
AG7GK
Digital Modes
Discussion
05/09/2019

Digital Mode Agenda

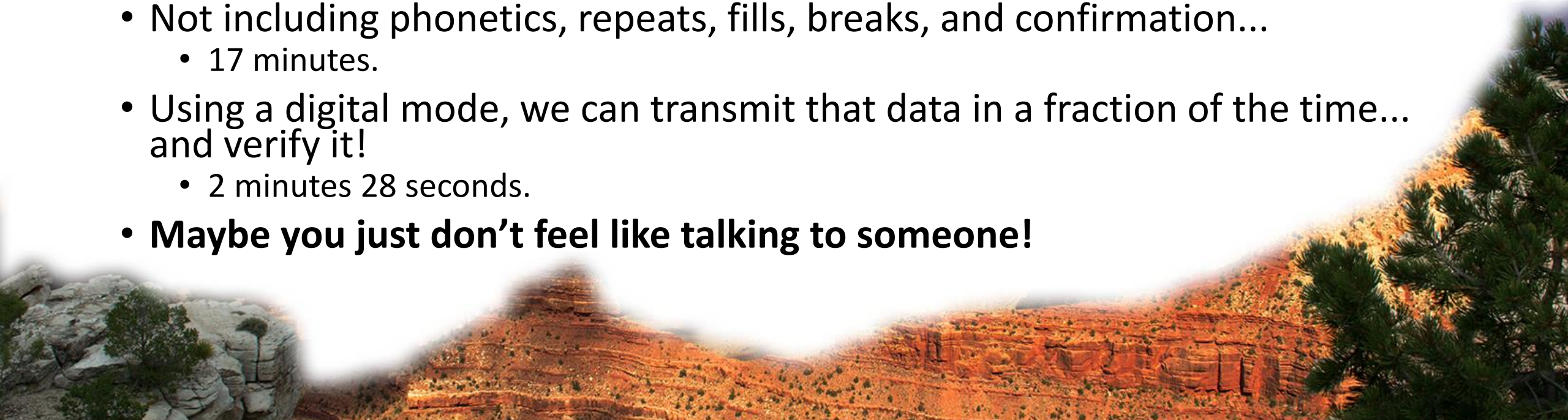
- Why Digital?
- Equipment requirements
- Examples of Modes and Interactive Demos (Bring your stuff)
- Digital Net Planning
- Reading Materials

Introductions

- Aaron Jones – AG7GK first licensed in 2016 as KI7DUK
- Summary of group experience
  - General / Extras
  - Technicians
  - Digital now?
  - Digital in the future?
  - EMCOMM
  - DX

Why Digital?

- CASE FOR DIGITAL EMCOMM
  - Voice example using NTS Traffic Protocols:
    - St. John's, prepare to copy.
    - Tag 176003, female, 20 - 30, transport helo, red.
- Now imagine having to transmit and verify that 20, 30, 50 times or more.
- How long would that take?
- Not including phonetics, repeats, fills, breaks, and confirmation...
  - 17 minutes.
- Using a digital mode, we can transmit that data in a fraction of the time... and verify it!
  - 2 minutes 28 seconds.
- **Maybe you just don’t feel like talking to someone!**



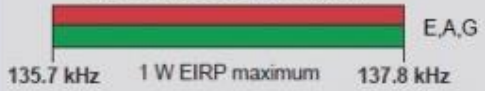
US Amateur Radio Bands

US AMATEUR POWER LIMITS — FCC 97.313 An amateur station must use the minimum transmitter power necessary to carry out the desired communications. (b) No station may transmit with a transmitter power exceeding 1.5 kW PEP.

ARRL The national association for AMATEUR RADIO®

Amateurs wishing to operate on either 2,200 or 630 meters must first register with the Utilities Technology Council online at **https://utc.org/plc-database-amateur-notification-process/.** You need only register once for each band.

2,200 Meters (135 kHz)



630 Meters (472 kHz)

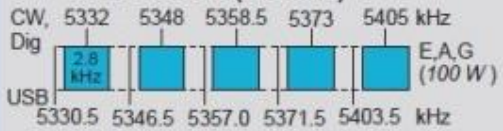
5 W EIRP maximum, except in Alaska within 496 miles of Russia where the power limit is 1 W EIRP.

160 Meters (1.8 MHz)

Avoid interference to radiolocation operations from 1.900 to 2.000 MHz

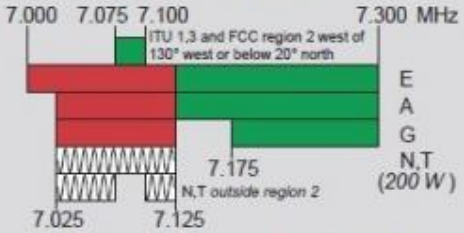
80 Meters (3.5 MHz)

60 Meters (5.3 MHz)



General, Advanced, and Amateur Extra licensees may operate on these five channels on a secondary basis with a maximum effective radiated power (ERP) of 100 W PEP relative to a half-wave dipole. Permitted operating modes include upper sideband voice (USB), CW, RTTY, PSK31 and other digital modes such as PACTOR III. Only one signal at a time is permitted on any channel.

40 Meters (7 MHz)

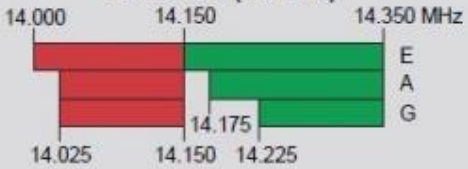


See Sections 97.305(c), 97.307(f)(11) and 97.301(e). These exemptions do not apply to stations in the continental US.

30 Meters (10.1 MHz)

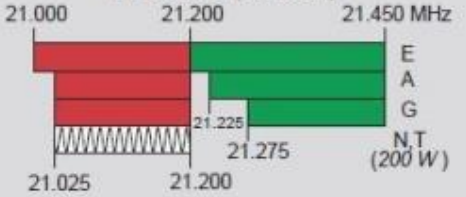
Avoid interference to fixed services outside the US.

20 Meters (14 MHz)

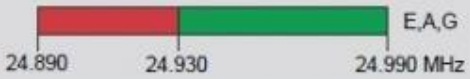


17 Meters (18 MHz)

15 Meters (21 MHz)



12 Meters (24 MHz)



10 Meters (28 MHz)

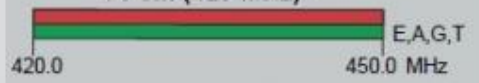
6 Meters (50 MHz)

2 Meters (144 MHz)

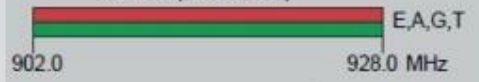
1.25 Meters (222 MHz)

*Geographical and power restrictions may apply to all bands above 420 MHz. See *The ARRL Operating Manual* for information about your area.

70 cm (420 MHz)*



33 cm (902 MHz)*



23 cm (1240 MHz)*

All licensees except Novices are authorized all modes on the following frequencies:

2300-2310 MHz	10.0-10.5 GHz ‡	122.25-123.0 GHz
2390-2450 MHz	24.0-24.25 GHz	134-141 GHz
3300-3500 MHz	47.0-47.2 GHz	241-250 GHz
5650-5925 MHz	76.0-81.0 GHz	All above 275 GHz

‡ No pulse emissions

KEY

Note:
CW operation is permitted throughout all amateur bands.

MCW is authorized above 50.1 MHz, except for 144.0-144.1 and 219-220 MHz.

Test transmissions are authorized above 51 MHz, except for 219-220 MHz

- = RTTY and data
- = phone and image
- = CW *only*
- = SSB phone
- = USB phone, CW, RTTY, and data
- = Fixed digital message forwarding systems *only*

E = Amateur Extra
A = Advanced
G = General
T = Technician
N = Novice

See *ARRLWeb at www.arrl.org* for detailed band plans.

