Digital Modes for Dinosaurs   by VK7JJ May 2010

Digital modes can be conveniently divided into three categories:

1. Picture modes: transmission of pictures where typically a JPG file is sent and received.
2. Text modes: transmission of text from keyboard to keyboard for QSOs both DX and local.
3. Weak signal or sub noise level reception of data for QSL via moon bounce, meteor scatter, etc.

Tonight we'll focus on categories 1 and 2 because there are plenty of stations on air using those modes with popular easy-to-use software.

What do we mean by digital modes?

Some people wonder what actually gets transmitted by our radios when we connect them to a computer:
Instead of transmitting our voice we transmit *audio tones* generated by the computer's sound card. Those tones range from simple to complex but like voices, they are just sounds. The software at the receiving end decodes the tones using the computer's sound card and reassembles the data as a replica of that on the originating computer. The word digital is used because computer data is stored in digital form, ie. binary *bits* with zero and one values.

With RTTY one tone represents a 'zero' and another tone represents a 'one', but there are many different tone encoding schemes for different modes. PSK31 uses a single tone and 'wobbles' it's phase and uses AM to reduce the tone carrier level to zero at each phase shift so as to reduce bandwidth; Olivier spreads the signal wider and sends multiple tones for each bit so as to obtain redundancy, if one tone is momentarily lost to a static pulse the other one might still get through.

Some digital modes use other error correction techniques. For example a mathematical formula might be used to place the binary zeros and ones into small packets; the software counts those packets and keeps track of them and can ask for missing packets to be re-sent. Packet information is thus sent in bursts of tones.

Non-error correcting modes don't care, they just send the information out over the air hoping that sufficient is received for the user to make sense of.

Some digital mode software is of high quality; some provide the option of controlling your radio by changing bands, frequencies and modes, and antenna rotator control. Some allow remote control of your radio via the Internet and many include log book facilities.

1. Picture modes

a) "Analogue" SSTV (Slow Scan TV is referred to as analogue because it has no error correction.)

- What its good for

   - Sending photos with easily added text annotations.
   - Typically transfers a 320 x 256 sized image in 110 seconds.
   - There is regular activity on HF for both worldwide DX and VK.
   - SSTV handles weak signals quite well because the human eye can often still enjoy a picture even when some of it is missing or has noisy patches.

- Popular SSTV software

   MMSSTV - free, easy to use, easy image and template creation, easy to use annotations.
   Digital Master 780 - free (part of Ham Radio Deluxe), comprehensive features, not as easy to use.

- Frequencies to listen

   14.230 day-time (AU webcam: http://users.tpg.com.au/adslsymb/VK6AAL/20m/20mpix.html)
   Also commonly found on 3.845 and 7.050

- SSTV repeaters

   Most are 1750Hz tone accessed, they receive the image and then immediately re-transmit it.
   14.236 VK3, 14.227 VK6 (the VK6 repeaters use Pal MultiMode as well as normal analogue mode).
   There are other VK6 repeaters on 7.050 and 21.349

- Internet gateways

   Internet gateways listen for SSTV transmissions on air and display the received images on the internet:

   Tasmanian - VK7AX on 145.625 -- http://115.69.164.149:15426/sstvgate/index.html
   Tasmanian - VK7OO on 14.230 -- http://vk7oo.tasme.com/sstv20m/
   International - W2SWR -- http://www.slowscantv.net/
   Australian - VK6AA on 14.230 -- http://users.tpg.com.au/adslsymb/VK6AAL/20m/20mpix.html
   Australian - VK6AA on 7.033 -- http://users.tpg.com.au/adslsymb/VK6AAL/40m/40mpix.html

b) "Digital" SSTV (Uses digital error correction and resends lost data to achieve a perfect picture)

- What its good for

- Sends higher quality photographs, animations, from your video-cam, or general data/text files.
- Can transfer a 1280 x 1024 sized image in a couple of minutes under good HF band conditions.
- Regular activity on HF for both worldwide DX and VK.
- note: unlike normal SSTV you don't see any image unless you copied it right from the start.

- Popular digital SSTV software

  EasyPal - free download, written by Eric VK4AES
  VK7DIK and a number of mainland hams use it quite often on 80m on 3.643 and 3.673

c) Hellschreiber (also known as Feld-Hell)

Developed in 1929 for sending newspaper text over phone lines, letters are picture blocks or symbols.
Mainly used for novelty value; start a QSO with somebody and change modes and see how it works.
Software: MixW, MultiPSK

d) Fax (amateur HF fax)

Some of the software packages support HF fax but its not in common use.

2) Text modes: keyboard-to-keyboard QSOs

a) PSK31 (Phase Shift Keying at a rate of 31 baud)

- What its good for

  - Popular for keyboard-to-keyboard QSOs, good worldwide DX and VK activity; handles fast typing speeds.
  - Excellent for low power because once a signal appears above the noise it's *100% copy* and thus 5 by 9.
  - Bandwidth of less than 160Hz means great power-to-bandwidth ratio and good interference avoidance.
  - Many different stations can fit simultaneously inside the 3KHz bandwidth of a single SSB transmission.
  - Easy to understand and get going, simple and fun to use; you can "jump in" and join other QSOs.

