

# Long-range Telecommunications in the HF band

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HERMES - High-frequency Emergency and Rural Multimedia Exchange System

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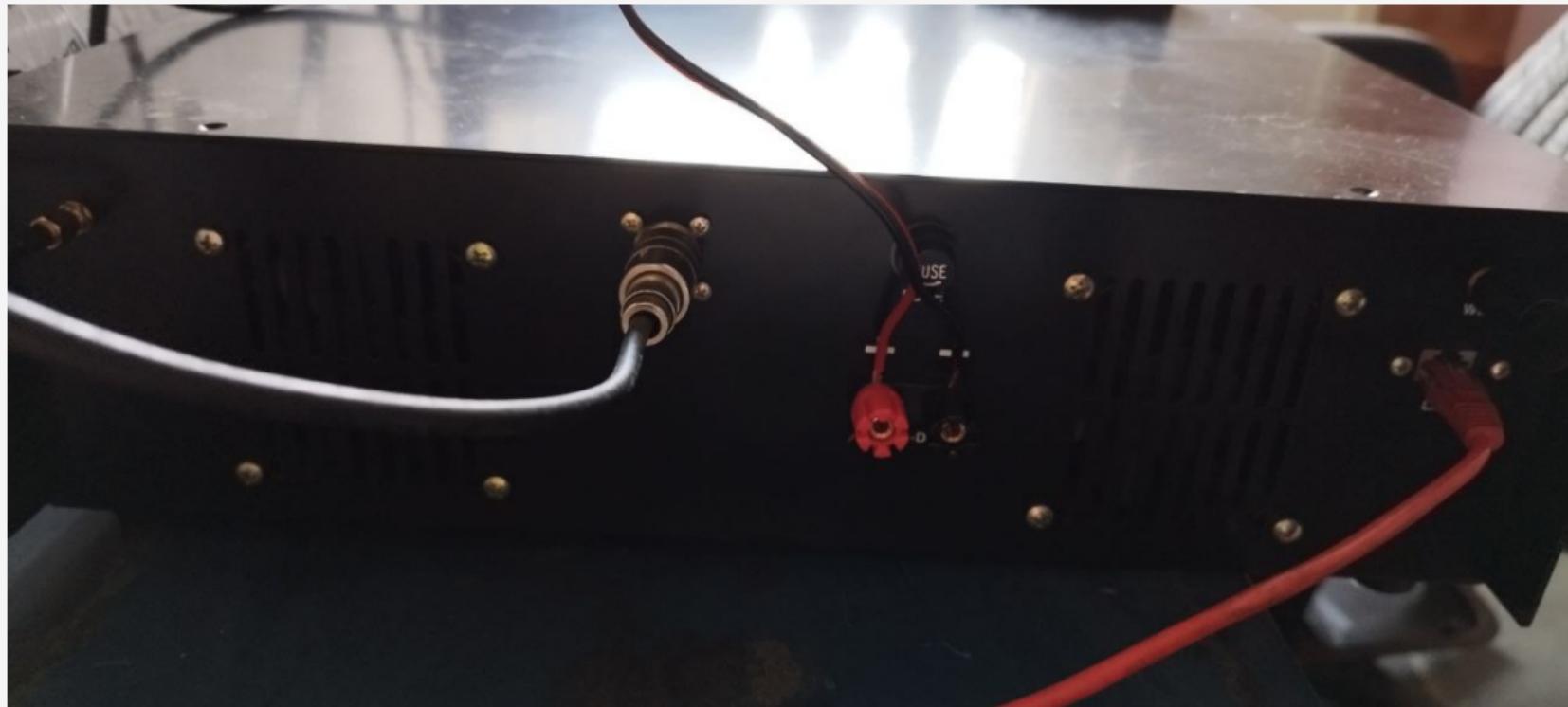




# HERMES

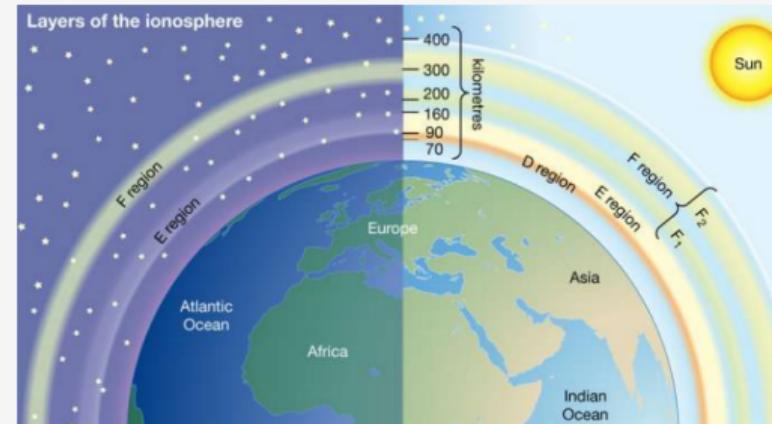


# HERMES



# The HF Band

- The band, as defined by ITU, between 3 MHz and 30 MHz
- The HF band allows very wide coverage thanks to the skywave propagation
- Civil HF telecommunication systems are stuck on time (around the 60's)
- Military HF telecommunication systems are very advanced, already in its 4G era (aka. WideBand ALE)