ARRL
We're At Your Service

ARRL Headquarters:
860-594-0200 (Fax 860-594-0259)
email: hq@arrl.org

Publication Orders:
www.arrl.org/shop
Toll-Free 1-888-277-5289 (860-594-0355)
email: orders@arrl.org

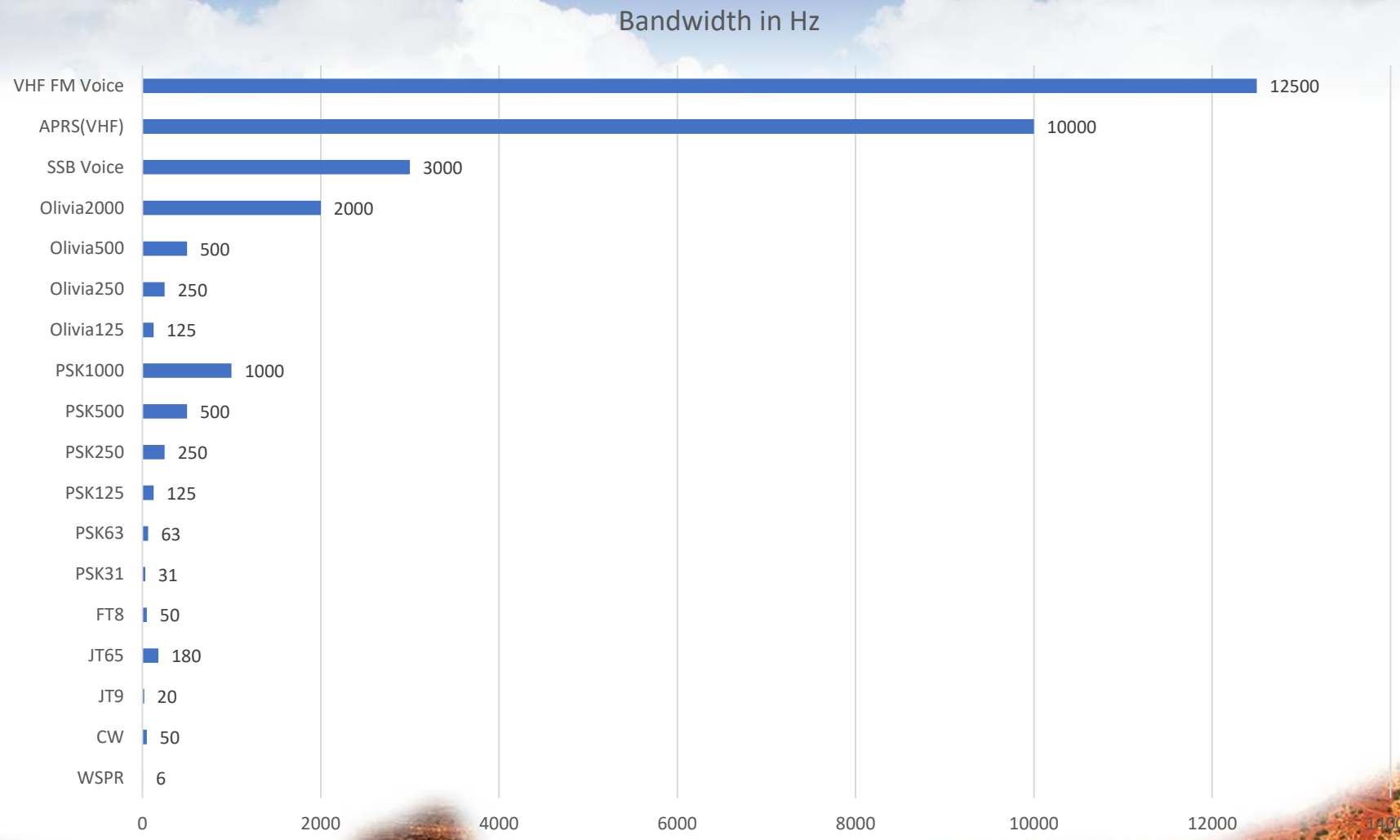
Membership/Circulation Desk:
www.arrl.org/membership
Toll-Free 1-888-277-5289 (860-594-0338)
email: membership@arrl.org

Getting Started in Amateur Radio:
Toll-Free 1-800-326-3942 (860-594-0355)
email: newham@arrl.org

Exams: 860-594-0300 email: vec@arrl.org

 rev. 9/22/2017

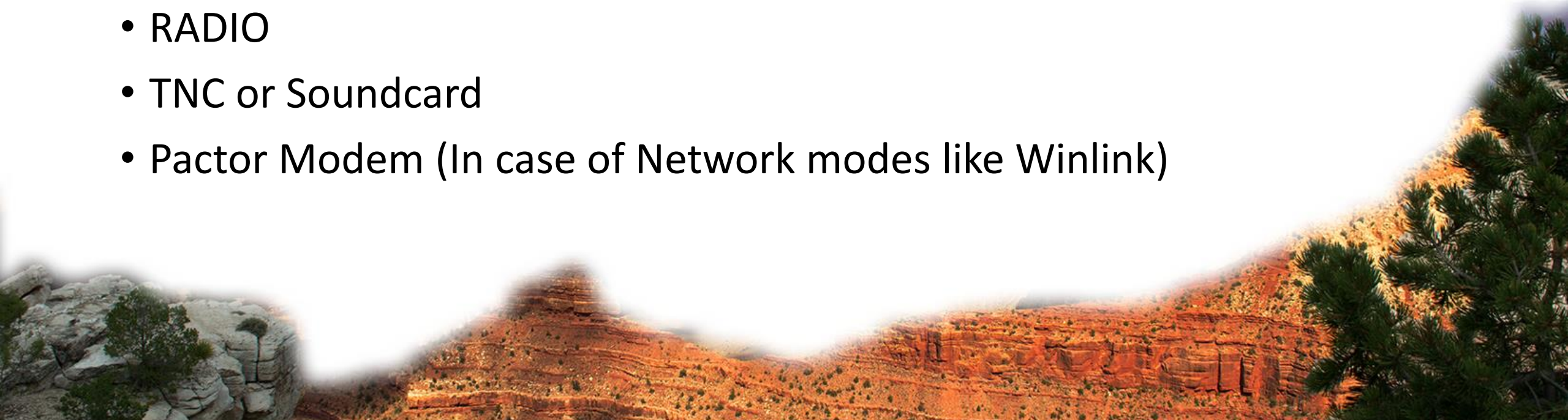
Bandwidth



Note: Not “necessary bandwidth” as defined by ITU

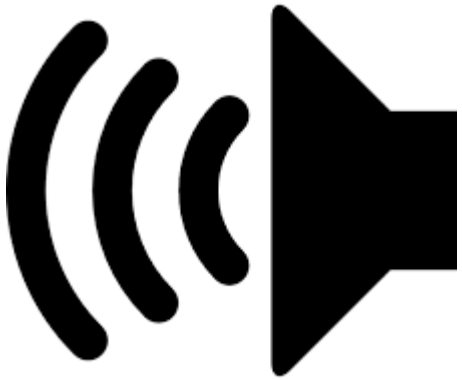
Equipment

- Computer OR Tablet / Phone
- Cables
- Radio with APRS
- GPS
- RADIO
- TNC or Soundcard
- Pactor Modem (In case of Network modes like Winlink)



HT Acoustical Coupling

- http://www.w1hkj.com/vk2eta
- Tablet / Phone / Computer
- Apps:
  - Android SSTV
  - AndFLMSG
  - Droid PSK
- HT with HT specific cables
  - Baofeng HT
- APRS Specific Setup
  - HT
  - MOBILINK TNC and Cable
  - APRS Droid



