VHF Contesting In The Age Of Digital Disruption

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Southeastern VHF Society

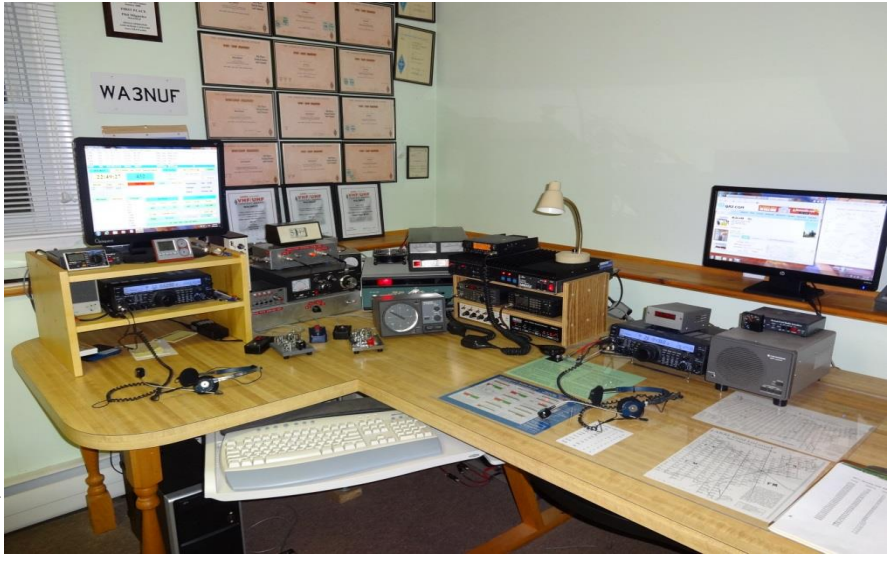
PACK RATS

North East Weak Signal group

WA3NUF HF thru 10 GHz Station

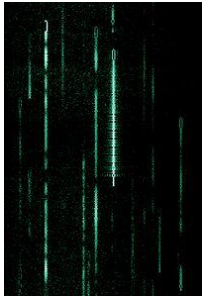
- 300’ ASL
- 50’ Tower / 18’ Mast
- 10 Bands (6M – 10G)
- Surrounded by trees
- Johnsville Airbase @ 360’ ASL
- Willow Grove Airbase @ 400’
- Placed in Jan VHF SS Top 10 1987 through 2017

WA3NUF Operating Position



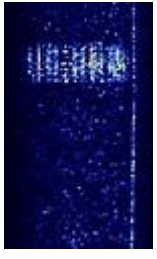
WA3NUF Tower / Antenna Stack

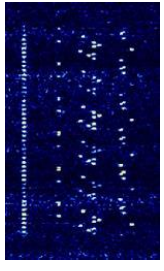
Evolution of Digital Modes (circa 1800 – 2000)

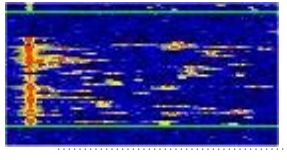


- On Off Keying – Earliest electronic mode. CW transmission using Morse Code. Still popular and going strong today
- Radioteletype – First used by the Navy in the 1920's then commercially in the 30's and wartime in the 40's. Surplus market fueled amateur radio use for many years
- PSK31 – Introduced in Dec 1998 by G3PLX. 31 Baud Phase Shift Keying of an SSB audio modulated carrier. Easy to implement. Only needed a PC + sound card + free software. Up to 20 signals in a 2.7 KHz channel

Evolution of Digital Modes (circa 2001 – 2016)







- WSJT was released in 2001 with a new mode for weak signal MS using FSK441 (4 tones, 441 Baud). Self synchronizing, requires accurate time calibration. Designed for 2M meteor scatter contacts
- JT6M – Introduced in 2002 and optimized for 6M MS and tropo. 43 tones plus 1 synchronization tone
- JT65 – Initial release in 2003. Optimized for weak slow varying signals (EME, Tropo). Uses RS FEC to improve data reliability and increase decode accuracy
  - Achieved unexpected widespread popularity on the HF bands

A Little More on JT65

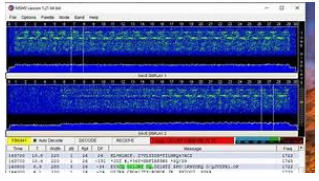
JT65 Minimum Usable Signal Levels

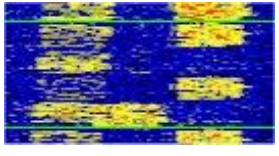
JT65 Message Type Minimum S/N	dB
Arbitrary message, including plain text	-24
Call sign in database (Deep Search)	-28
Arbitrary message, with averaging	-29
Message synchronization	-30
Shorthand RO, RRR, 73	-32

- WSJT JT65 Features
  - T/R sequence: 60 seconds
  - Message length: 72 bits
  - FEC: Reed-Solomon
  - Modulation: MFSK, 65 tones @ ~4 Hz each*
  - Slow data rate (14.4 characters/sec)
  - Occupied BW: 177.6 Hz
  - Transmission Duration: 46.8 s
    - 126 symbols*4096/11025
  - Decoding threshold: -25 dB

* Tone spacing for JT65A

Evolution of Digital Modes (WSJT-X)