# Real-world network example

- In the Amazon rainforest region, Pará state, northern Brazil

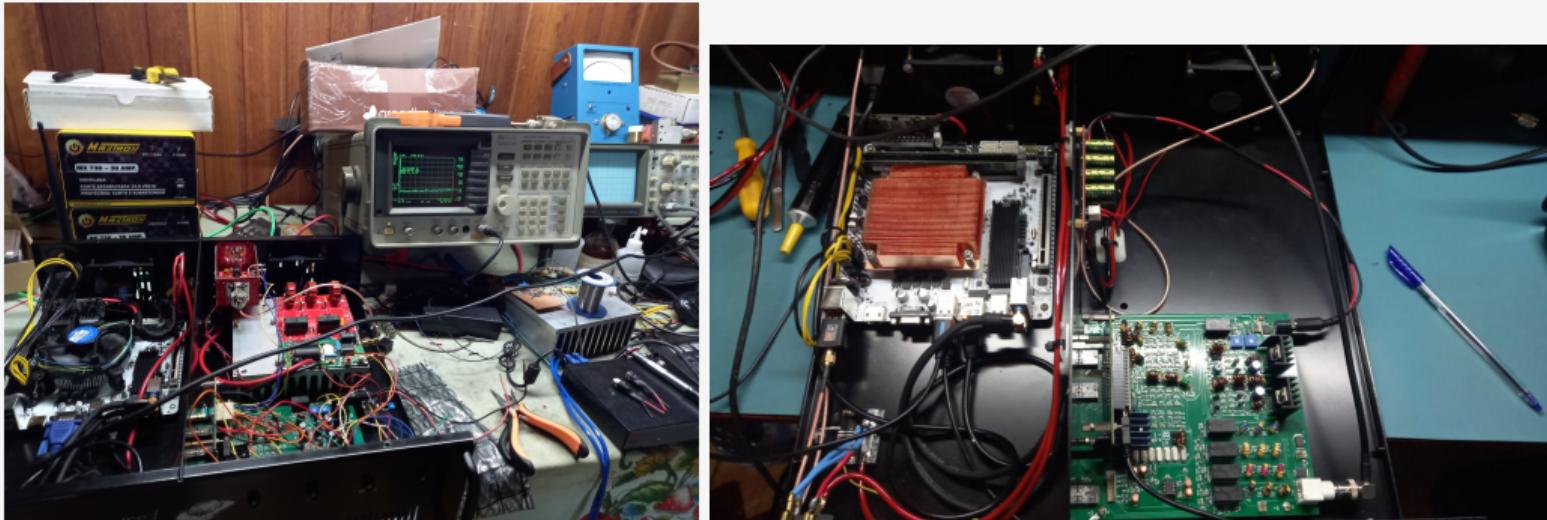


# Antenna



# System Description

- HF Transceiver
- UUCP-based Network Stack (x86 PC)
- User-facing services



# HF transceiver

<https://www.hfsignals.com/index.php/ubitx-v6-buy-the-full-kit/>

## μBitx v6 based

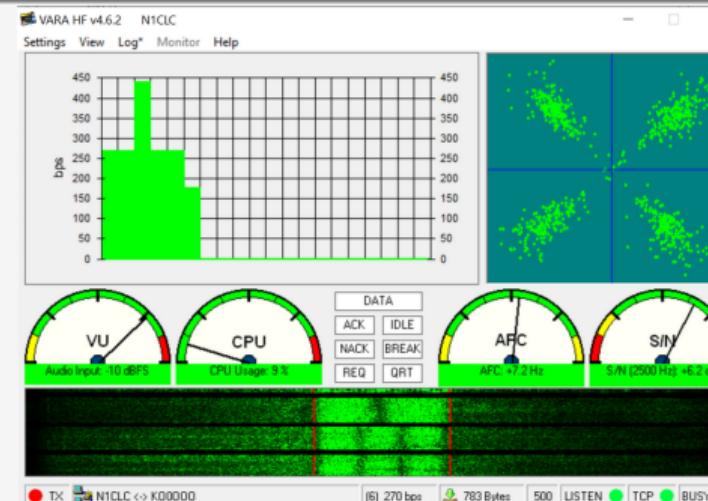
- Arduino firmware re-written, includes a new serial communication protocol, LEDs control...
- Added a GPS for calibration of the PLL offset (Si5351A)
- Added a lambda bridge for forward and reflected power measurement