HT / Audio Cable

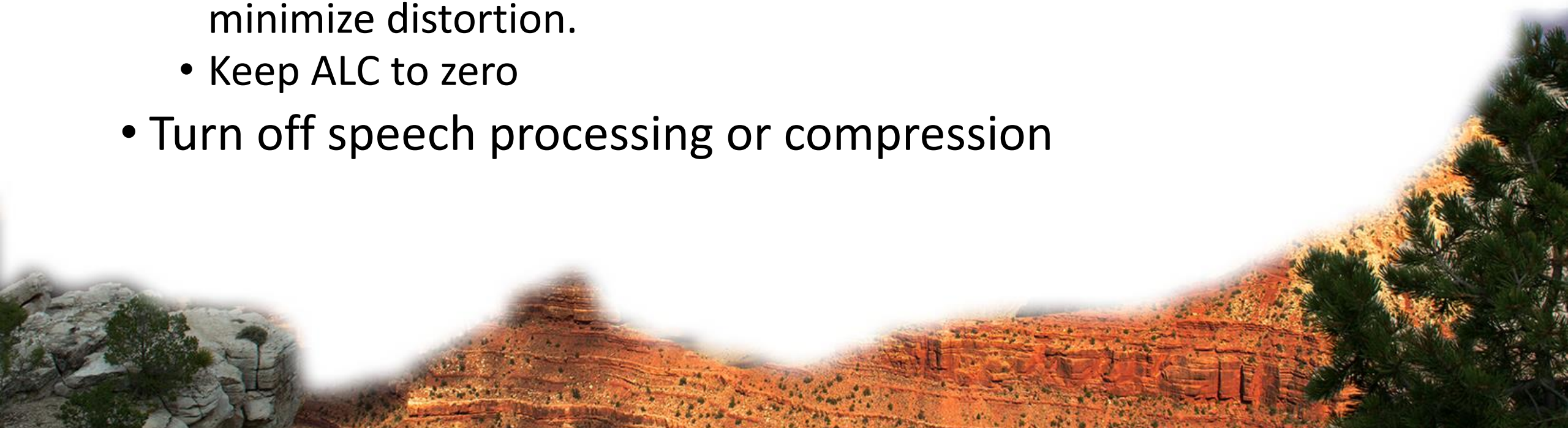
- Tablet / Phone / Computer
- Apps:
  - Android SSTV
  - AndFLMSG
  - Droid PSK
- HT with HT specific cables
  - Baofeng HT
  - Baofeng BT Tech APRS Cable using VOX PTT OR
  - Custom Audio interface cable to trigger PTT
- APRS Specific Setup
  - HT
  - MOBILINK TNC and Cable
  - APRS Droid

Basestation

- Computer / Tablet
- Soundcard either built in or USB
- Apps:
  - MMSSTV
  - FLDIGI- FLMSG-FLRIG
  - WSJTX
  - WSJT-X JTalertX
- Bastation
- Any Antenna – Mag Loop, Dipole, Vertical, anything to get a signal in and out

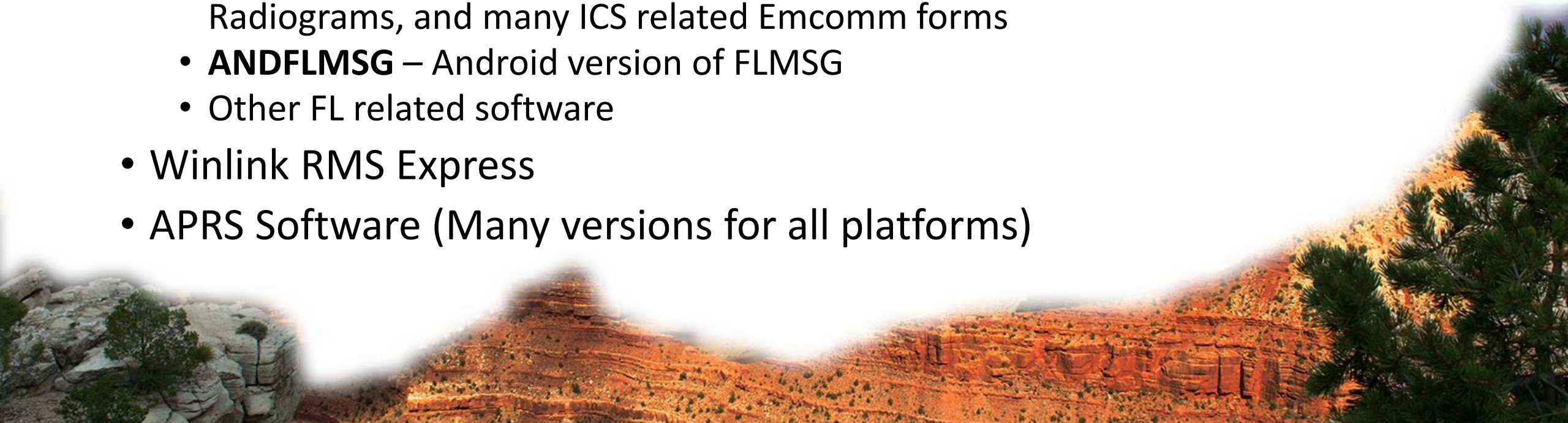
Warning about Duty Cycle

- Reduce your power!
  - Unlike SSB, these modes either run at 100% duty cycle, or use multiple tones sensitive to intermodulation distortion!
  - Be kind to your finals!
  - Keep **peak** power out well below key-down CW maximum to minimize distortion.
  - Keep ALC to zero
- Turn off speech processing or compression



Software

- WSJTX – used for FT8, JT Modes, WSPR, and Meteor Scatter
- MMSSTV – Used for Slow Scan TV
- FLDIGI – Many modes and options with companion software such as:
  - FLAMP - Amateur Multicast Protocol (One to Many Transmission of Files)
  - FLMSG – Message sending, one to many including CSV data, Text, Images, Radiograms, and many ICS related Emcomm forms
  - **ANDFLMSG** – Android version of FLMSG
  - Other FL related software
- Winlink RMS Express
- APRS Software (Many versions for all platforms)



Propagation Websites

- PSKreporter.info: https://pskreporter.info/pskmap.html
  - Use the stats page to see what modes are happening: https://pskreporter.info/cgi-bin/pskstats.pl
- Wsprnet for WSPR results; http://wsprnet.org/drupal/wsprnet/map OR alternative: http://wspr.aprsinfo.com/
- Hamspots.net: https://hamspots.net/
- APRS.fi: https://aprs.fi
- Online listing of hosted SDR receivers, great for verifying your signal on voice OR digital: http://websdr.org/

