Automatic **L**ink **E**stablishment

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1. What is Automatic Link Establishment (ALE)?

- ALE is a worldwide standard for HF radio communications system which enables an HF radio station to initiate a circuit, between calling station and receiving HF radio stations.

- ALE provides a reliable method of calling and connecting stations during constantly changing HF ionospheric propagation, reception interference, and congested HF channels.

- An ALE radio system combines an HF SSB radio transceiver with the necessary computer systems and modem to meet the ALE standards.

- The ALE system is programmed with a unique ALE address, similar to a phone number.
  - When not actively linked with another station, the HF transceiver constantly scans through a list of HF frequencies, listening for any ALE signals transmitted by other radio stations.

- When it decodes calls and soundings sent by other stations
  - The system ascertains if the call is for the receiving station,
  - and uses the bit error rate to store a quality score for that frequency and transmitter location/address.

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1. What is Automatic Link Establishment (ALE)?

To reach a specific station via ALE, the caller enters the ALE Address in the calling station's system.

- The ALE controller selects the best available idle channel for that destination address (based on link quality analysis data).

- The ALE system then transmits a brief selective call signal containing the ALE address the intended recipient.

- When the receiving scanning station detects ALE activity, it stops scanning and stays on that channel until it can confirm whether or not the call is for that station. If the call is for that station,

  - The two stations' ALE controllers automatically handshake to confirm that a link of sufficient quality has been established, then notify the operators that the link is up.

  - If the receiving station fails to respond or the handshaking fails, the calling ALE station selects another frequency either at random or by making a channel estimation based on predictive algorithms.
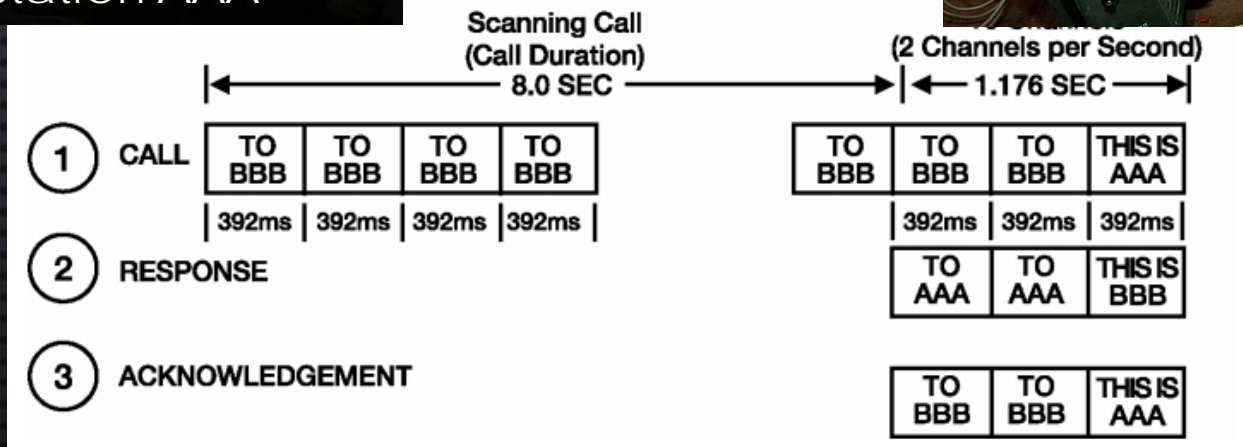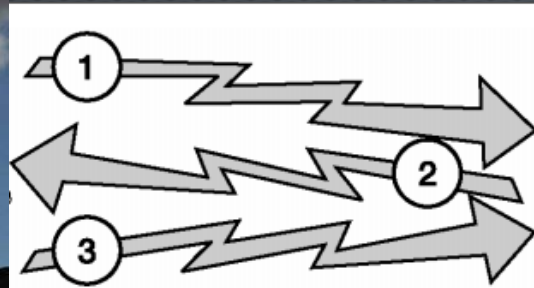
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1. What is Automatic Link Establishment (ALE)?

- **Upon successful linking,**
  - The ALE software indicates the call sign or other identifying information of the linked station, similar to Caller ID.

  - The receiving operator then answers the call by voice, data link, or the ALE built-in short text message format.

  - Digital data can be exchanged via modem (hardware or software).

  - The ALE built-in short text messaging facility (AMD) can be used to transfer short text messages to allow operators to coordinate external equipment such as phone patches or for short tactical messages.