# (software-defined) Modem

Currently using VARA HF

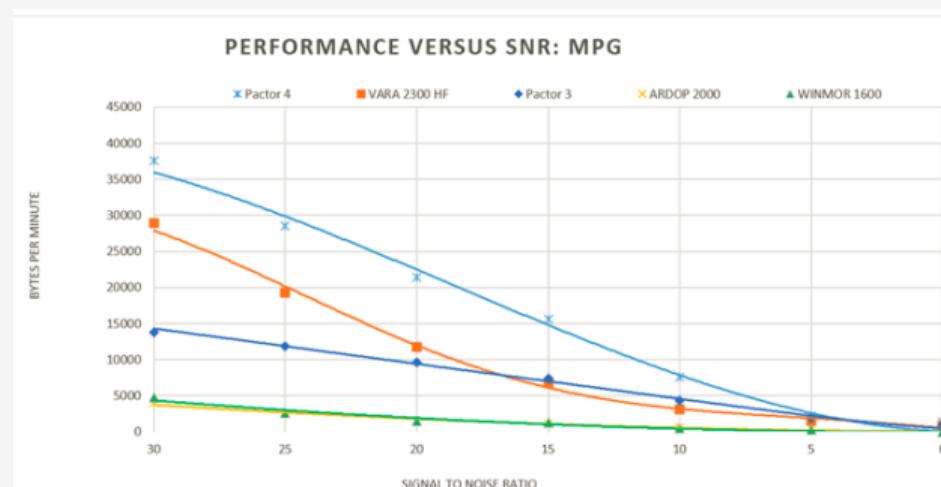
- 2300 Hz BW, ARQ, Adaptive Modulation
- Modes range from 16 bps up to 5 kbps
- Proprietary Visual Basic 6 application (runs well on Wine)



# New Modem

We are developing Mercury modem

- Flexible BW (including wideband waveforms greater than 3 kHz)
- Uses OFDM modulation and LDPC
- <https://github.com/Rhizomatica/mercury>



# Good ol' UUCP

## Taylor's UUCP goes over the air

- UUCP connects to the modem using pipes and shared memory
- The UUCP nodename is the station callsign
- Is composed by a daemon which transfers the uucp payload between uucico and the HF modem.
- Protocol 'y' is used, and long timeouts are set.

/etc/uucp/port:

port HFP

type pipe

command /usr/bin/uuport -c \Z

# The network stack (hermes-net repo)

<https://github.com/Rhizomatica/hermes-net>

- `trx_v1-firmware`: The HF transceiver firmware
- `trx_v1-userland`: radio control daemon and cli tool
- `uucpd`: UUCP daemon and tools (bridge between UUCP and the modem)
- `uuxcomp`: uux wrapper which compresses an e-mail before enqueueing it, and `crmail` to decompress
- `system_scripts`: image and audio compression scripts, email and uucp management, gateway “caller”, etc
- `system_services`: init scripts and udev rules

# REST Backend

<https://github.com/Rhizomatica/hermes-api>

- Radio API: set/get frequency, mode, bfo, pll offset, pwr ref, fwd, swr, ...
- User API: user management for web admin access and e-mail accounts (same login)
- Messages API: direct message between hosts (just a uucp copy of a packaged message)
- System API: set/get system status / configuration
- UUCP API: provides a way to list and delete UUCP jobs, and start a connection (uucico)
- Special Gateway API: provides scheduling facilities and station/frequency table

# WEB Frontend

<https://github.com/Rhizomatica/hermes-gui>

- Provides users Web access to the needed configurations
- Multi-language: en, es, pt
- System logs, UUCP queue management
- Message writing / received / transmitted messages
- User management is tied to email user management

# WEB Frontend

 e-mail

 mensagens

mensagens email admin ajuda sair

 mensagens email admin ajuda sair

**Mensagens públicas**

escrever  enviadas

Pesquisar mensagens:  

PU4GNU, 10/3/22, 2.27  
teste hmp 4

PU4GNU, 10/3/22, 2.27  
teste hmp 4

PU4GNU, 10/3/22, 2.26  
teste hmp 3

PU4GNU, 10/3/22, 2.26  
teste hmp 3

V21 | Estação: estacao3.hermes.radio | Estado: ● | Espaço Livre: 91.63 GB

 messages email admin help logout

**Radio Configuration**

Disconnected	Radio frequency 7115 kHz
SWR 0	REF (0 W) (0 V)
FWD (0 W) (0 V)	Operation mode RX
Serial Number 666	