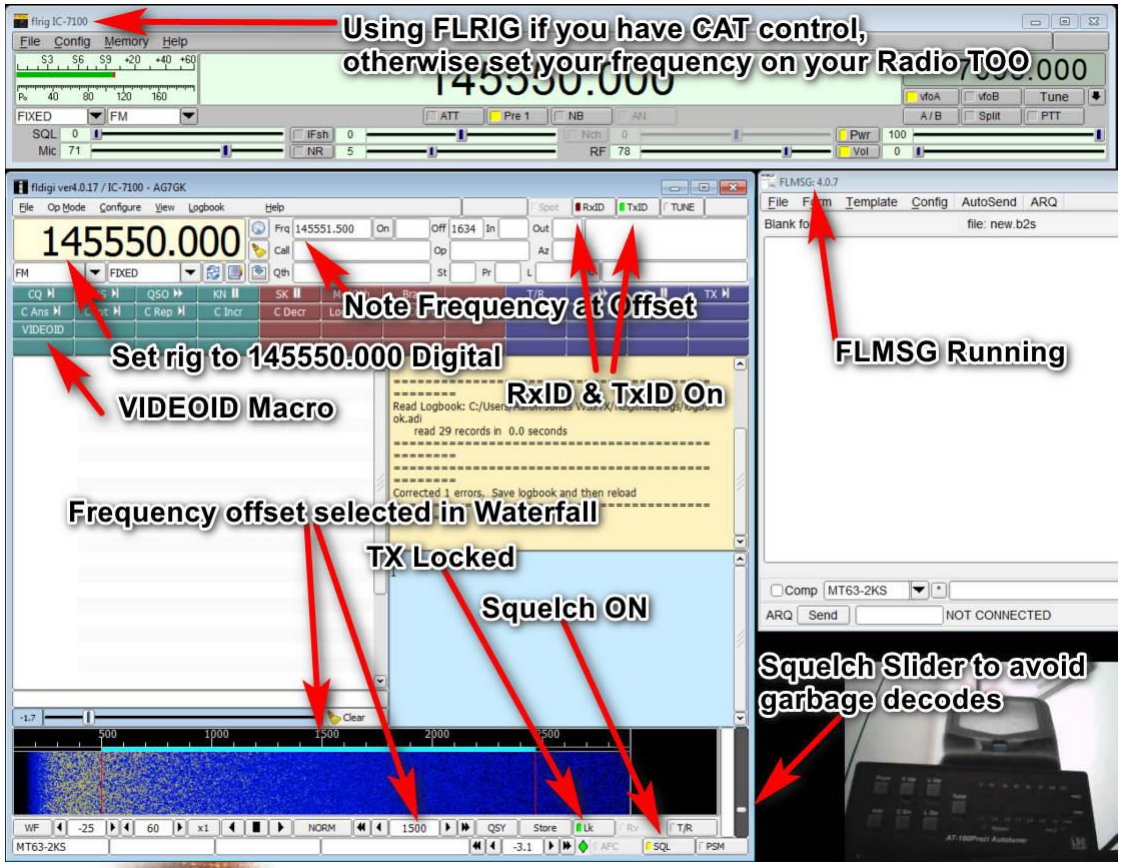
NBEMS / FL "Suite"

- Narrow Band Emergency Messaging System
- *http://www.w1hkj.com/NBEMS/NBEMS.ppt*
- Software (All free):
  - FLDIGI – Main application for mode selection, rig control, QSO's
  - FLAMP – Application for sending files in chunks, allows for retries and relays of missing chunks
  - FLMSG – Your go-to application for sending text and forms (Radiograms)
  - **ANDFLMSG** – Android version
  - FLRIG – Rig control application if you have a CAT control interface to your RIG

NBEMS - Demo

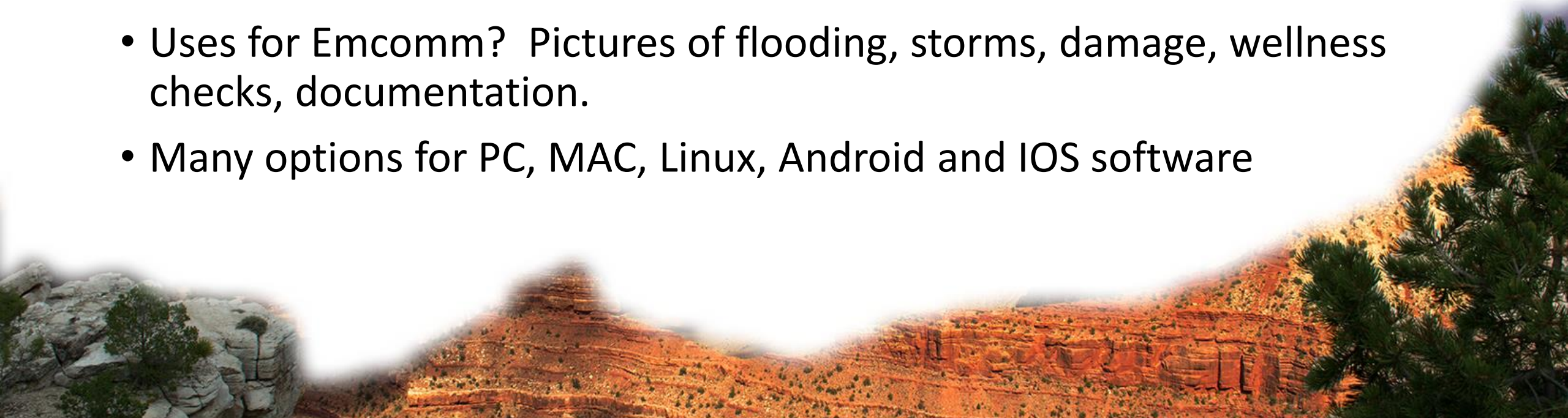
- FLDIGI Interactive Demo
- ANDFLMSG on a tablet and Handheld using Acoustic Coupling

NBEMS - Demo


Using FLRIG if you have CAT control,
otherwise set your frequency on your Radio TOO
Note Frequency at Offset
Set rig to 145550.000 Digital
VIDEOID Macro
RxID & TxID On
FLMSG Running
Frequency offset selected in Waterfall
TX Locked
Squelch ON
Squelch Slider to avoid
garbage decodes