  - Once the comms are complete, one of the stations will hang up or terminate the link. This allows stations to go back to scanning.

- **ALE allows radio operators a with of minimum HF propagation and experience to contact another station via NVIS or skywave circuits.**

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2. General Overview of How ALE Works.

Calling Station AAA

Receiving Station BBB

Scanning Call
(Call Duration)
8.0 SEC

(2 Channels per Second)
1.176 SEC

① CALL	TO BBB	TO BBB	TO BBB	TO BBB		TO BBB	TO BBB	TO BBB	THIS IS AAA
	392ms	392ms	392ms	392ms		392ms	392ms	392ms	
② RESPONSE							TO AAA	TO AAA	THIS IS BBB
③ ACKNOWLEDGEMENT							TO BBB	TO BBB	THIS IS AAA

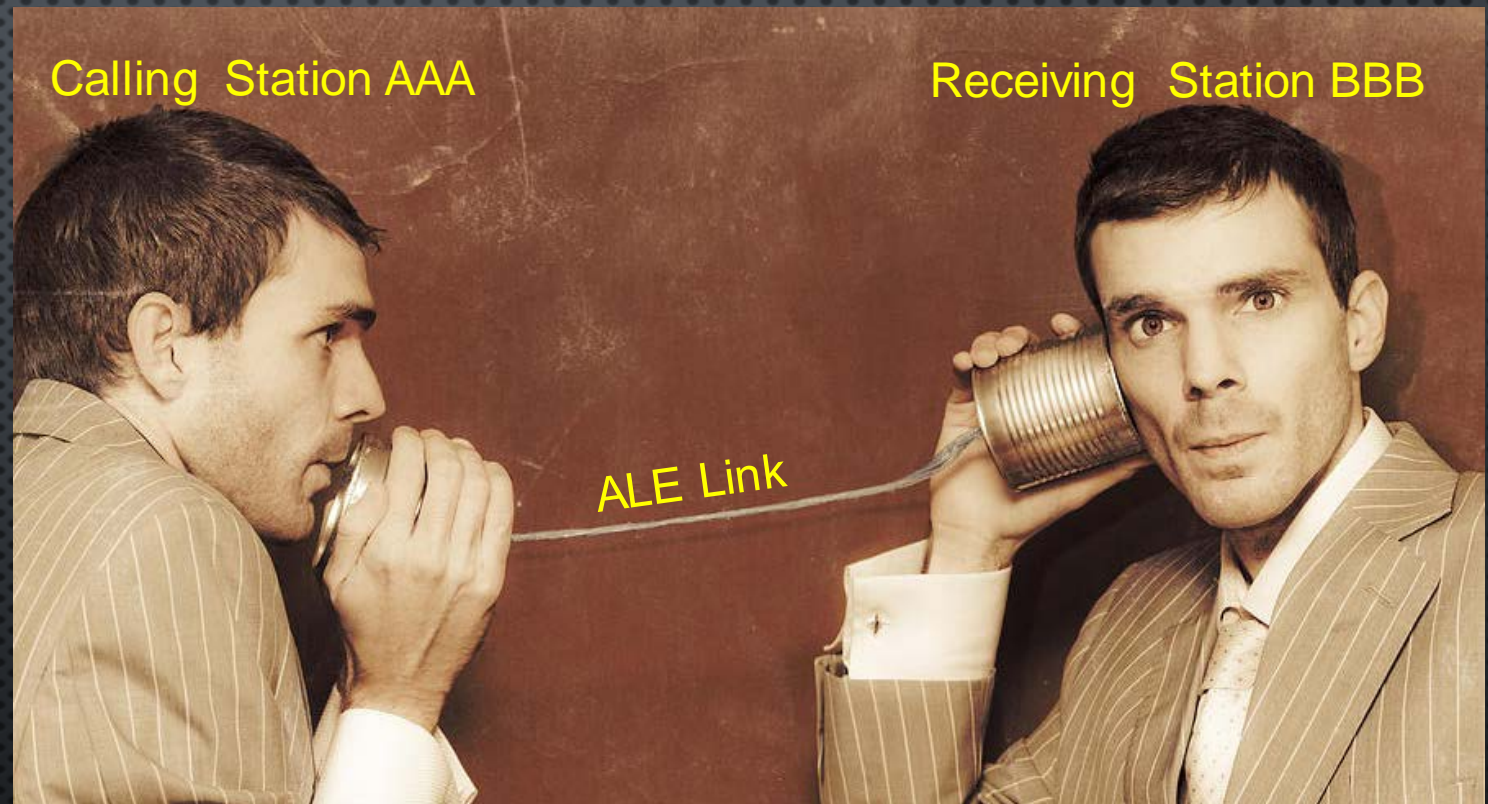# **A**utomatic **L**ink **E**stablishment