- Popular PSK31 software

  AirLink Express - free download, well written, it offers several PSK and RTTY modes.
  PSK31 - free download (part of the Ham Radio Deluxe package), comprehensive features.
  MixW - have fun with the free 15 day trial. Registration costs $50. *See comments at the end of the article.
  MultiPSK - free. *See comments at the end of the article.
  CocoaModem   - for Mac OSX, free, well written; supports PSK, FSK and RTTY modes, CW and HF Fax.

- Frequencies to listen

  14.070.15 USB (as long as you are tuned in, USB or LSB does not matter).
  3.580.15 and 7.035.15

b) RTTY (Radio TeleType)

- What its good for

  - Longer established than PSK31 it was used originally with old hardware TTY machines.
  - Some RTTY you hear is not from amateurs; non-standard speeds and shifts can be difficult to decode.
  - Fun to use, unique visual tuning, easy to get going.
  - Downsides include wider bandwidth, less interference resistance, upper-case text only.

- Popular RTTY software

  MMTTY - free download, excellent implementation from the author of MMSSTV and MMANA.
  All the same programs listed under PSK31 above can also do RTTY.

c) Olivia   (see http://hflink.com/olivia/ for more information)

- What its good for

  - A very robust keyboarding mode popular for long-haul DX, uses forward error correction and redundancy.
  - Is it possible to "chat" in signal to noise conditions where the human ear can hardly detect a signal.
  - Uses specified frequency channels so that users can find signals they can't find with the VFO.

- Popular Olivia software

  MixW - free 15 day trial, then $50. *See comments at the end of the article..
  Olivia-Aid - free download, untested by me.
  MultiPSK - free download. *See comments at the end of the article.

d) Other keyboard-to-keyboard text modes

CW - several packages handle CW including MixW. CW does not use tones but switches the carrier on and off.
MT-63 - 1KHz bandwidth, handles fading and phase shift better than PSK modes; has a simple error correction.
MFSK16 - 316Hz bandwidth, 16 or 8 tones, good pulse / static rejection, similar to PSK31.
THROB - a precursor to MFSK16 using 5 tones, fairly rare.
CLOVER - a PSK mode which provides full duplex simulation, works best under good HF conditions, rarely heard.

e) Packet modes

Packet Radio - bundles text into packets with error correction and addressing built in; packets can be given a
destination and sent out via a string of store-and-forward relay/repeater stations.
APRS - built on top of packet radio, it encodes GPS information (and simple messages) inside standard packets.

AMTOR / SITOR / PACTOR - early error correcting implementations of RTTY, not in common use.

MixW provides a complete TNC emulation. You don't have to connect up your old hardware TNC, just set up for normal digital modes and then choose Packet from the menu. There are preferences that may need to be set for correct packet operation.

3. Weak Signal Communications Software

a) WSJT (Weak Signal Communications by K1JT [free download])

- What its good for

    - Optimised for meteor scatter, EME (moon bounce), ionospheric scatter.
    - Used on UHF/VHF as well as HF skywave in the JT65 mode.
    - It can decode fraction-of-a-second signals from meteor trails.
    - Over a time period it can decode signals 10dB or more below the audio threshold.

It supports a number of different low-signal modes, including good old CW.
FSK441 - used on VHF/UHF meteor trails from general background meteor activity; data rate is 441 baud.
JT6M - used mostly on 6m for meteor and ionospheric scatter; data rate is 14 baud (characters per second).
JT65 - used for extremely weak but slowly varying signals, typically HF tropo scatter and EME.

HF signals can be found on 14.076 and 21.076 MHz but it is sometimes necessary to set the software on the frequency and keep an eye on it over a period of time; there may be stations you can read but not hear.

b) WSPR (Weak Signal Propagation Reporter [free download])

    - designed for sending and receiving low power (QRP) signals to test propagation paths on MF and HF.
    - for more information try WSPRnet on http://wsprnet.org/drupal/

Useful References

A good summary of digital modes can be found here (thanks Joe): http://hfradio.org.uk/html/digital_modes.html
This document can be found online on the NTARC web site here: http://www.ntarc.net/dfd.html

*Comments about MixW and MultiPSK:

Phil (VK7JJ) IMHO **MixW** is the best single program for all modes.
Greg (VK7YAD) I don't use it and I don't have a copy on my computer.

Greg, (VK7YAD) IMHO **MultiPSK** is the best single program for all modes.
Phil (VK7JJ) I don't use it and I don't have a copy on my computer.

Operating Tips - the Golden Rules of Digital

Rule 1: Turn the power output of your rig down by 50% *or more.*

  - unlike voice, tone levels are constant and drive radios hard; digital modes can overheat your rig quickly.
  - our radios are not designed for continuous 100% power output on transmit but can usually handle 30%.

Rule 2: Turn off your speech compressor. Do not turn it on. Ever!

  - Speech processors filter out the very high and very low voice tones and clip the voice peaks.
  - When the peaks of your *voice* are clipped your signal sounds stronger and a little distortion does not matter.
  - When the peaks of your digital signal are clipped it *does* matter; tones that are clipped or distorted don't decode.

Rule 3: Turn down the level of modulation so that there is absolutely no ALC operation.

  - ALC stands for Automatic Level Control; above a certain power output level the RF peaks are cut off.
  - ALC simply prevents voice peaks over-driving your finals and losing your voice peaks doesn't matter much.
  - tones don't have any unnessary peaks to clip so any clipping removes essential data.

Remember this: a 100% decodable signal is as good as it gets!