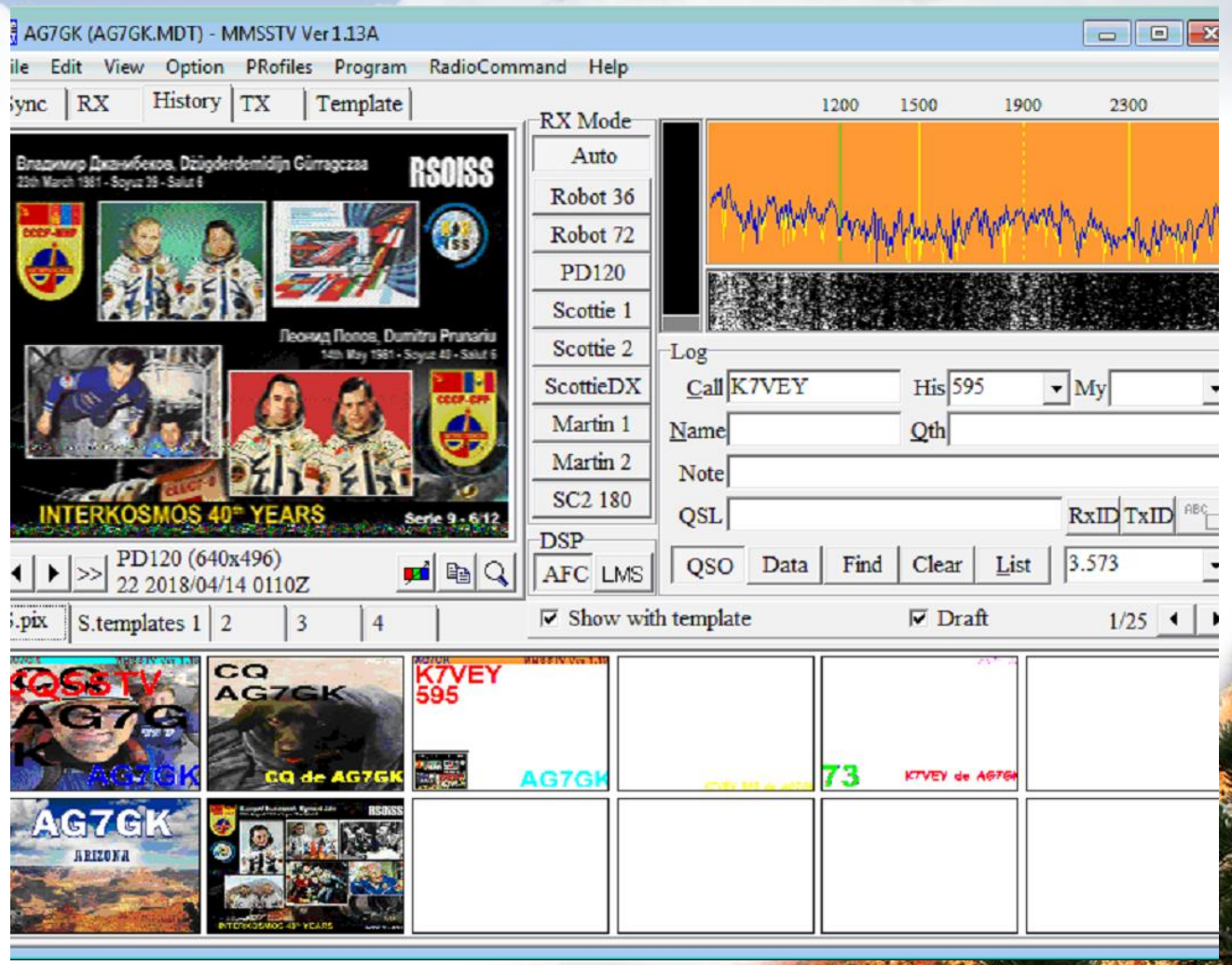
SSTV DEMO

- A single image is converted to individual scanned lines and those lines sent as variable tones between 1500 and 2300 Hz
- A color image takes about 2 minutes to transmit, depending on mode. Some black and white modes can transmit an image in under 10 seconds
- Uses for Emcomm? Pictures of flooding, storms, damage, wellness checks, documentation.
- Many options for PC, MAC, Linux, Android and IOS software



SSTV

- SSTV Software “MMSSTV”
- Captured on 145.500 Mhz VHF from International Space Station from Russian Cosmonauts celebrating 40 years in space
- Fun mode for sending pictures and various software options for computer, Android, and IOS

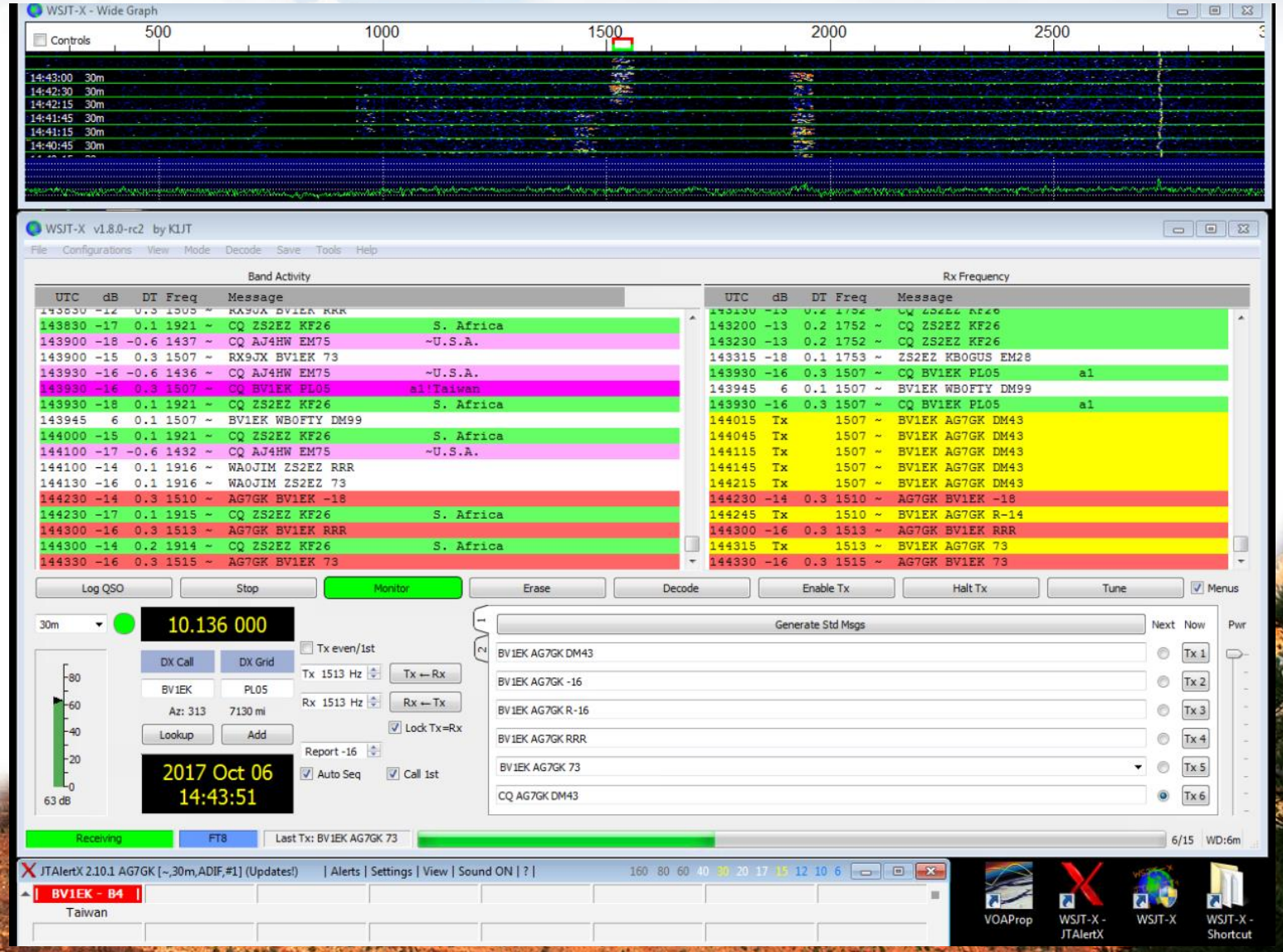


JT Modes (JT65, JT9, FT8)

- Origin: Created by Joe Taylor W1JT in 2003 for EME work
  - A way to have a QSO using a computer
  - A weak signal digital communications mode for Amateur Radio
  - A Multi-Frequency Shift Keying scheme employing Forward Error Correction with 65 tones
- Bandwidth: 50-180 hz
- Prevalence: Predominant modes for DX contacts
- Equipment requirements: HF Radio, Soundcard(ext/int), Computer, Rpi can work, WS-JTX software, other options exist
- Pros: Widespread, with FT8 very fast QSO's, SNR resilience
- Cons: Not conversational

