Digital Communications – A Brief History

Digital Communications have been available to amateur radio operators for many years, and can be divided into 4 separate eras:

1. **The early days Morse Code Only – Still popular today.**
2. **The Middle Years (mid 1940s to early 1980s)**
3. **The Age of Innovation (early 1980s to late 1990s)**
4. **The Modern Era (late 1990s to present)**

Morse Code History

- This is really a hybrid mode since the code does not have a finite alphabet of symbols (speed and duration modulation make it extremely difficult to receive automatically). Nothing today beats the human error for human sent code.
- Samuel F. B. Morse did not invent the Morse Code, it was originally developed for his telegraph machine by Alfred Vail in the early 1840's. That first code was the basis on which the modern day, International Morse Code (IMC) was founded.
- In the early 20th century, most high-speed international communications took place via Morse Code on telegraph lines, undersea cables and over radio.

Morse Code History

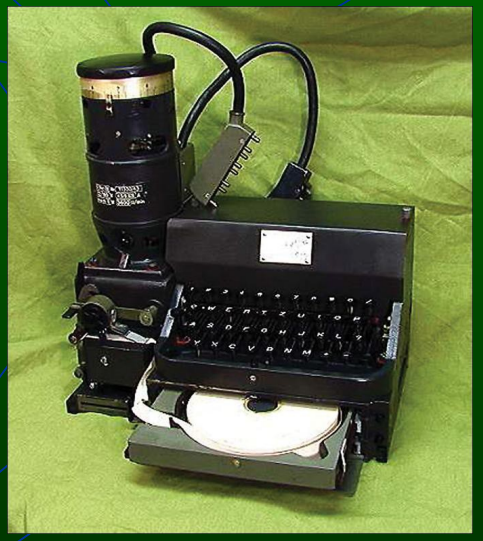
- Variable Character Lengths, a limited character set and the lack of Forward Error Correction made this mode unsuitable for computer reception.
- With the incorporation of the computer, and newer digital modes, Morse Code ended as a means of commercial message transmission.

1. The Middle Years

- Began after World War 2, when surplus mechanical print machines become readily available for amateur use. Prior to then, there was some experimentation with Hellschreiber, but this and radioteletype were both mainly confined to military and commercial use prior to the 1940s. Communications were “live,” requiring both the receiving and transmitting station to actively interact with each other over the airwaves.

- **Modes of Operation** – Radioteletype (RTTY).

- **Equipment Required –** Transceiver, teletype printer, oscilloscope, homemade interface to actuate teletype printer, lots and lots of yellow paper and oil.



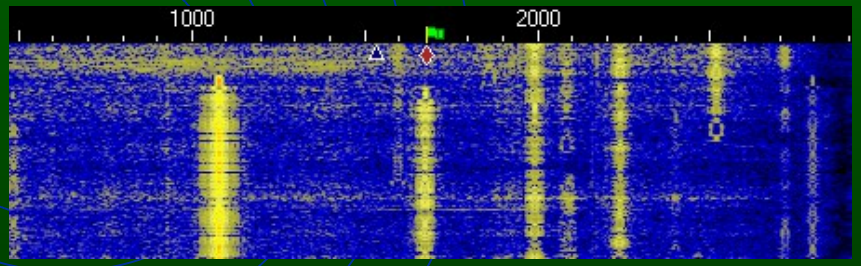
2. The Age of Innovation

- Began in the early 1980s with the rise of the personal computer. Key differences w/1st era: error-free or error correction transmissions now available, and automatic operations (e.g. electronic mailboxes, etc.) could be set up without requiring "live" participation by the licensee.
- **Modes of Operation** – Started with AMTOR, then grew with the popularity of Packet. Pactor, Pactor II, Clover, and G-Tor also appeared during this period.
- **Equipment Required –** A stable transceiver, PC (Commodore 64 on up to 286 or 386), multimode processor (TNCs) used as the interface, software needed to interpret signals.

3. The Modern Era

- Began in the late 1990s with the rise of the Internet. Key differences w/2nd era: return to emphasis on “live” communications. Easier, more affordable set up costs led to broader acceptance of digital communications by hams in the U.S. and overseas.

- **Modes of Operation** – Predominately PSK31, followed by MFSK, Hellschreiber, MT-63, and PSK63.



