MESSAGE THROUGHPUT CONSIDERATIONS IN EMERGENCY COMMUNICATIONS

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How much information can we move through emergency amateur radio communications, by various techniques?

It would seem beneficial for amateur radio to make use all all available modes of information transfer during an emergency-- but also to increasingly move toward modes that offer greater throughput with the available resources.

So what moves information the fastest? Let's compare several available amateur radio communication modes. For the purposes of discussion in this article, a "word" will be the typist's definition: five characters of any type.

Mode	**VOICE**	**PSK31**	**MT63-2K**	**WINLINK**
Most Apparent Limiting Factor	Writing/typing speed of receiving station	Protocol is only 31 baud	User efficiency in making connections.	Overhead baggage of message headers and error-correction handshakes.
Peak sustained throughput, 5-character words per minute	30 wpm (estimated sustained accurate typist copy speed)	48 wpm (calculated from baud rate)	200 wpm [1] [2] Measurement: 240 wpm	PACTOR P3: 2,400 wpm estimate. [3] WINMOR: >1000 wpm (large file, actual measurement)
Estimated efficiency (considering overhead)	50%	50%	50%	Depends on size of emails; better efficiency for larger emails.
Estimated Effective Words per minute	15 wpm	24 wpm	100-120 wpm	WINMOR: Actual words per minute (30K file): 1,042 wpm; much lower for 50-word emails: 150 wpm.
Estimated 50-word messages per minute	0.30	0.48	2.0	WINMOR: Actual messages per minute: 3.02

Advantage over VOICE	1.0	1.6 (60% faster)	6.66 (566% faster))	10.06 (906% faster) for multiple short emails; up to 69 times the speed of voice for large files (6,800% faster)

VOICE is the gold standard, and you can talk hundreds of words per minute....but the fellow at the other end has to either TYPE or WRITE the messages down if they are going to go to the right person/family/place down the line....and most people can't write over 20 wpm for extended periods, and can't type over 30wpm accurately. Further, there is overhead to get the two of you together on the frequency, etc. I will estimate a 50% overall efficiency.

PSK31 is a common digital method – but certainly not the fastest. It does use only a tiny bit of bandwidth. At only 31baud (bits per second) that's about 4 characters per second or so, or 240 characters per minute. I estimate the same 50% overhead to get on frequency, etc.

MT63-2K would do MUCH better, while using more bandwidth. It should perform around 200wpm – five times better than my PSK31 estimate.[1] [2] Using FLDIGI to create the MT63-2000S audio for a 30K selection from the Book of Job in an actual test took 25 minutes, equating to 240 words/minutes. Estimate 50% overhead as before.

WINLINK Consider one WINLINK client (user) station, forwarding traffic out of a damaged area, to a Remote Message Server (RMS) in an unaffected area still maintaining Internet access. Upon reaching the RMS station, email will immediately go out over the Internet. (If all of the Internet is down, email will be queued up over ham radio toward any known Message Pickup Stations.) WINLINK on HF has both soundcard-based WINMOR and proprietary-modem-based PACTOR protocols. WINMOR can consume up to 1600 Hz bandwidth, and in the U.S., amateur radio PACTOR is limited to P3 throughput (2400 Hz bandwidth). Uncompressed P3 raw throughput can reach 300 characters/second, or 3600 words per minute [3] though in practice a conservative estimate might be 200 characters/second (2400 words per minute). Compression techniques make useful throughput larger than this. Inexpensive soundcard-based WINMOR performance may be in the range of half of P3. Most land-based amateurs are presently going to use the slower WINLINK sound-card based mechanism, although most mariner and RMS stations have PACTOR available. (Government-related disaster communications WINLINK networks exclusively use PACTOR, and allow the much faster P4 speed.)

In actual testing, WINLINK using Signalink WINMOR seems to have great raw character throughput, but a very considerable “message overhead baggage” associated with each message. (With some additional connection/disconnection baggage.) WINLINK is an error-corrected transfer, requiring handshakes to acknowledge packets or request repeats.

I performed two on-the-air tests to measure the actual WINLINK throughput using

Signalink/WINMOR: (1) sending a 30K character segment of the Book of Job, and then (2) separately sending 20 individual messages, each of 250 characters total (50 "words"), including the email address and subject line. Sound-card based WINMOR was used with perfect signal conditions (one station, a vacuum tube Heathkit SB-102 into a lightbulb "dummy" load, and the other, the RMS Server, a solid state ICOM 718 at 5 watts, on the same property). Identification is automatic using WINLINK.

(Test 1) Large email result: The 30,000 character (6000 "word") email transferred in only 5.66 minutes including contact and disconnect time. That equates to an amazing 1,042 words per minute, five times the estimated MT63-2K throughput!

(Test 2) Multiple 50-word emails: Demonstrating the high overhead baggage, it took 6.62 minutes to transfer 20 individual 50-word messages, a reduced effective throughput of 150 wpm, or 3.02 messages per minute, which is still far faster than voice, but not nearly as fast as WINMOR large email transfer rates.

Maximizing emergency station utilization: There are presently a limited number of WINLINK-capable stations spread out over the United States, and perhaps 50 WINLINK RMS server stations.[4] In a disaster situation, with large amounts of emergency traffic to be forwarded by any means available (including voice, digital, and WINLINK), available WINLINK stations in the affected area would likely stay nearly continuously connected to strong-signal RMS servers for as long as band conditions allowed. While the default maximum connection time is 2 hours per day, this can be easily altered by the systems operator of RMS server stations to allow nearly continuous connection by stations conducting emergency operations. Using available software [5], email traffic could be "funnelled" already in digital form, into available HF forwarding stations' computers, from multiple input sources, including desktop email clients, and Packet systems accepting input traffic from outlying shelters or disaster teams. This relieves the emergency WINLINK forwarding operator of the need to ever type any messages. (Similar techniques could be utilized to best use the time of available digital operators using MT63 or similar modes.)

CONCLUSION:

One digital station using a faster digital protocol (MT63 – 2K) is likely to be able to perform the same throughput of short, 50-word emergency messages of **6 voice stations**. One WINLINK station using the same Signalink equipment may be able to perform the throughput of **10 voice stations**, with error-corrected text transmission. For larger data files, the throughput of the WINLINK station dramatically improves to over 1,000 words per minute, apparently due to decrease in the required message overhead baggage—makingit the equivalent of over SIXTY voice stations working together.

Because of this ***tremendous throughput advantag***e in emergency communications, it would be useful to both develop, train, and include both digital and WINLINK-based HF stations in emergency communications planning.

REFERENCES

[1] http://www.w0btu.com/wm2u/mt63.html
[2] http://www.arrl.org/mt-63
[3] http://www.arrl.org/pactor-iii
[4] Maps of various server type are available at: http://www.winlink.org/RMSChannels

[5] http://www.winlink.org/ClientSoftware and ftp://autoupdate.winlink.org/