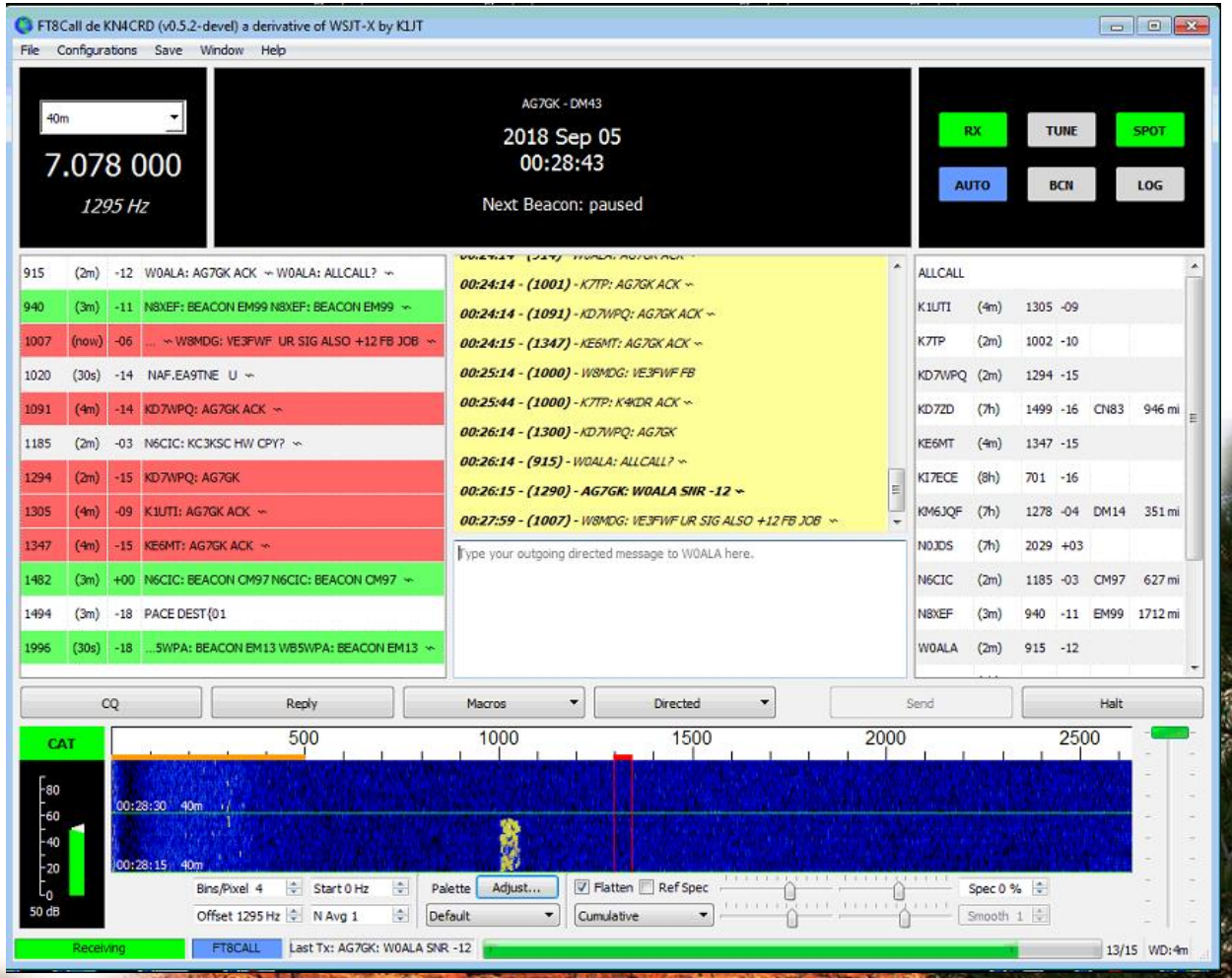
JT Modes (JT65, JT9, FT8)

- Exchange with TAIWAN
- 30 Meters
- Very weak signal, BV1EK reported my signal at -18 SNR and I reported his at -14



FT8CALL New Software

- New software being built TODAY
- Uses FT8 Protocol but allows keyboard to Keyboard Conversational Style
- Integrated with APRS to allow location updates and EMAIL-2 directed messages
- Getting Popular but get ready to WAIT, very slow.

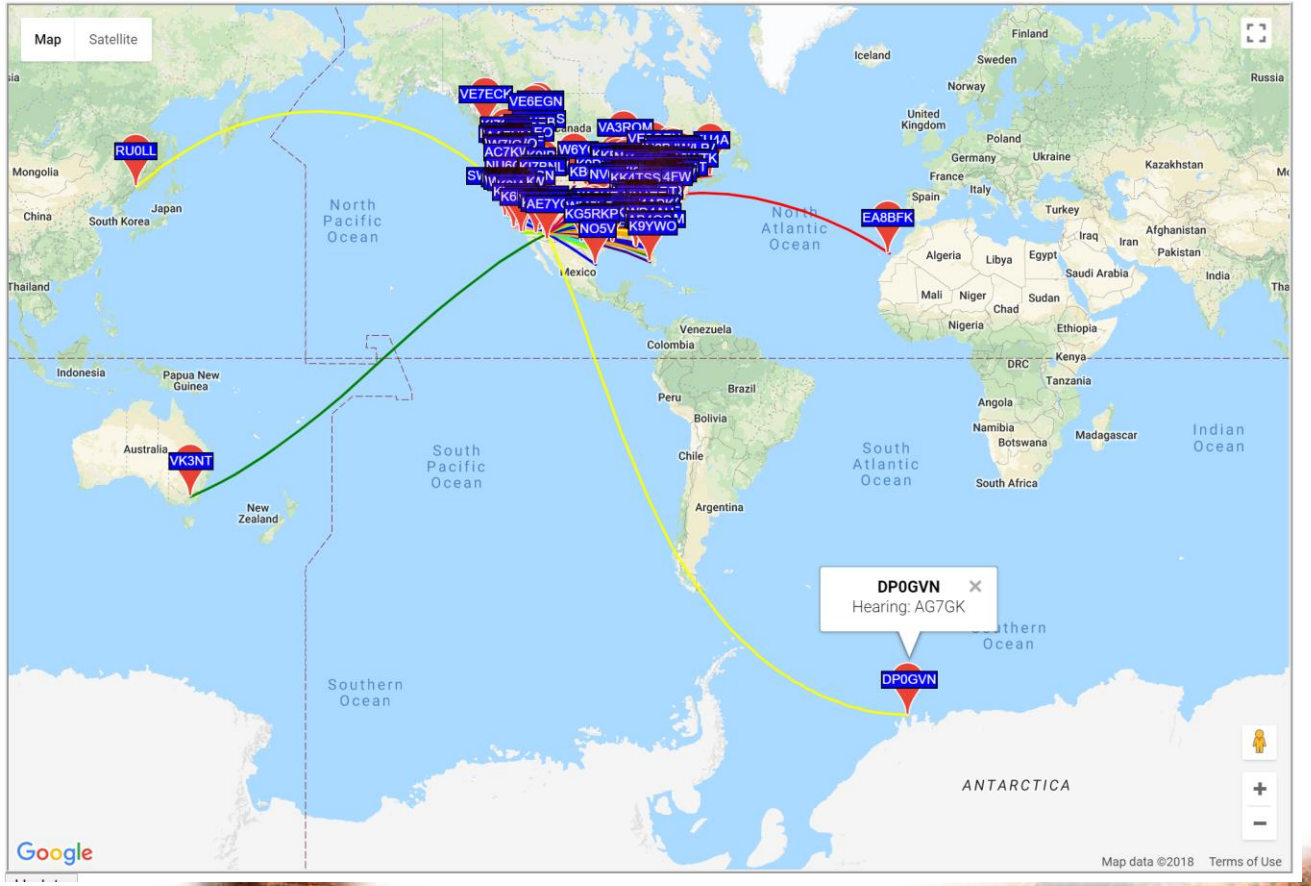


WSPR (Demo)

- Origin: 2008 by Joe Taylor
  - The Weak Signal Propagation Reporter
  - An automated system designed for sending and receiving low-power transmissions to test propagation paths on the MF and HF bands.
  - The program can decode signals with S/N as low as -28 dB
- Bandwidth: 6 hz
- Antenna propagation at: http://wsprnet.org/drupal/wsprnet/map OR http://wspr.aprsinfo.com/
- Equipment requirements: HF Radio, Soundcard(ext/int), Computer, Rpi can work, WS-JTX software, other options exist
- Pros: Great for seeing where your signal is going
  - “WSPR is about 11 dB better than ear-and-brain CW.
  - “For most operators, the difference is more like 15 dB."

