Candidate Ribbit metadata and routing algorithm for message replication between offline nodes via HF/VHF/UHF analog radio

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Executive Summary

The last 30 years have seen unprecedented investment in the civilian cellular communication infrastructure, following the population where they live and work, and enabling commerce along trade routes.
However, there are still wide areas of land that are inhabited or temporarily visited that do not have enough population density to justify the investment in cellular communications infrastructure. In these areas, the imperative to support human life in emergencies has driven the local population to rely on affordable means of communication like analog VHF/UHF radio.
Furthermore, the efficiencies in manufacturing have made VHF/UHF radios extremely affordable for the general public in developing countries. VHF/UHF radio communications can be seen as the lowest common denominator of connectivity, and its utility can be measured during disasters when wildfire or tornados damage the cellular infrastructure. In absence of cellular connectivity, the local population falls back on VHF/UHF radio for the coordination of local emergency response, disaster mitigation and recovery efforts.
Ribbit has demonstrated the ability to augment the capabilities of any analog voice transceiver by leveraging the computing power, GPS, and touchscreen interface of modern smartphones, even when the smartphone is without cellular connectivity.
Ribbit is able to encode 256-byte text messages in the audio spectrum and implements multipath mitigation and strong forward error correction.

Ribbit mode

A Ribbit message is fixed in duration at 1250 milliseconds. It is sent over audio modulation with a 2kHz bandwidth centered on 1.5kHz. It is preceded by 400ms of white noise to open analog squelch circuits.

Ribbit message metadata

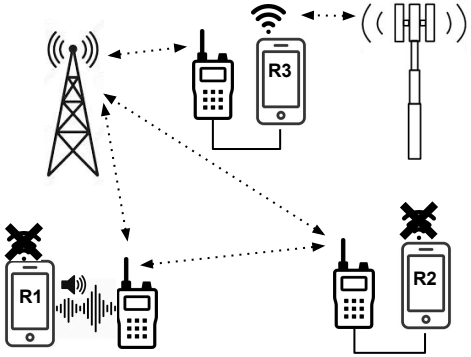
A Ribbit message is fixed in size at 512 bytes with a 2:1 forward error correction, allowing for 256 usable bytes.

Message header [16 bytes]:
+ Phone Number with Country Code
+ Epoch time (3sec resolution - rolls over in 36 days)
+ Location
+ Altitude
+ Offline/Online indicator

Variable Length Message Payload [5 to 235 bytes]:
+ UTF-8 encoded message, with Topic

Remaining available space [235 to 0 bytes]:
+ {optional Emergency Message retransmission}
+ Received Message ID {Phone#+Epoch}
+ Received Message ID {Phone#+Epoch} ...until full...

A distinct characteristic of a Ribbit message is to fill the remaining available space with acknowledgement of past received messages in reverse order with most recent first. This allows stations to transmit metadata on who received each message as messages are exchanged in the course of a communication.



Ribbit message broadcast

After each message transmission, stations follow this behavior:

+ For stations with automatic PTT control via an audio cable between the cellphone and VOX HT: Randomized anti-collision automated sending. Queued messages are sent within approximately 3 seconds of the last message received.

+ For stations using manual PTT and audio coupling: Screen prompt to wait for 6 seconds of silence after last message is heard before manually sending a message

At any time, an operator can resend a past message. If no message is in the queue, after 3 minutes, stations send an empty message to acknowledge reception.

Ribbit message routing

By using phone number and epoch, it is possible to generate a unique Message ID {Phone#+Epoch} for proper routing in an offline/online decentralized radio network.
Use of the cell phone GPS to include location, altitude and exact time in each message is essential during emergencies but also allows for reporting someone's position periodically to the network.
+ Messages are received by listening stations and acknowledgements are sent progressively as the conversations continue, or at the latest 3 minutes after the last message sent.
+ If a station joins in the middle of a conversation, it will be informed of past Message IDs and can request missing messages to be resent to it.
+ Any station connected to the internet acts as a gateway and routes messages to the Ribbit cloud server. If all stations are offline, messages are cached and uploaded to the Ribbit server when a station gets back online.
+ Messages follow topics and the Ribbit cloud server operates on a publish/subscribe mechanism.
+ Online stations only see messages in the topics subscribed to.
+ Offline stations see all messages received via radio.
+ Emergency messages have priority over all messages and are retransmitted in the Remaining Available Space of other messages.

Benefits

With this simple implementation, Ribbit messages can cohabitate with voice traffic on HF/VHF/UHF frequencies and allow for automatic message replication as well as manual message transmission on the same network. This cohabitation is a key benefit of the implementation.