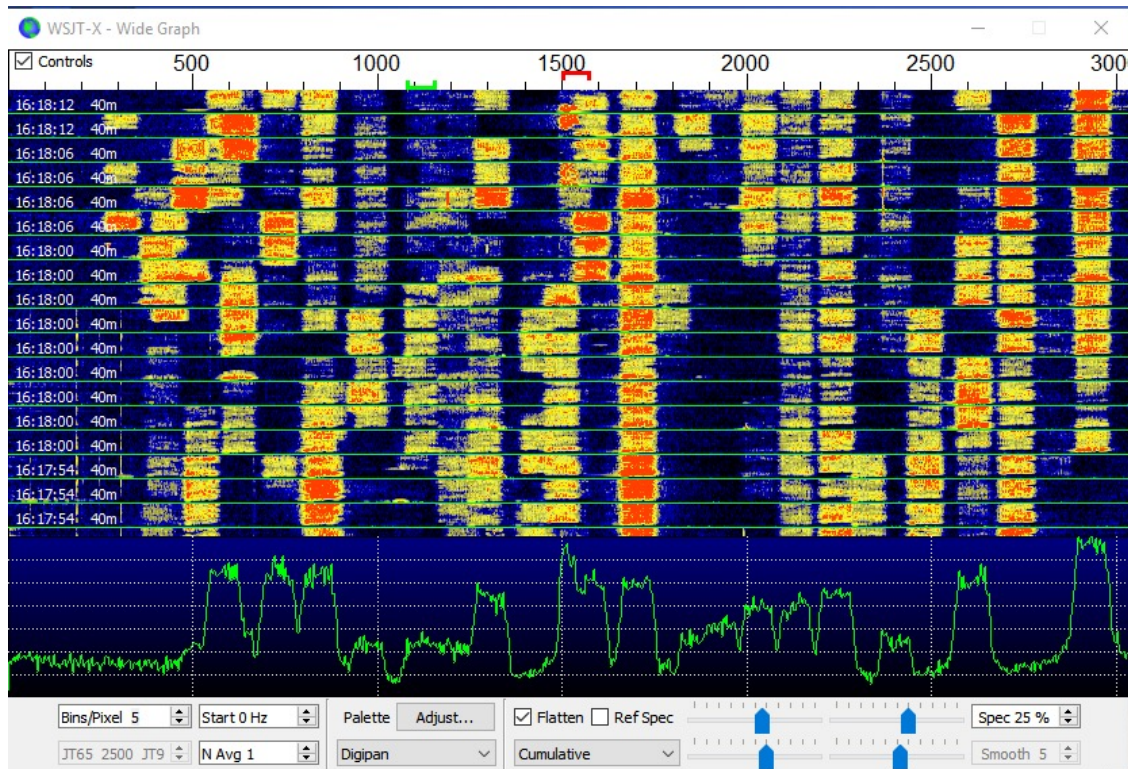


# WSJT: Brief History



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# Overview

- WSJT: digi-modes for **W**Weak **S**ignal DXing
- Why ? (motivation, goals)
- What ? (what can these modes do ?)
- How ? (how do they work ?)
- Current examples: **FT8**, **Q65**
- **Q & A, open conversation ...**

# WSJT: Weak-Signal Communication

- **WSJT** – 2001 – VHF+: meteor scatter, EME, ...; (HF: QRP DXing)
- **MAP65** – 2006 – Wideband (90 kHz) EME: multi-decode, adaptive polarization
- **WSPR** – 2008 – QRP propagation probe
- **WSJT-X** – 2012 – All bands, many modes  
LF MF HF VHF UHF SHF
- Today: ~ 40,000 active users, world-wide

# Why ?

- VHF DXing is a challenge
  - My start: solar cycle 19; IGY 1957-58
- Hams like to “keep score”  
(DXCC, WAS, VUCC, contests, ...)
- Voice, CW limitations
- We’re in the Digital Age !
- Even *minimal* QSOs are fun !
- Overall goal: push fundamental weak-signal communication limits