WSPR (Demo)

Map



OTHER Digital "Systems"

APRS

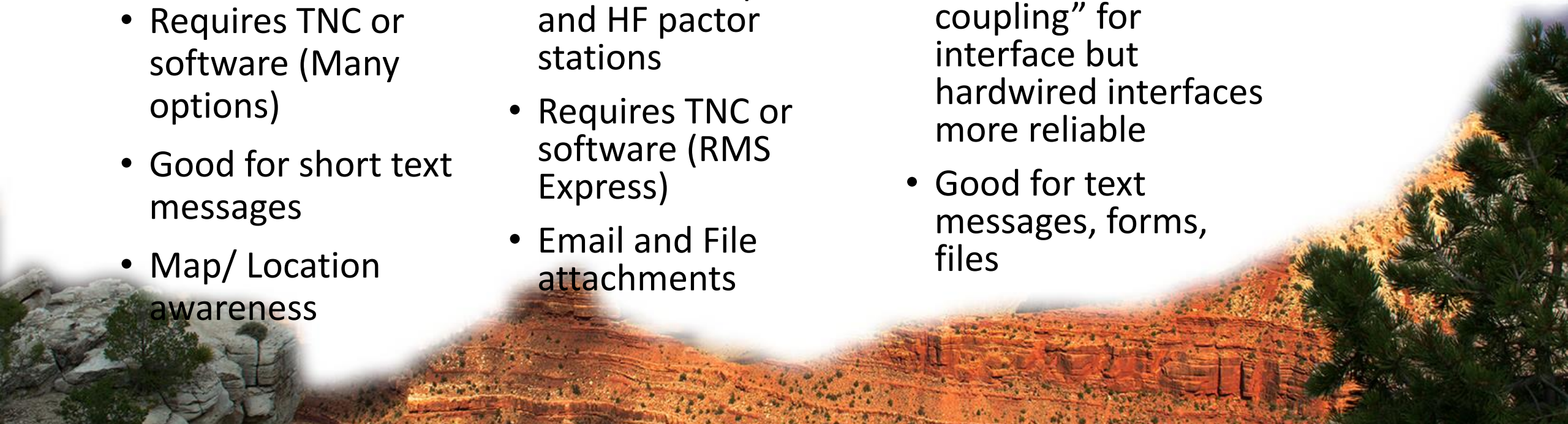
- VHF 144.39 MHz simplex
- Utilizes "Digipeaters"
- Requires TNC or software (Many options)
- Good for short text messages
- Map/ Location awareness

Winlink

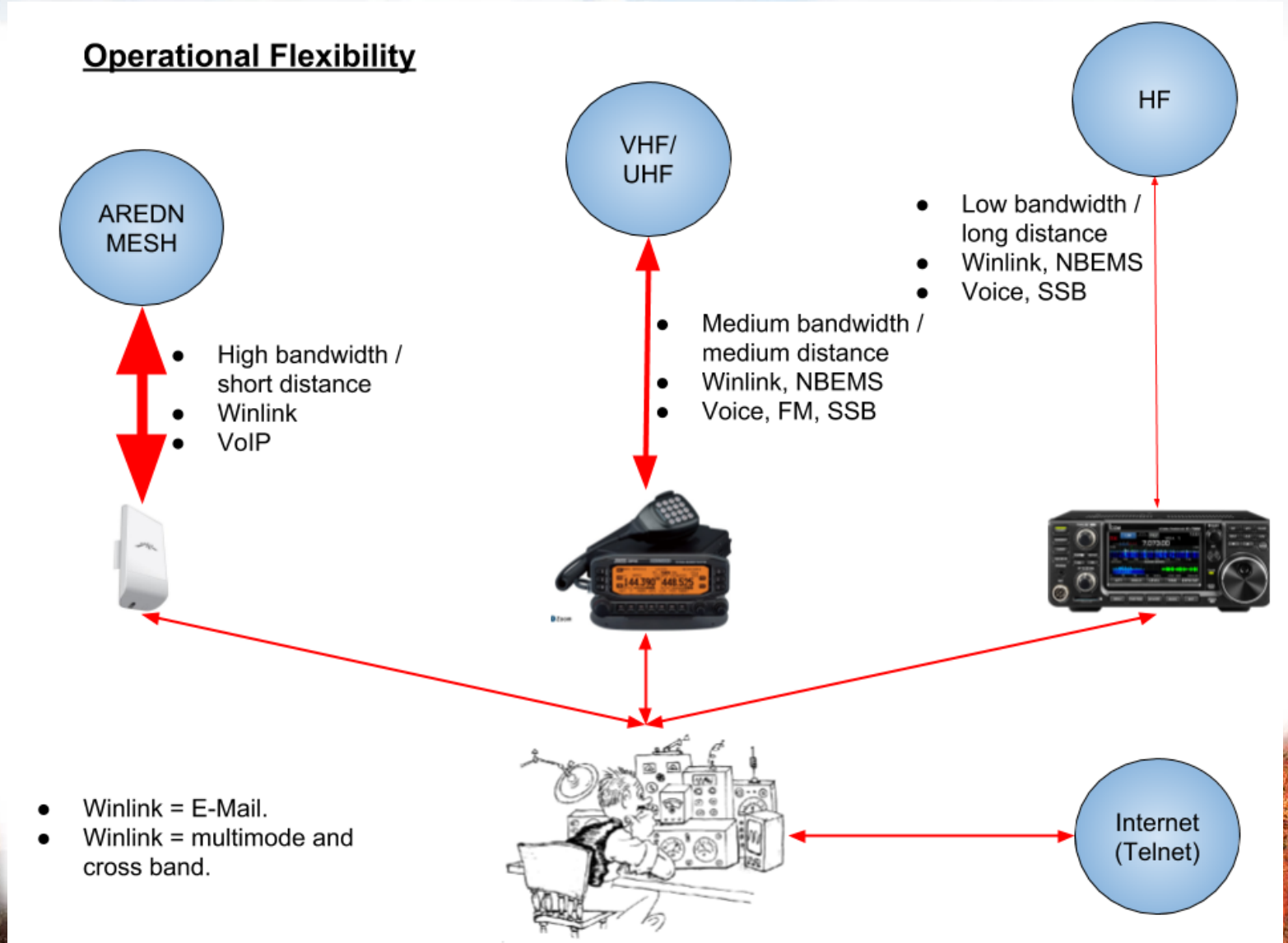
- VHF 145.01 MHz simplex and certain HF
- Utilizes RMS packet and HF pactor stations
- Requires TNC or software (RMS Express)
- Email and File attachments

NBEMS/FLDIGI

- Can utilize any VHF/UHF simplex freq, repeaters, HF
- Can use "acoustic coupling" for interface but hardwired interfaces more reliable
- Good for text messages, forms, files

