# HF Digital Modes:
# What / When / Where / Why

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# What is this talk about?

- This talk is both an introduction to digital modes as well as give hints on how choose the right one and tune them for optimal performance

- We cover different digital modes and how they address a <u>broad array</u> of interests

# So who is the presenter anyway?

- Amateur Radio licensed since 2009 - KI6ZHD

- Degree in Computer Engineering

- Been using computers since the Z80 days - Epson QX10 / CPM and been running Linux since 1991 installed from 14 floppies!

- Author of several Linux documentation sets:

  IP Masquerade (NAT), TrinityOS (entire system administration), SANS Linux Security - Step by Step* and recently the Centos HamPacket suite

- My bent on Ham Radio?  Digital HF modes, SDR, Packet Radio with Linux

# A Poll: Who is the Audience?

- Who uses HF digital modes today?
  - PSK31, RTTY, Olivia, PACTOR, Analog SSTV, Digital SSTV, etc?
- Who uses VHF digital modes
  - Packet, Dstar, YSF, etc?

?

# Ok, you're here and listening.. What are Digital Modes good for?

The adage that "If you can't hear them, you can't work them" ***no longer applies!***
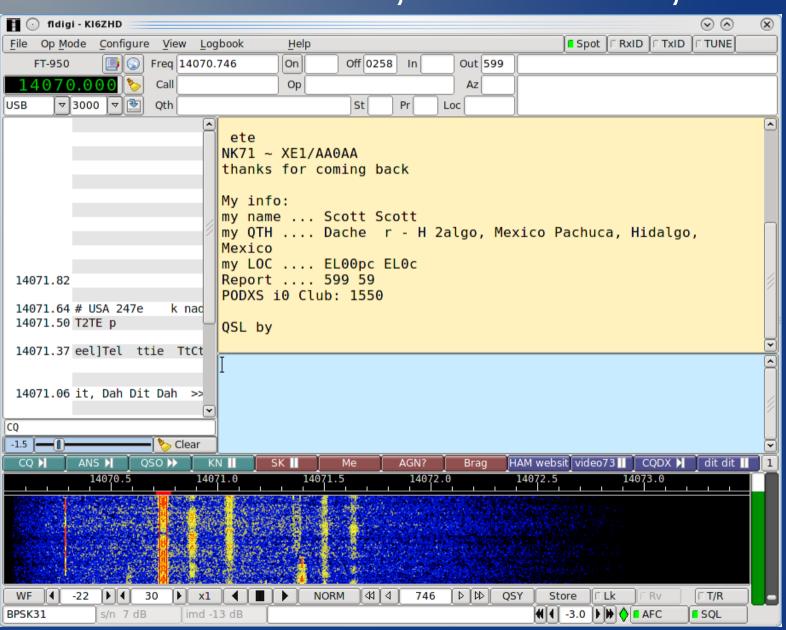
- The weak signal WSPR and JT9 modes have worked with -30db signals (that's *very* buried in the noise floor)

- Though CW is still a strong performer, digital modes provide higher speed, improved accuracy and a simplified operation

- Mixing SDR technologies have enabled a whole new level of operation and very low costs

# Digital Modes Programs for Data Transport

# Digital Mode Programs

- Ham Radio Deluxe – Windows – Commercial
  - Popular and has many many features
- Fldigi – Windows/Mac/Linux – Free
  - Digital modes and logger only – suite of SW
- Multi-PSK – Windows
  - Complete digital mode program – *complicated* UI
- MixW, DigiPan – Windows
  - Older programs, still work
- CocoaModem – Mac
  - Older but still works

# Digital modes with Fldigi, Ham Radio Deluxe / DM780, Multi-PSK, etc

# A wide range of supported modes..

- CW
- Contestia (10 variants)
- DominoEX (8 variants)
- Hell (8 variants)
- MFSK (9 variants)
- MT63 (6 variants)
- Olivia (9 variants)
- PSK (13 variants)