2. General Overview of How ALE Works.

The ALE Link is the conduit, providing a circuit of know propagation and signal quality between two stations for:

- VOICE,
- DATA (not limited to MIL-STD),
- AMD (texting and commands), and
- PHONE PATCH communications.

Think of ALE as the dial up phone line establishing a point to point circuit;

- the microphone providing voice, and

- the modem providing data communication.

Calling Station AAA

Receiving Station BBB

ALE Link

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3. ALE 2G or 3G What is the Difference?

- **2G ALE is what we use as MARS station**
    - More widespread with hardware and software solutions.
    - Surplus hardware solutions are available used and new.
    - Requires no external sync signal, requires HF only.
    - The de facto standard for current amateur emergency services use.

- **3G ALE offers**
    - Reliability in linking to time base synchronization via satellite or other synchronization solutions.
    - Shorter link acquisition time due to time slots available because of synchronization.
    - More likely to link in an extremely poor HF environments.
    - Poor market penetration to the amateur community, generally limited to military, government, and commercial uses.

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3. ALE 2G or 3G What is the Difference?

- **Standards for ALE**
  - Standards for ALE are based on
    - US MIL-STD 188-141D
      - 2G ALE is technically described in Appendix A of this document.
      - 3G ALE is technically described in Appendix C of this document.

    - Federal Standard 1045A, Telecommunications: HF Radio Automatic Link Establishment

    - NATO - STANAG 4538-Technical standards for an automatic radio control system (arcs) for hf communication links.

    - NTIA High Frequency ALE Radio Application Handbook

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4. Link Quality Analysis (LQA).

The LQA process measures the quality of a channel by placing a score on the circuit between two stations. LQA incorporates three types of link analysis information:

- bit error ratio (BER),

- Signal + noise + distortion to noise + distortion ratio (SINAD),

- a measure of multipath (optional).

The LQA scores are stored in memory for future use.

The channel with the highest LQA score has the highest probability of being suitable for communication.

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4. Link Quality Analysis (LQA).

There are 3 method of obtaining LQA scores:
- Sounding
  - non-linking one-way one-to-many transmission;
  - stations that hear it calculate an LQA score.

- LQA Call
  - Uses two-way, one-to-one transmissions;
  - each of 2 stations gets an LQA score for the path to the other.

- Passive Link Quality Analysis
  - An LQA score can be calculated from an intercepted ALE transmission   (passive) – A calls B, and C calculates LQA between C and A.

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5. Hardware versus Software ALE.

It's the age-old question, hardware versus software, whether in a modem   or an ALE system, the answer is hardware is better! But at what cost?

- Hardware is generally a dedicated system based on a commercial grade radio able to withstand high duty cycles but has no VFO on most models.

- Systems from CODAN, ICOM, Barrett, and others are high-performance systems, with integrated hardware modems providing exemplary performance but designed for commercial use (little user feedback and should be programed by a PC).

- Alternatives include hardware ALE controllers, normally integrated with a MIL-STD-188-110 modem from companies like RapidM. These external controllers generally require interfacing to your particular radio.