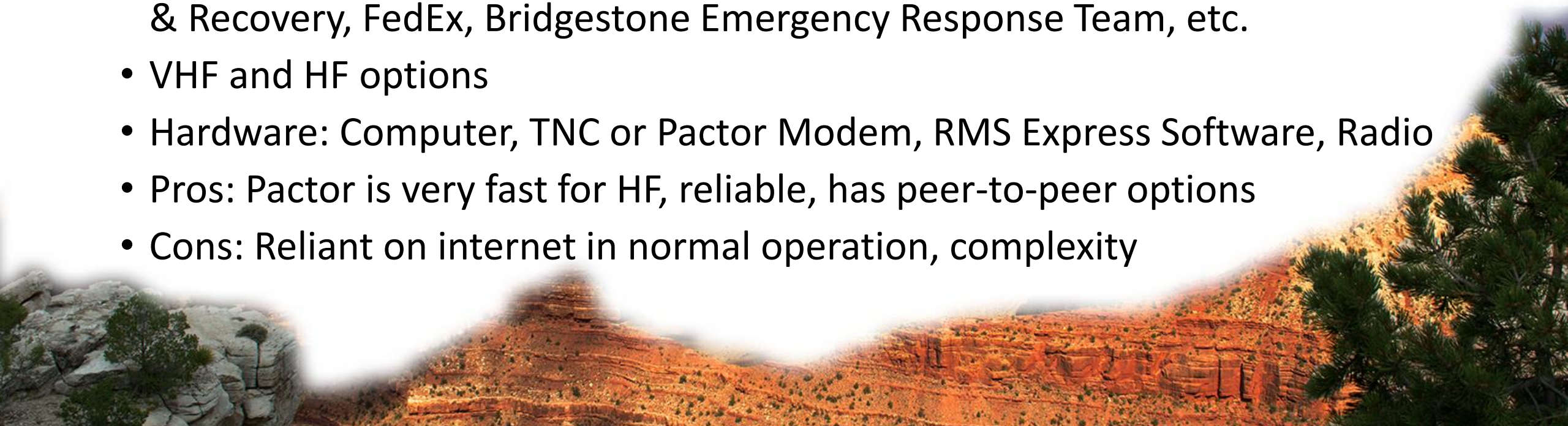


Operational Flexibility

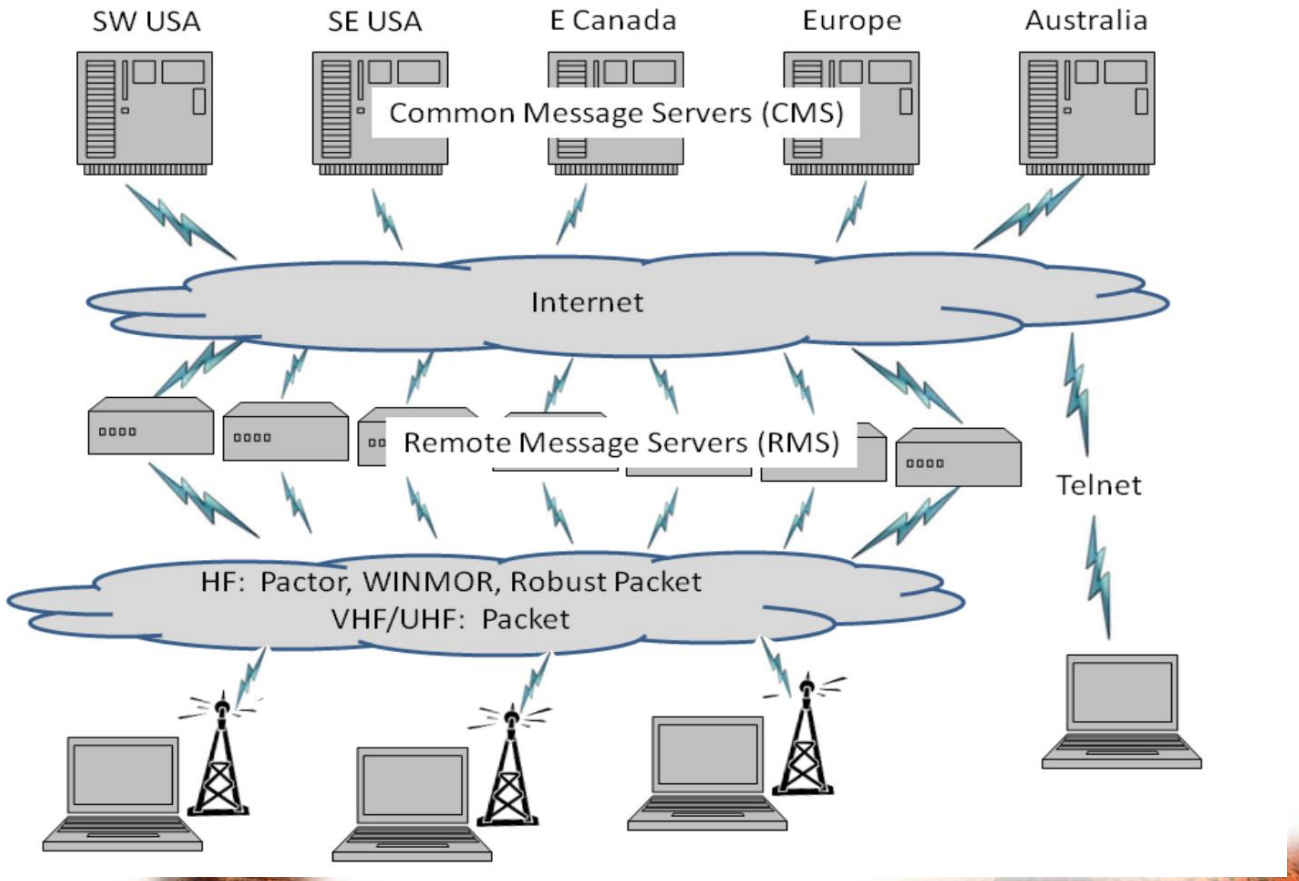


Winlink

- Worldwide system for sending e-mail via radio
- Provides e-mail from almost anywhere in the world.
- Adopted for contingency communication by many government agencies
- Used by infrastructure-critical NGOs such as International & American Red Cross, Southern Baptist Disaster Relief, DHS Tiered AT&T Disaster Response & Recovery, FedEx, Bridgestone Emergency Response Team, etc.
- VHF and HF options
- Hardware: Computer, TNC or Pactor Modem, RMS Express Software, Radio
- Pros: Pactor is very fast for HF, reliable, has peer-to-peer options
- Cons: Reliant on internet in normal operation, complexity



Winlink


SW USA
SE USA
E Canada
Europe
Australia
Common Message Servers (CMS)
Internet
Remote Message Servers (RMS)
Telnet
HF: Pactor, WINMOR, Robust Packet
VHF/UHF: Packet

APRS

- **A**utomatic **P**acket **R**eporting **S**ystem
- Original Developed in 1984 to Map Navy Positions, with availability of GIS in the 90's became feasible for GPS integration
- The system is based on the AX25 Packet protocol, and was developed by Bob Bruninga WB4APR, a senior research engineer at the United States Naval Academy.
- North American frequency is usually 144.390, though operable at UHF, 6 meters and some HF
- Mostly a one-to-many system, though there are some one-to-one applications
- Public service and events, search and rescue, emergency services

Digital Net Discussion

- Interest
- Every Sunday Night around 8:45 PM on 145.550 mhz using MFSK64 Mode
- Examples
- Goals
- Netiquette
- Lessons Learned
- HF and VHF?

Useful Websites

- Comprehensive Guide to NBEMS / FLDIGI, equipment setup, instructions, etc: http://gblakesl.net/ARES/Basic-NBEMS-Workshop.pdf
- Presentation on Winlink: http://www.philsherrod.com/Winlink/Winlink_RMS_Express.pdf
- Excellent Presentation on NBEMS and FLDIGI: https://www.jeffreykopcak.com/drive/ham_radio/digital_modes/vhf_uhf_nbems_an_introduction_using_fldigi_and_flmsg_presentations/vhf_uhf_nbems.pdf
- Presentation on JT Modes: http://www.informationtechnologies.com.au/files/JT65%20Presentation.pdf
- WSPR Presentation: https://www.powershow.com/viewht/1a4552-ZDc1Z/What_is_WSPR_powerpoint_ppt_presentation
- Meteor Scatter Introduction: Link

More Useful Websites

- APRS: http://www.aprs.org/APRS-mobile.ppt
- A PRACTICAL EVALUATION AND COMPARISON OF SOME MODERN DATA MODES: http://www.qsl.net/zl1bpu/MFSK/datmodes2.pdf
- ARRL presentations on NBEMS (Narrow Band Emergency Message System) with FLDIGI
  - http://www.arrl.org/files/file/On%20the%20Air/Tutorials/Introduction_to_NBEMS_ARRL.pdf
  - http://www.arrl.org/files/file/On%20the%20Air/Tutorials/Advanced_NBEMS_3_0.pdf
  - *http://www.w1hkj.com/NBEMS/NBEMS.ppt*
- Digital Mode Comparisons from FLDIGI Help files: http://w1hkj.com/FldigiHelp-3.21/Modes/Compare.htm
- Signal ID Wiki – listing of all digital signals, explanations, samples:
- https://www.sigidwiki.com/wiki

Nerd Reading