- QPSK (5 variants)
- PSKR (24 variants)
- AFSK RTTY (4 variants)
- THOR (10 variants)
- THROB (6 variants)
- WEFAX (2 variants)
- Navtex / SITOR-B
- Some have Packet, JT65, etc

# Common Modes & Less Common (today)

- PSK31 (narrow and fast)

- RTTY (contesting)

- JT65/JT9 (weak signal / low power)

- Olivia (poor conditions)

- Pactor 2/3 (Winlink)

- Analog and Digital SSTV

- WinMor (Winlink)

- V4 and ARDOP (Replacing WinMOR)

- Hell

- IFSK

- ROS (not legal in US)

# WSJT

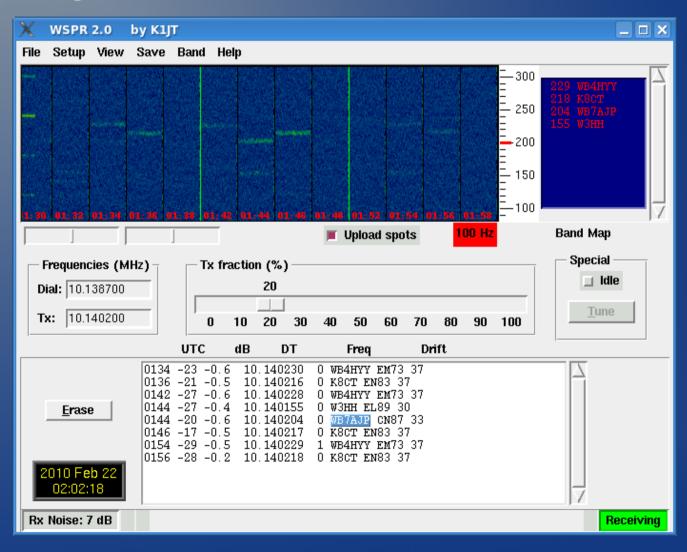- Weak Signal (terrestrial, meteor scatter, moon bounce) for HF / VHF with SDR support and more written in Python

# WSJT-X

- New generation application with new JT9 mode and support for JT65.

- The -X version does not have IQ interface support for SDRs yet

- New -X version was re-written in Qt (KDE) for improved UI, new fully open-sourced decoder, speed, and improved sound support (vs using Qt sound system)

# WSPR – most stations run <5w!

- Weak signal / Internet enabled Beacon network

# More Details about some Modes..

- RTTY: FSK – 170hz wide - 60WPM - requires clean signals, sensitive to errors, no FEC, commonly run at 500W+; immune to ALC

- PSK31: AFSK – 62.5Hz wide - 40WPM – No FEC but very narrow BW; optimized for speed

- MSFK16: AFSK – 316hz wide - 78WPM w FEC

- MT63-1000: AFSK – 1000hz wide - Heavy FEC (25% redundant thus slow but VERY reliable)

- JT65: AFSK – 355Hz wide / JT9: AFSK – 16Hz wide – SLOW - 48 secs to send 13 characters but works at milliwatts into **rain gutters**

# New Modes & Other Tech on the Rise

- 8PSK Mode Family – High speed with strong FEC – Works over FM repeaters – is noticeably faster than 1200 baud packet

- ARDOP – New multi-platform mode to replace Winmor – Faster than Pactor2 – BPQ32 support giving a resurgence to HF BBSes

- FSQ – New chat mode in FSQCall, Fldigi, etc. - using new IFKP mode similar to DominoEX / Thor – Similar to chat interface in D-RATS

- KISS interface in Fldigi – Brings all HF digital modes to automated stations (BBSes, D-RATS)
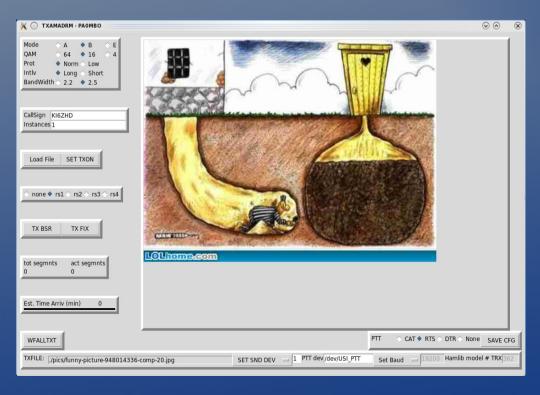
# Digital Modes for Pictures (and data too..)