# What ?

## Tools designed for job:

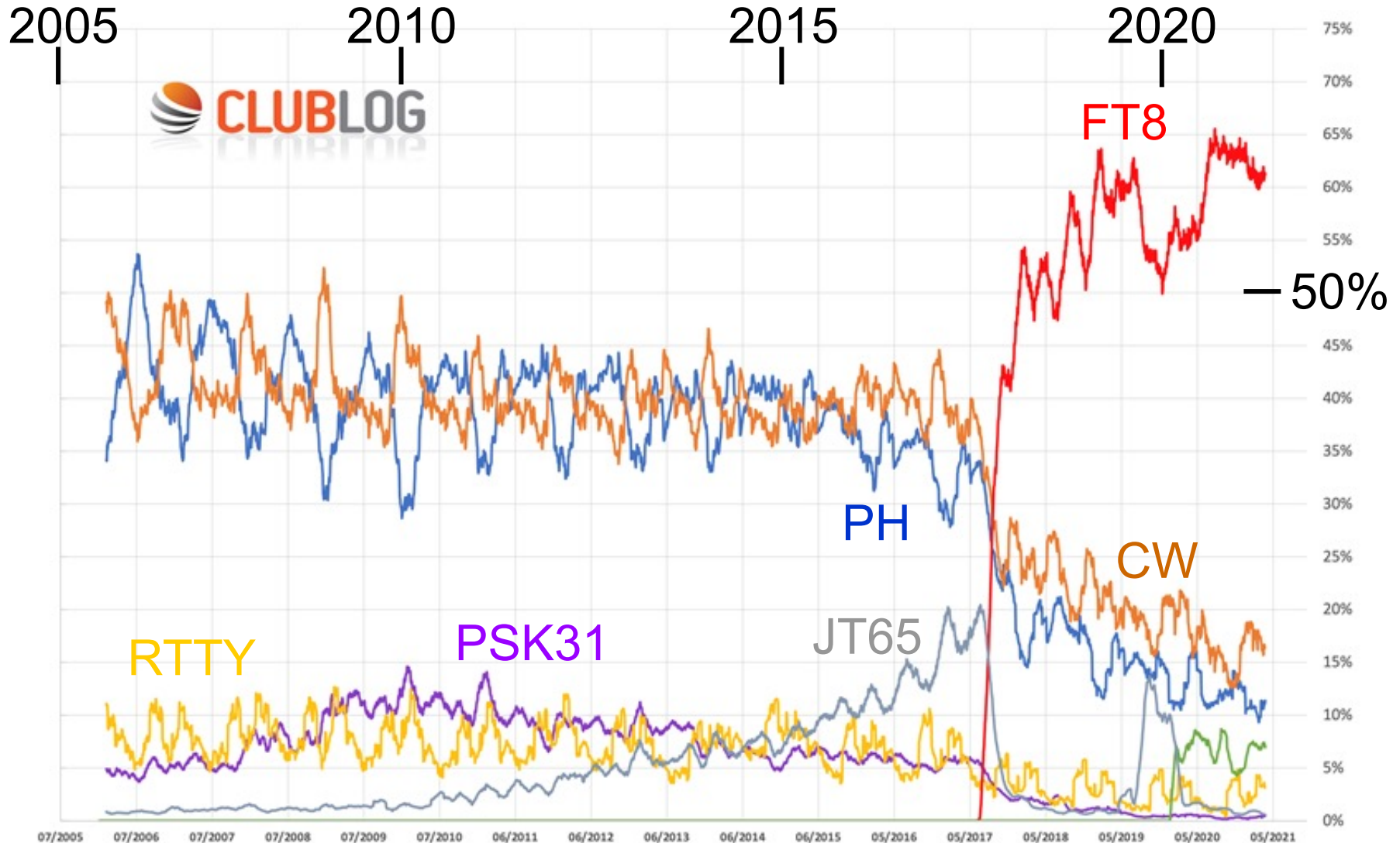
- Meteor scatter: ~~FSK441~~ MSK144
- EME: ~~JT65~~ Q65
- QRP propagation probe: WSPR
- HF VHF UHF DXing: FT8
- Contesting: FT4
- LF and MF DXing: FST4, FST4W