- Hardware ALE radio systems are an investment costing anywhere from $2500-$7000 per radio.
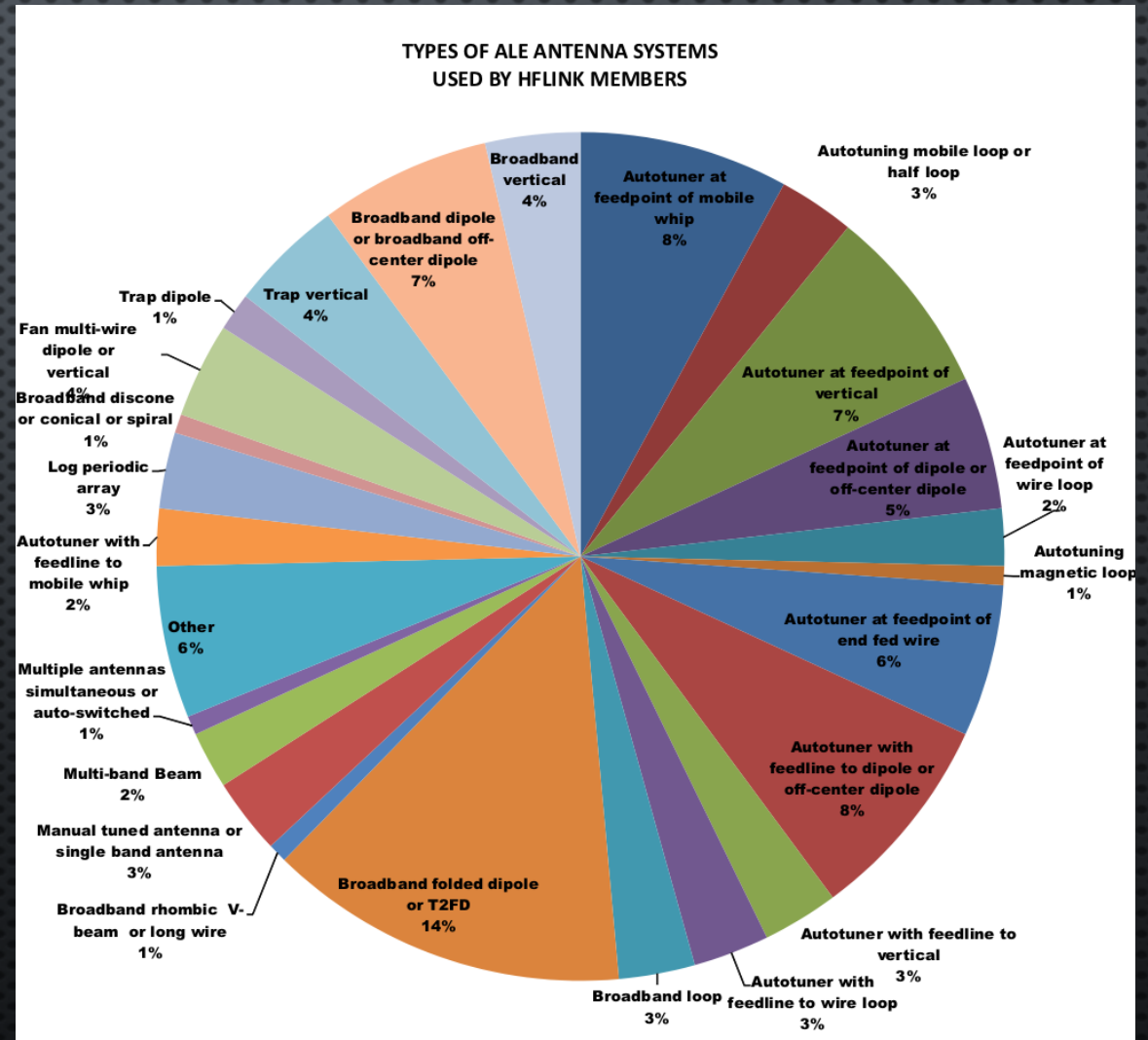
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As important as the ALE radio, and maybe more important is the antenna system.

This chart shows the variety of antenna systems as surveyed by HF link, the amateur radio ALE group.

Rodney's opinion on this controversial issue:
- I operate a broadband terminated 3 wire dipole inverted V at
- 38 feet peak, 12 feet at the ends.

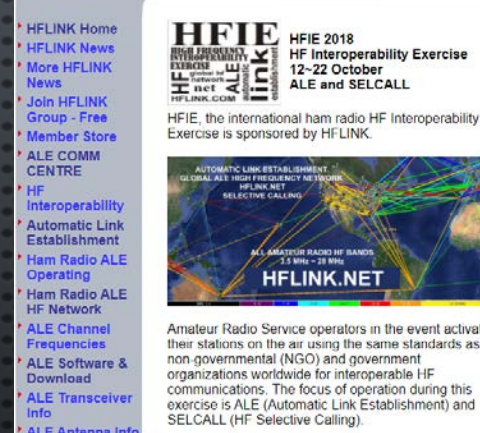- To compensate for the terminated dipole, I operate with a 500 watt amplifier.

Your mileage may vary.