# SSTV: Analog modes



- MMSSTV, DM780, MultiPSK, Qsstv

- Full QSO editor with templates and macros

- Supported modes
  - Martin, Scottie
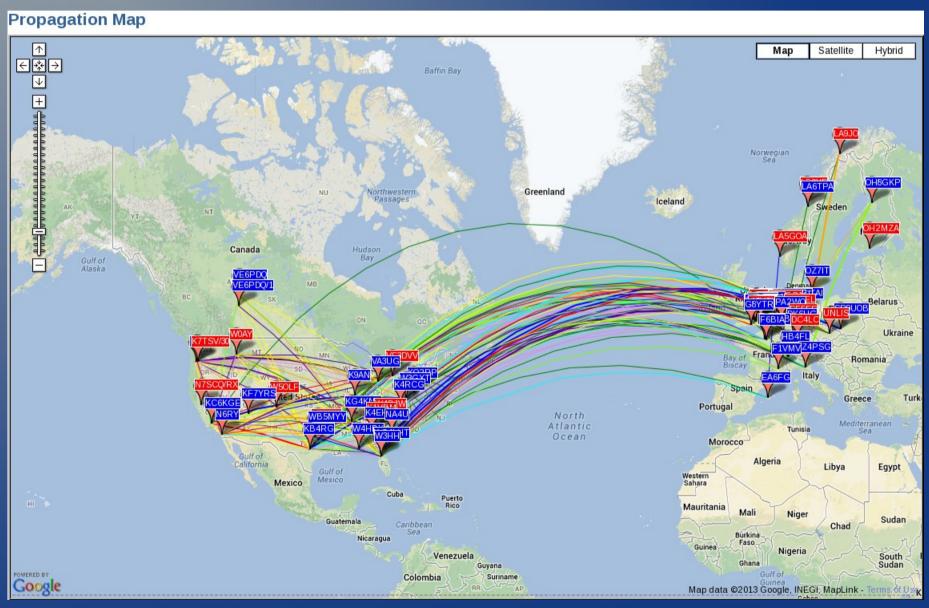  - Robot, PD
  - MP & more

# SSTV: Digital modes

- EasyPal, MMSSTV, Qsstv, TRXAMADRM - support HamDRM and new Hybrid mode modes of RF and Internet

# The other end of the Connection: Confirming <u>Who</u> Hears You

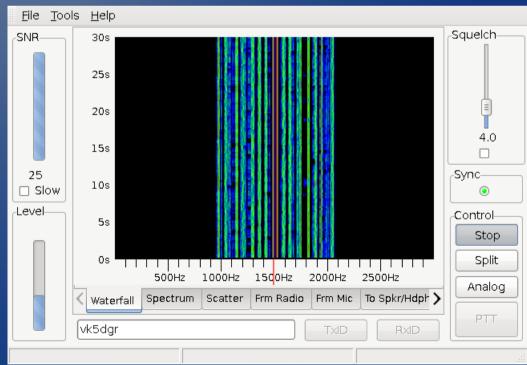# Who hears you and what bands are hot? RSID, PropNet & PSK Reporter

# Digital modes for Voice!

# Digital Voice with OpenDV and CODEC2

- An open digital mode is here for HF + VHF for Windows, Mac, and Linux

- CODEC2 is the open source codec

- Original mode is 1.6Khz but new mode is 700khz

# So which modes to use and When

# Your Choice depends on the need, band conditions and propagation

- Are you trying to Contest (RTTY – fast), ragchew (PSK31 – decent fast), PSK63 (faster), send attachments (bulk data), exchange reports (JT65/JT9 – slow at low power)?