# Why ?

## ... are these modes so popular ?

- HF: Work the World with low power, compromise antennas
- VHF+: extend your distance range
- Boost your DXCC/WAS/VUCC score
- Make “near-impossible” QSOs
  - Meteor scatter, EME, aircraft scatter, ...
- *WSJT-X*: “The finest arcade game in radio land”

# ClubLog Modes: 636M QSOs



# Weak-Signal S/N Limits

Mode	S/N (dB)	Target Applications
SSB	~ +5	
RTTY	-5	
MSK144	-1 to -8	Meteor Scatter
CW	~ -10	
FT8	-21	HF VHF UHF
Q65-30A	-25 to -27	Troposcatter, Ionoscatter, ...
Q65-60A	-28 to -30	EME
FST4-60	-28	LF MF
WSPR	-31	Propagation probe
FST4W-120	-33	LF MF Propagation probe
FST4W-1800	-45	LF MF Propagation probe



# How? Protocol Designer's Tools

- Information throughput rate
- Constraints on message format
- Source encoding (compression)
- Error detection (parity, CRC, ...)
- Error correcting code (ECC)
- Code alphabet (number of different symbols)
- Modulation type (OOK, FSK, PSK, QAM,...)
- Synchronization method
- Symbol rate (baud)
- Bandwidth (Hz)

# Example #1: FT8

- Introduced July 2017
- Designed for multi-hop E-skip on 6m
- Short, **structured** messages
- Fast minimal QSOs
- Timed T/R sequences, 15 s
- Works well at  $S/N \geq -21$  dB
- Highly effective for HF, VHF DXing
- **Not for casual chats or rag-chewing!**



# FT8: Protocol Details

- Messages “source-encoded” to 77 bits
- Error detection: 14-bit CRC
- Error correction: LDPC (174,91) code
- Synchronization: three 7x7 Costas arrays
- Modulation: 8-GFSK → 3-bit symbols  
6.25 baud, BW=50 Hz
- Tx duration:  $(174/3 + 3 \times 7)/6.25 = 12.64$  s

# FT8: Good Features

- “Meeting place” (3-5 kHz) on each band
- Decode all signals in passband
- State-of-the-art decoder: 50% copy at -21 dB (with AP, to -24 dB)
- False decodes very rare
- No partial copy or corrupted messages
- → Signal subtraction works !

## Example #2: Q65

- Structured messages: again, 77 bits
- Error detection: 12-bit CRC (not sent)
- ECC: QRA (63,13) code, 6-bit symbols
- Modulation: 65-FSK
- Synchronization: 22 “tone 0” symbols
- Submodes: T = 15 30 60 120 300 s,  
tone spacings = A B C D E
- 85 symbols at (for example) 1.667 baud

# Recommended Q65 Submodes

- EME
  - 50,144 MHz: Q65-60A
  - 432 MHz: -60B
  - 1296 MHz: -60C
  - 10 GHz: -60D
- 6m ionosscatter: -30A, -120E
- 6m TEP: -15C, -30C
- 10 GHz tropo-, rain-scatter: -60D
- 10 GHz aircraft scatter: -15C

# Future path? Wish List?

- All signals now in ~3 kHz slice, per band  
(Can this possibly make good sense ???)
- Wider spectral slices needed ?
- SDR technology → wider Rx bandwidths
- IARU Band Planning Committee ...
- More contesting features ?



# WSJT-X Programming Details

- User interface: C++ and Qt
- Number crunching: Fortran
- Core developers: K1JT, G3WJS (SK), K9AN, IV3NWV, DG2YCB, N9ADG, G3WDG
- Open source: GPLv3 license
- Version control with git:

```
$ git clone https://git.code.sf.net/p/wsjt/wsjtx
```