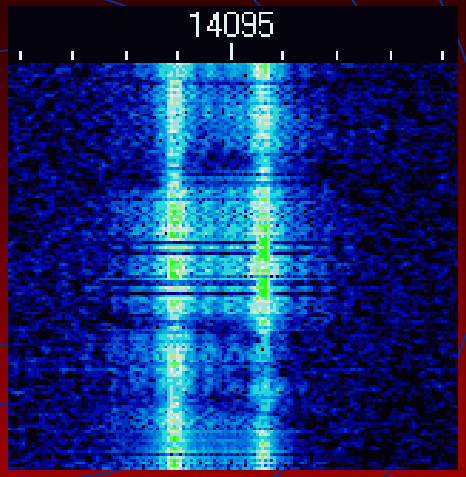
- **Equipment Required –** A stable transceiver that can tune in 1 Hz steps, modern PC (Pentium 133 Mhz on up, w/ sound card), sound card interface, and software needed to interpret signal.

II. Overview of Various HF Digital Modes

1. RTTY
2. AMTOR
3. Packet
4. PACTOR I, II, III
5. Clover/G-TOR
6. Hellschreiber
7. MFSK
8. PSK31
9. MT63
10. Olivia

1. RTTY (Radioteletype)

- RTTY is the “old fart” of digital communications. Basically works using a 5 bit code for characters and numbers. Transmits 2 tones: a 2125 hz *mark* (or “1”) tone, and a 2295 hz *space* (or “0”) tone.



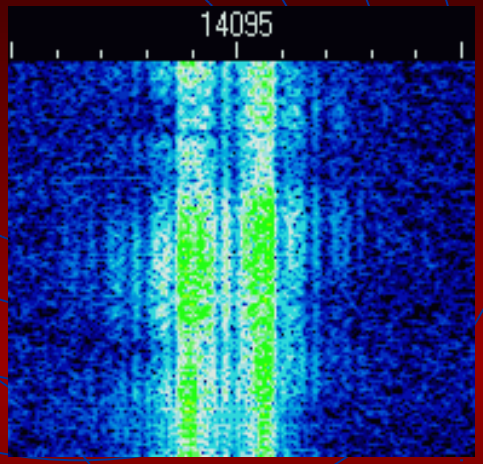
RTTY Trace

- **Bandwidth** – 170hz – 200 hz
- **Sounds Like** – A very fast *blee-blee-blee-blee…*
- **Advantages** – Any radio can be used, it’s still the *modus operandi* for DX and digital contests. Has very fast transmission speed, can be used at maximum power without affecting signal quality, and is fairly reliable for HF communications, even w/poor band conditions.
- **Disadvantages –** Print is all UPPER CASE. No error correction, can’t backspace what you transmit. Has rapidly been replaced by PSK31 for daily use.

2. AMTOR (Amateur Teleprinting Over Radio)

- AMTOR is the 1st error-free/automatic digital mode. Although it's still available w/most digital sound card and TNC software, it's been out of use since the early 1990s and was surpassed by PACTOR.

- **Bandwidth** – 170hz – 200 hz



AMTOR Trace

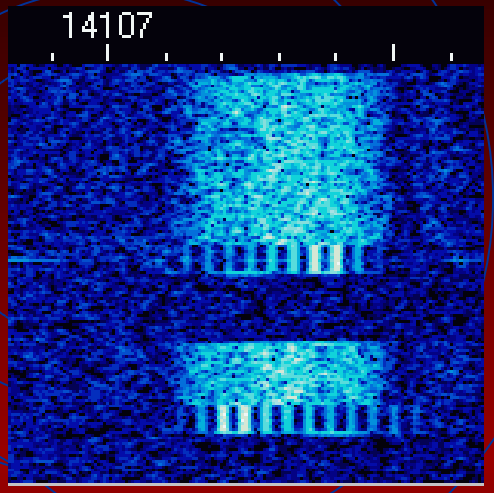
- **Sounds Like** – Much like RTTY, but w/ a scratchy *chirp chirp* added…

- **Advantages** – None, other than it's free

- **Disadvantages –** No one uses it

3. Packet

- Packet is the next error-free/automatic digital mode, with data being sent in short bursts . Very popular in the 1980s on the VHF/UHF bands, was 1st mode to be able to send binary data. Still in use for DX spotting and APRS.



HF Packet Trace

- **Bandwidth** –200 hz - 2 Khz

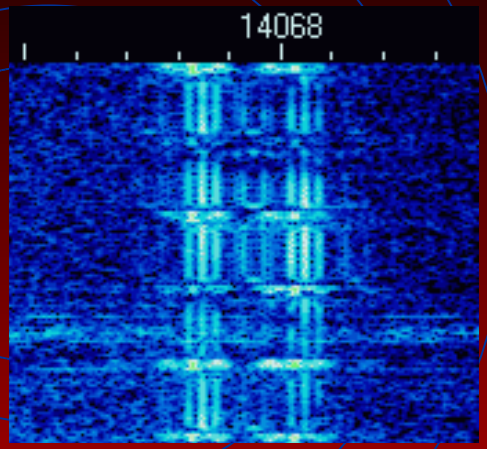
- **Sounds Like** – a loud *beee chirrrrrrp*

- **Advantages** – Fairly common mode on VHF/UHF, provides for a wide variety of live and automatic uses. Lots of Packet equipment can be had on the cheap.

