify that noise
- Putting the LNA at the receiver can actually leave you with a worse SNR than not having the LNA
- The best LNA is a higher gain antenna!

Link budget is the fundamental tool for designing and analyzing RF communication paths

- In words: Power at the receive antenna is the power leaving the transmit antenna, attenuated by the propagation path
  - Tonight we will simplify and discuss just power, rather than SNR
  - Including noise in the calculation complicates without clarifying the power discussion
- Link budget is often used to determine equipment requirements for a specific link distance
- We will turn that around to show theoretical distance for several different station configurations
- Trying to provide a tool that lets you analyze what changes to your station will improve performance

Generic system diagram



Link budget that can yield a number

- Calculations are traditionally done in dB because of the large dynamic range of the values involved
- Receive power = Transmit power – Transmit feedline loss + Transmit antenna gain – Path loss + Receive antenna gain – Receive feedline loss
- Friis equation is established method for free space – result not useful for terrestrial VHF/UHF because of terrain effects
- We operate near terrain, so a more tailored model is required
- Eglis model is straight forward, if imprecise
  - Intended to improve on plane earth model
  - Fit to measured data
  - Implementation shown tonight is limited to short distances by underlying plane earth model
- Other popular options, also fit to measured data
  - Okumura-Hata – urban and suburban environments
  - Longley-Rice – requires detailed terrain description as input

Examples using Egli's model

- Will go through several examples, showing value of things you can actually change
  - Antenna height
  - Coax cable loss
  - Antenna gain
  - Transmit power
- Figure of merit will be range

- Will take requests to vary any parameter

Two HTs with rubber duckies – starting point

Spread sheet creator suggests
-3 dB antenna gain for HT

Free space value is interesting,
but not relevant

Two HTs with better antennas – no other change

After market bigger antennas

Free space value is interesting,
but not relevant

Effects of coax type and length at various frequencies

- Feedline losses will be booked as reduction in transmit antenna gain
- Receive feedline will be left as magic lossless cable
  - Not much effect on results

Effect of feed line losses, shown by reducing transmit antenna gain

Put a 6 dBi antenna at each end,
20 feet high, 50 feet of coax

Subsequent examples will assume LMR-400

Sending 5 W HT has a 2 dBi J-Pole in a tree

Two HTs; J-Pole 20 ft up and 30 ft of LMR 400 (0.45 dB loss)

10 W mobile feeding same J-Pole and same receiver

Note that doubling power does not double range, because loss is dependent on R^2. Some models use even larger exponents.

10 W mobile feeding same J-Pole higher up the tree

50 ft up, 60 ft coax. Slightly more coax loss, but still a net gain

Spare – taking requests

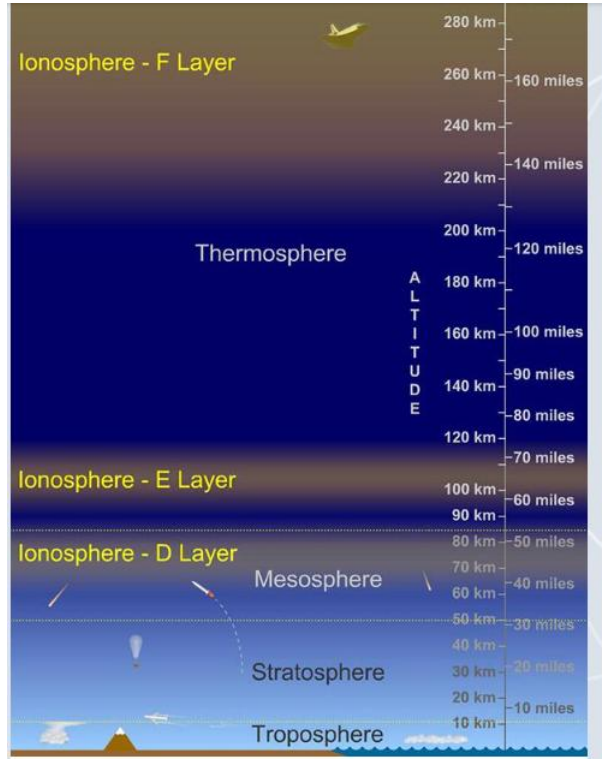
VHF/UHF Propagation Beyond the Horizon

One or More of the Following

- At least one of the three
  - Reflect off something conductive, even poorly conductive
  - Diffract over a sharp feature
  - Refract through density gradients in the atmosphere
- Sometimes combinations of the above