TYPES OF ALE ANTENNA SYSTEMS
USED BY HFLINK MEMBERS

- Broadband vertical 4%
- Autotuner at feedpoint of mobile whip 8%
- Autotuning mobile loop or half loop 3%
- Broadband dipole or broadband off-center dipole 7%
- Autotuner at feedpoint of vertical 7%
- Autotuner at feedpoint of dipole or off-center dipole 5%
- Autotuner at feedpoint of wire loop 2%
- Autotuning magnetic loop 1%
- Autotuner at feedpoint of end fed wire 6%
- Autotuner with feedline to dipole or off-center dipole 8%
- Autotuner with feedline to vertical 3%
- Autotuner with feedline to wire loop 3%
- Broadband loop 3%
- Broadband folded dipole or T2FD 14%
- Broadband rhombic V-beam or long wire 1%
- Manual tuned antenna or single band antenna 3%
- Multi-band Beam 2%
- Multiple antennas simultaneous or auto-switched 1%
- Other 6%
- Autotuner with feedline to mobile whip 2%
- Log periodic array 3%
- Broadband discone or conical or spiral 1%
- Fan multi-wire dipole or vertical 4%
- Trap dipole 1%
- Trap vertical 4%

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6. HF ALE Group

- Provides support for the amateur community related to ALE.

- Coordinates frequencies and scan groups for amateur ALE.

- Provides technical assistance ranging from software, radios, antennas.

- Provides a central clearinghouse for all things ALE including a very informative forum for the new user.
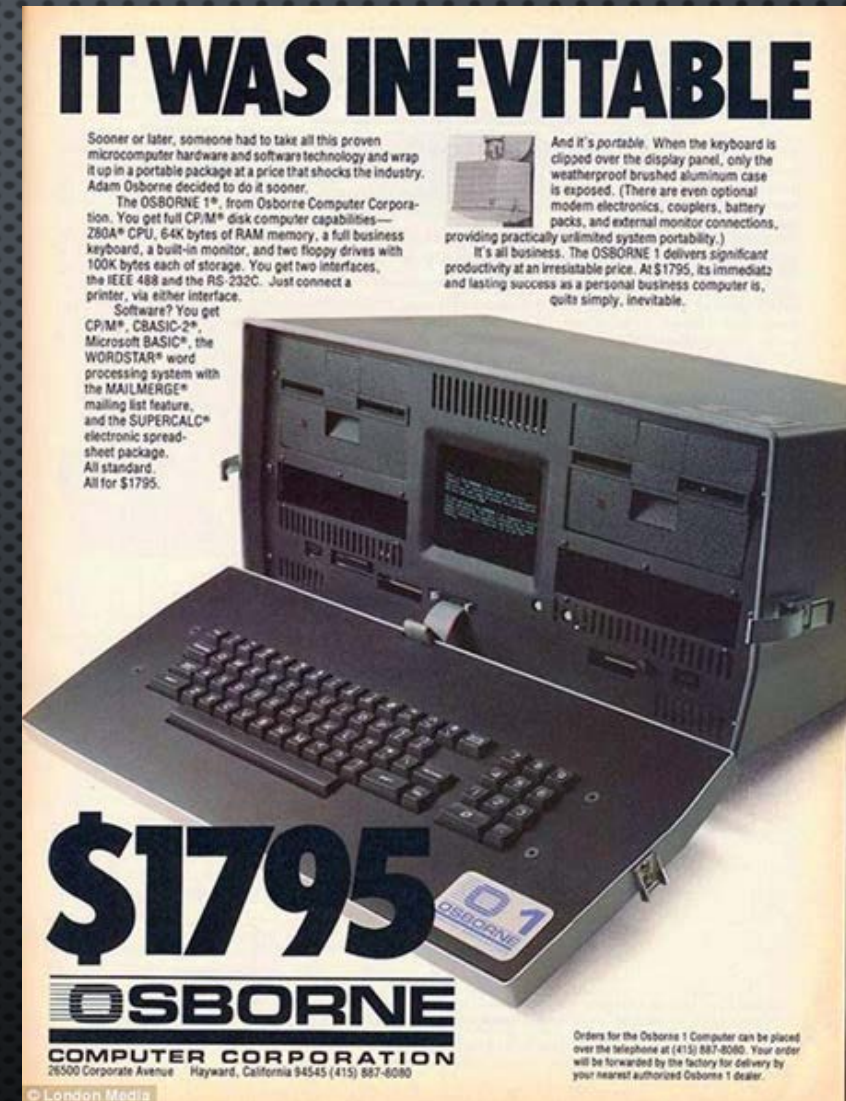
- http://hflink.com/