- WSJT-X – First announced in 2012, released in Dec 2016
- MSK144 – New mode optimized for 6M MS
  - Employs LDPC forward error correction coding
  - Coherent detection for increased signal sensitivity
  - Includes contest mode and short messages to enhance decodes with short pings typical at higher frequencies
- FT8 – Released July 2017 with version 1.8
  - QSO's 4 times faster than JT65
  - Received message sensitivity down to -20 dB S/N
  - Auto sequencing accelerated contacts, reduced operator error
- Updated in May 2018 (R1.9) – Dxpedition mode
- Updated in Sept and Dec 2018 (R2.0) – Rover fix, 77 bit msg

A Little More on FT8

- WSJT-X FT8 Features
  - T/R sequence length: 15 s
  - Message length: 77 bits + 14 bit Cyclic Redundancy Check (FEC) + 83 Parity bits
  - Forward Error Correction: LDPC
  - Modulation: 8-FSK, keying rate = tone spacing = 6.25 Hz
  - Waveform: Continuous phase, constant envelope
  - Occupied bandwidth: 50 Hz
  - Synchronization: three 7x7 Costas Arrays (start, middle, end of transmission)
  - Transmission duration: 79 symbols*1920/12000 = 12.64 s
  - Decoding threshold: -20 dB maximum (potentially -24 dB due to synchronization)
  - Operationally familiar to HF JT65 users
  - Multi-decoder: finds and decodes all FT8 signals in passband
  - Auto-sequencing after manual start of QSO

What Happened in the 2019 January VHF SS?

- Poor conditions combined with freezing rain and heavy snow impacted many operators in the northern and northeast regions
- After the first few hours of the contest the majority of stations focused on 6 meter FT8 and to a lesser extent 2 meter FT8 leaving the CW/SSB portions of the band almost vacant
- 6M scores exploded, all other band scores collapsed
- This was the first VHF contest where digital modes were dominant
  - Instant congestion as all stations tried to occupy 50.313 MHz
  - Calling frequencies for higher bands above 2M were undefined
  - Operators had no easy means to move stations to other bands

Where Can FT8 and Other WSJT-X Modes Expand?

6 Meters (50-54 MHz)

50.0-50.1	CW, beacons
50.060-50.080	beacon subband
50.1-50.3	SSB, CW
50.10-50.125	DX window
50.125	SSB calling
50.3-50.6	All modes
50.6-50.8	Nonvoice communications

2 Meters (144-148 MHz)

144.10-144.20	EME and weak-signal SSB
144.200	National calling frequency
144.200-144.275	General SSB operation

Where Can FT8 and Other WSJT-X Modes Expand?

1.25 Meters (222-225 MHz)

222.10-222.15	Weak-signal CW & SSB
222.15-222.25	Local coordinator's option; weak signal, ACSB, repeater inputs, control

70 Centimeters (420-450 MHz)

432.10-432.30	Mixed-mode and weak-signal work
432.30-432.40	Propagation beacons
432.40-433.00	Mixed-mode and weak-signal work

Where Can FT8 and Other WSJT-X Modes Expand?

33 Centimeters (902-928 MHz)

902.075-902.100	CW/SSB	Weak signal	
902.100	CW/SSB	Weak signal calling	Regional option
902.100-902.125	CW/SSB	Weak signal	
903.000-903.100	CW/SSB	Beacons and weak signal	
903.100	CW/SSB	Weak signal calling	Regional option
903.100-903.400	CW/SSB	Weak signal	

23 Centimeters (1240-1300 MHz)

1296.080-1296.200	CW, SSB	Weak Signal
1296.100	CW, SSB	CW, SSB calling frequency
1296.200-1296.400	CW, digital	Beacons

Cumulative Contest Scores Were Lower

Mt. Airy VHF Radio Club January VHF SS Previous Aggregate Claimed Scores		
Year	**Logs Submitted**	**Score**
2019	71	1,138,372
2018	60	1,911,495
2017	65	1,998,637
2016	70	2,238,450
2015	68	2,065,073
2014	68	2,277,747
2013	65	2,659,242
2012	77	2,491,702
2011	67	2,156,784
2010	70	2,699,809
2009	58	1,891,225

- 6M FT8 activity was booming
  - FT8 expanded station grid totals
  - Band openings focused only on FT8
- Higher band activity was slow and mostly local contacts
- Rovers were not prepared to run FT8 and relied solely on schedules
- Station total scores generally lower
- Club scores much lower yr over yr
  - Packrat club score down 40% from 2018

Proposals to Save the UHF and Above Bands

- Increase the points level per contact for CW/SSB QSO's
- Increase the multiplier for 222 and higher bands
- Petition the ARRL to establish FT8/WSJT national calling frequencies for all VHF/UHF bands from 6M to 3cm
- Expand FT8 activity bandwidth +/- 5 KHz around the calling freq
- Add a QSY UP message to the FT8 protocol sequence
- Establish contest activity hours per band on a national level
  - Create a mini-Sprint for 222 and above bands during the contest period
- Other?

Summary

- Digital modes have invigorated amateur radio and enhanced station communication range and capability
- WSJT-X FT8 is revolutionary, disruptive, and has exposed the need for band plan and contest operating procedure changes that include the higher frequency bands
- The January VHF SS was a first test of FT8 in a major contest and should be studied to determine what changes need to be made
- The VHF community must work together to make the necessary recommendations and changes needed to assure that digital mode use in VHF/UHF contests promote the spirit and expansion of higher frequency communication

Thank You

"Listen for the Weak Ones"