- **Disadvantages –** Very susceptible to static, noise, and fading signals, making it not very good for HF. Ubiquitous functionality has rapidly been replaced by the internet.

4. PACTOR/ PACTOR II & III

- PACTOR, PACTOR II, and PACTOR III are hybrids of Packet w/the HF functionality of AMTOR. It memorizes error-free data and fills in the gaps missing from interference or QRM w/subsequent correction blasts, making it faster and easier to use than Packet or AMTOR on HF



PACTOR Trace

- **Bandwidth** – 200 hz – 500 hz

- **Sounds Like** – similar to Packet sound, typically makes repetitive *chirping* noises on HF.

- **Advantages** – It's the most common error-free data mode on HF, mostly used for automatic operations such as having internet access or email from remote locations. PACTOR II is backward compatible w/ regular PACTOR. Often used nowadays for WinLink 2000

- **Disadvantages –** Normally requires TNC, or PCKTERM 3.0 software for soundcard use ($100.00). PACTOR II used to cost a lot of money, required specific type of TNC. Not suited for daily "live" communications.

5. Clover / G-TOR

- Clover is a 4 tone, error-correcting digital mode, a proprietary creation originally designed to compete w/ PACTOR. G-TOR is very similar, but uses 2 phase-continuous tones instead.
- **Bandwidth** – 500 hz (Clover) / 300 hz – 500 hz (G-TOR)
- **Sounds Like** – a staccato *brrrrrrrrr* (Clover) / similar *chirp* sound as w/PACTOR (G-TOR).
- **Advantages** – Much better error-correcting ability, can handle large volumes of data, both perform very well under bad HF conditions.
- **Disadvantages –** Requires multimode processors, cannot be used w/ soundcards. Clover requires controller hardware to be installed into your PC. Both are proprietary digital modes and cost a lot of money. Almost never heard on the HF bands, functionality is superceded by the internet.

6. Hellschreiber

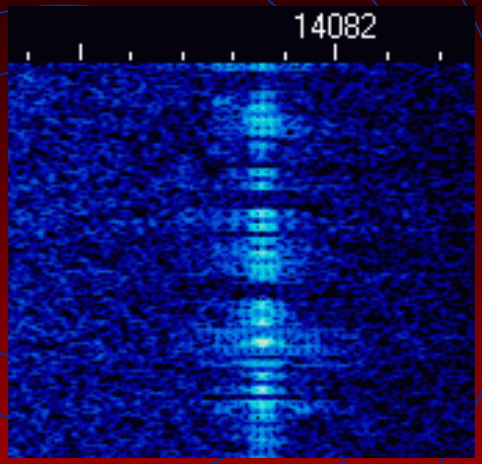
- Hellschreiber is a visual or “image text” digital mode, very similar to fascimile. Characters appear to scan across your viewing screen as you receive or transmit text. Mode was pioneered back in the 1920s and 1930s, used extensively by German Army in World War II.

- **Bandwidth** –1 hz - 245 hz

- **Sounds Like** – a light, fast *tic tic tic brrrrrp brrrp… brrrrrp brrrp*

- **Advantages** – Prints text twice to reduce the effects of phase shifts and timing errors due to QRM. Moderately fast digital mode for it’s extremely narrow bandwidth.

- **Disadvantages –** Not very common on the HF bands.



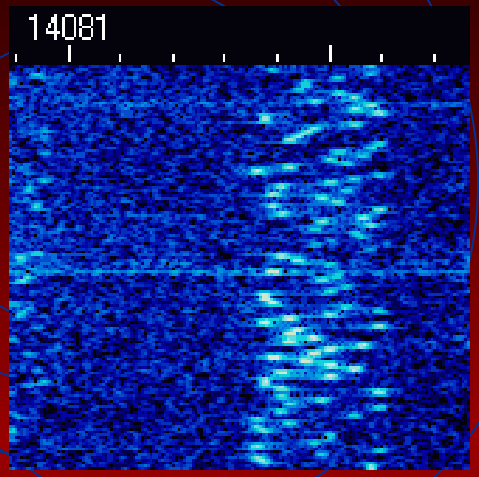
Hellschreiber Trace

“HOGAN!!”--

Colonel Klink

7. MFSK

- MFSK is essentially a super-RTTY mode, using 16 to 32 different tones instead of just 2. Developed in the heyday of commercial teleprinter HF communications, for use when RTTY was no longer receivable.
- **Bandwidth** – 300 hz
- **Sounds Like** – Think of an insane picolo solo, playing completely random notes.