Propagation enhancements

- Tropospheric ducting
- Sporadic E
- Meteor Scatter
- Aurora
- Reflective paths with earthbound/man-made objects



Reflection

- Reflection opportunities include…
  - Mountain side
  - Moon
  - Meteor trails
  - Rain cell
  - Chinese “weather” balloons
  - Aurora
  - Airplane
  - Troposphere layer – more a microwave thing
- Path loss for a reflection path is similar to “radar equation”
  - Free space (roughly) loss to object
  - Reflection of reduced power
  - Free space (roughly) loss to distant station

Diffraction

- Sometimes possible to diffract power over a mountain ridge or around a corner
- Very dependent on specific conditions

Refraction

- Radio waves propagate through atmosphere at slightly varying rates, depending on density
- Slight curving almost always occurs just because of density dependence on altitude
- With more pronounced density variations, a “duct” can form
  - Can lead to very long range propagation – hundreds of miles
  - Most often seen over oceans
  - Not real likely in our area

Questions?

Annual dues!

- Annual dues payable January1, 2023
  - $25 per year for an individual
  - $35 per year for a family
- If you have already paid your dues – Thank you!
- If you haven’t dues plus the renewal form can be paid to Pat Cox, KJ7SJU, BCARC Treasurer

Upcoming Radio Events

- Bouvet Island 3Y0J is on the air!
  - FT8 F/H 21.105 MHz, 18.107 MHz, 14.105 Mhz
  - Best around 00:00 UTC
- School Club Roundup
  - February 13-17, 2023
  - Sandpoint Charter School, using KJ7YOZ, 10:00 -16:00 Local 20m &10m
- Idaho QSO Party
  - March 10-11, 2023
  - For them – work as many Idaho counties as possible
  - For us – work as many states/DX countries as possible
  - Rules http://www.pocatelloarc.org/idahoqsoparty/

Breakfast at Connie’s
Saturday, February 25, 2023
09:00 hrs.

Next Meeting
March 8, 2023
VFW Post, Sandpoint, ID
18:00 hrs. Informal Discussions and Eyeball QSO’s
18:30 hrs. Meeting
Topic: *Power Poles and Coax Connectors*

CW Bingo?

Bibliography

These are some references I (Doug) used while preparing this talk

- *VHF Propagation – A Practical Guide For Radio Amateurs, Second Edition.* Ken Neubeck, Gordon West, Chip Margelli. ISBN 978-0-943016-67-2. CQ Communications, Inc.
  - Thanks to John Kludt for alerting me to the second edition, which includes a section on digital modes
  - Good discussion of many modes, without rigorous math
- *VHF/UHF Propagation Basics for Radio Amateurs.* Christian Volle. Version 1.01. Accessed on-line February 2023.
  - https://www.qsl.net/dl7ayd/vuhfprop/vuhfprop.html
  - Very useful. Good mix of narrative and rigor, with math supported by graphics. This was the source of the spreadsheet I used range effects of gain, power, height

Bibliography, continued

- *The CQ Shortwave Propagation Handbook – 4th Edition,* Carl Luetzelschwab, George Jacobs, Robert B. Rose. ISBN 978-0-943016-62-7. CQ Communications, Inc.
  - Focus is on HF, but some coverage of VHF/UHF propagation
  - Good discussion of propagation prediction tools
- *Radiowave Propagation Physics and Applications,* Curt A. Lewis, Joel T Johnson, Fernando L Teixeira. ISBN 978-0-470-54925-8. John Wiley & Sons.
  - Rigorous treatment of all frequencies and all modes
  - Good discussion of interaction with terrain

Bibliography, continued

- *Propagation of Radiowaves, 3rd Edition.* Edited by Les Barclay. ISBN 978-1-84919-578-2. The Institute of Engineering and Technology.
  - Another book that provides a rigorous treatment of all frequencies and all modes
  - Good coverage of troposphere effects, unfortunately mostly microwave