- NVIS modes (e.g. 80m for local propagation) <u>doesn't work well</u> with phase shift modes (PSK) due to Doppler shifts – Use MFSK, DominoEX, Thor, etc

- Poorer the band condition, the larger requirement for  forward error correction (Contestia, Olivia, etc.)

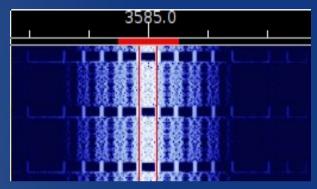# Getting Started with Digital Modes at your QTH!

# What you need to start using Digital Modes

- Radio, Computer, Dedicated Soundcard
  - <u>Don't use your computer's built-in soundcard;</u> you'll be sorry (reset levels, default sounds, etc)
- The soundcard does NOT need to be fancy!
  - A $7 USB sound dongle and a $0.50 transistor circuit works surprisingly well!
- Nicer devices like TigerTronics Signalink, RigBlaster Advantage, Timewave Navigator include audio Isolation & PTT.  Some have FSK, multi-RX support, WinKeyer, etc
- Many free digital mode SW to try things out

# Digital Mode Performance / Tune-up Tips

# Performance Tips – Watch that ALC!

- ALC is enemy #1 for AFSK modes as it represents a distorted output signal



100% ALC BAD!

# Reducing ALC Distortion – Method #1

- Two methods to minimize - RF Control - *Better*

    – Turn down your soundcard's ouput to 5%

    – Turn your radio up to 50% RF output

    – Increase soundcard output until output is at desired level (usually 50%)



50% ALC.. better!
Usually IMD reports of -27

# Reducing ALC Distortion – Method #2

- AF Control - *Best*

    - Turn down your soundcard's ouput to 5%

    - Turn your radio up to 100% RF output

    - Increase soundcard output until output is 50%



0% ALC.. Best!
Usually IMD reports of
-30 or better

# More Performance Tips

- Always <u>disable audio processing</u> on your radio

- Galvanic isolation in sound devices (Signalink, Navigator, etc) helps avoid hum, etc. but <u>masks</u> station grounding issues.  Most isolation transformers also create levels of distortion / non-linearities in the RX/TX signal

- Consider disabling AGC – can hurt  weak signal decodes in the presence of strong signals

- WSJT/-X requires multi-core CPUs and strictly NTP accurate time to complete all JT65/JT9 decodes in the allotted 12 seconds per period

# So on to some homework.. Really!

- Trying out digital modes is easy

- It doesn't require you to install anything to your computer

- If your computer can boot from a CD / DVD or better yet, a USB Pen drive, you're ready to go!

- Andy's HAM Radio Bootable Pendrive / DVD

# Credits:

- Most screen captures done by David Ranch

- Elements of HF modes from Brian Johnston – W8TFI and the Michigan Digital Presentation Team

- Front Tux 'hamradio' image copyright of Linux Journal

- Other images owned by their respective owners

# Any Questions?

# Backup Slides

# Copying Andy's DVD to your Bootable device

- Download "Universal USB Installer" for Windows  (or similar tool) to image USB Pendrives. Runs in place.. no installer required

- Insert the USB Pendrive

- Select "Disk Image", point to the downloaded ISO and wait

- The image only takes 1.4GB so click on "Space used to preserve files across reboots" and give it at least 1GB on say a 4GB pendrive

# Booting your new Andy DVD pendrive

- Turn *off* your computer

- Insert the newly created USB pendrive into a free USB port

- Turn on the computer

- Your computer should briefly show you options to boot off other media say "Press F10 for boot options"

  - If you don't see anything like this, you need to go into the BIOS and either enable this option or change the boot order to boot from USB first and Hard Disk second