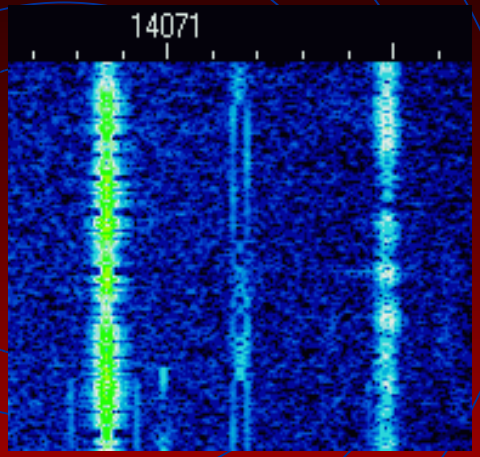


MFSK Trace

- **Advantages** – Perfect mode for DX long-path and polar operations, good for QRP ops. It's very resistant to noise and QRM, making it ideal for low band operations. Print is moderately fast (40 WPM).
- **Disadvantages –** Can be hard to sync up w/on your software. Although it does have some error-correction capabilities, it is strictly a live operation mode.

8. PSK31

- PSK31 stands for Phase Shift Keying. The 31 stands for the bit rate, but this number is also the typical bandwidth for PSK ops. Mode was pioneered by AMTOR creator Peter Martinez, G3PLX, as a live communications alternative to RTTY for weak signal use. Gained popularity in 1999, when a Windows-based software platform was made available. BPSK is the standard binary mode, while QPSK is an error-correcting version.



PSK31 Trace

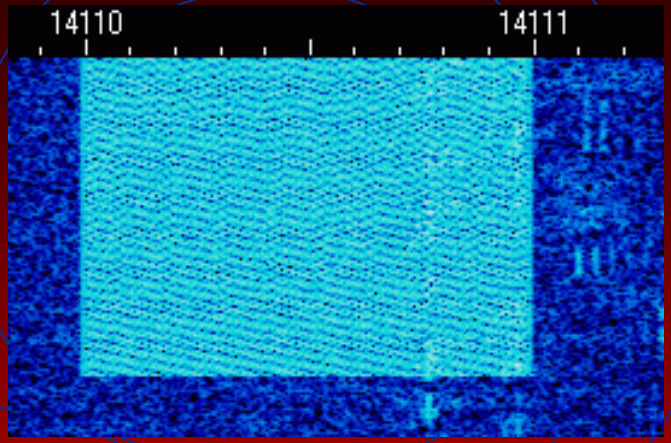
- **Bandwidth** – 31 hz
- **Sounds Like** – A continuous tone with slight warbles in pitch.
- **Advantages** – Most common digital mode on HF. Narrow bandwidth allows for dozens of signals in a given Khz. range. Extremely well suited for poor band conditions, QRP ops.
- **Disadvantages –** Has the 2nd slowest print rate of all digital modes. Not as efficient as RTTY in contests.

9. MT63 (Used in NBEMS)

- MT63 uses 64 different modulated tones to transmit large amounts of data, offering superb impulse noise rejection and robust forward error correction capabilities.

- **Bandwidth** – 1-2 khz

- **Sounds Like –** Low pitch, hoarse *wrrau-wrau-wrau-wrau*



MT63 Trace

- **Advantages** – Offers incredibly fast data transmission speeds on HF bands, very hard for intermittent or static noise to affect data sent, easy to sync up once signal is found, often found packaged with multi-mode digital software

- **Disadvantages –** Seldom found on the bands, takes up a lot of bandwidth and tends to blanket other digital modes (causing much irritation to other hams), typically used only as a live operation mode

10. Olivia (Used in NBEMS)

- Olivia is technically another MFSK mode, but it uses 32 different tones over a larger bandwidth. This mode is much more robust, and therefore can be sent and received when band conditions are very poor, even being received when not audible to the human ear.

- **Bandwidth** – 250 hz, 500 hz, or 1 Khz

- **Sounds Like** – Yes, much like MFSK, this mode sounds like an insane flute solo, playing completely random notes, but more muffled.

- **Advantages** – Another great mode for DX and QRP operations. It combines the best strengths of MFSK with the weak signal capabilities of PSK31.

- **Disadvantages –** Fairly new mode (2005), not widely used yet. Wideband capabilities tend to infringe on other neighboring digital modes.