Open Ham Radio ALE Nets
International Amateur Radio Service

NET ADDRESS	ENTITY	ACCESS	COMMENTS, FUNCTIONS, OR RESTRICTIONS	NUMBER OF MEMBER SLOTS	MEMBERS	CHANNELS USED FOR THE NET
HFL	Ham Radio ALE Voice Interoperation	Open to all ham radio operators	Standard Net for all stations, all locations, all organisations.	10	Any ham may join in any SLOT in any random order.	HFL Channels
HFN	Ham Radio Global ALE High Frequency Network	Open to all ham radio operators. Netcall HFN to link with HFN Pilot Stations	Standard Net for all stations, all locations, all organisations. For sounding, calling, and internet, interconnect.	10	Any ham may join in SLOT#1 only. All other slots are reserved for HFN Pilot Stations.	HFN Channels
QRZ	General use.	Open to all ham radio operators	Mainly for text keyboarding QSOs on the alternative data channels.	3	Any ham may join in any SLOT in any random order.	Alternative Data Channels
GPR	ALE-GPR use only.	Open to all ham radio operators.	ALE Geo Position Reports Only, via GPR standard fixed format AMD with TWS (This Was)	3	Any ham may join in any SLOT in any random order.	HFN Channels
RPT	Status and bulletin reporting.	Open to all ham radio operators.	General Reporting via any format Text AMD with TWS (This Was)	3	Any ham may join in any SLOT in any random order.	HFN Channels
HAM	International Disaster Relief and Emergency Interoperative Net	Open Liaison with non-amateur frequencies	Emergency, Disaster Relief, or Simulated Emergency Tests Only	10	Use for pre-planned net configurations with specific organizations.	Global ALE Emergency Comm Channels (mainly SSB Voice)

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7. Software ALE

- Requires an external computer, which controls your radio for scanning and transmitting.
  - The same computer supports a modem for digital traffic.

- Graphical user interface – point and click. All major controls for the radio are accessible through the computer.

- Automates programming the radio through the application.

- Uses computer keyboard to prepare text messages.

- More information available to the user about what is going on.

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## 7. Software ALE Alternatives.

PC ALE
- Been around quite some time
- Windows-only

Fldigi
- Newcomer to ALE – still under development
- SHARES stations already use fldigi to transfer data (MT63)
- No need to have a second program
- Windows, MacOS X, Linux, Raspberry Pi

HamRing
- Newcomer – under testing in the field
- Comprehensive set of features
- Status reporting
- Releasing a version specifically for SHARES/Government,
  - The new package is called Maxwell-2G and will be offered by Heaviside Communications, Inc.
- Windows, MacOS X, Linux, Raspberry Pi

Ham Ring
Selective Calling
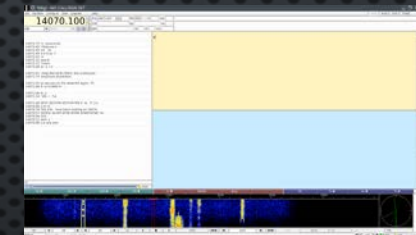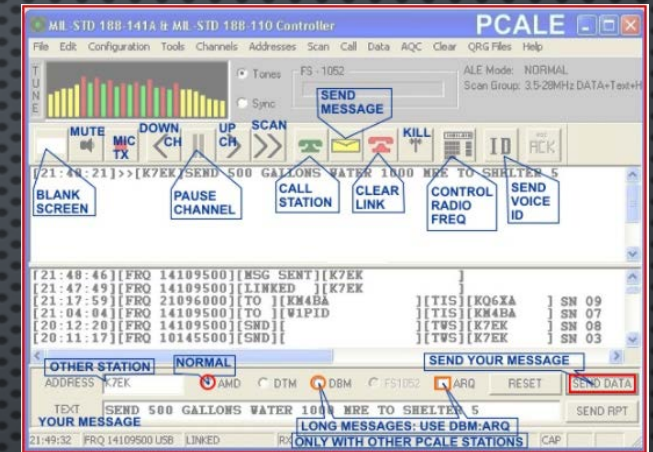
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Questions