Radio frequency: 7115 kHz

V21 | Estação: estacao3.hermes.radio | Estado: ● | Espaço Livre: 91.63 GB

 messages email admin help logout

**Transmission list**

Total size of files to transmit: 496 B

0: 0.58 02-02  
sms@hermes.radio  
destination: PU2UIT  
size: 496 B

force →

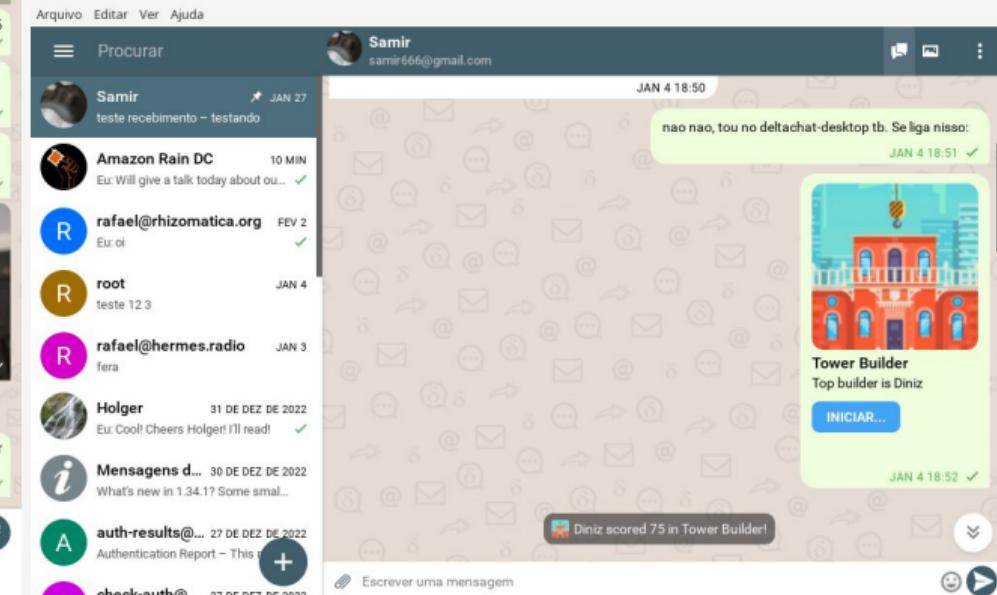
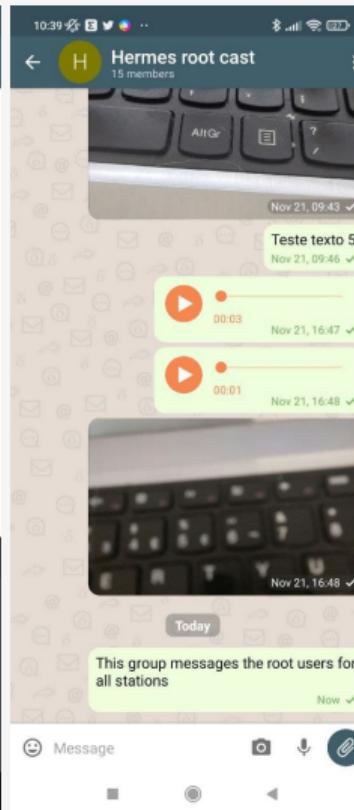
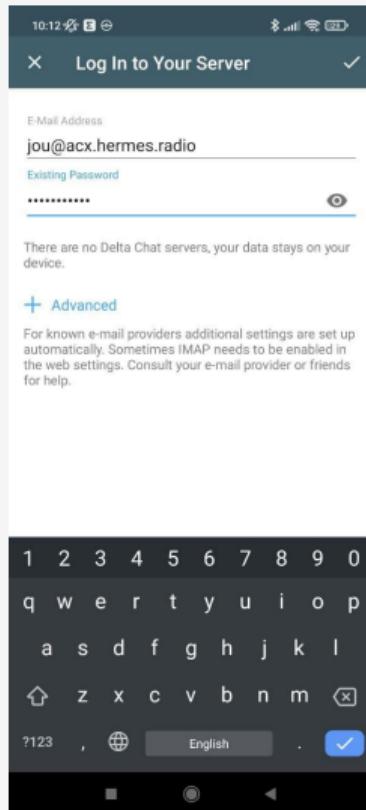
V21 | Station: estacao3.hermes.radio | Status: ● | Free Space: 104.341 GB

# E-mail

## E-mail stack

- Full e-mail stack with Postfix, Dovecot and so on
- E-mail compression using uuxcomp called directly from postfix (!crmail), many headers stripped, xz compression
- Specific transcoding for DeltaChat audio (LPCNet) and image (VVC) messages in uuxcomp
- One station (called “gateway”), which must have an Internet connection, routes the emails (uucp nodes postmap) from/to our email server in digital ocean

# DeltaChat



# Near Future

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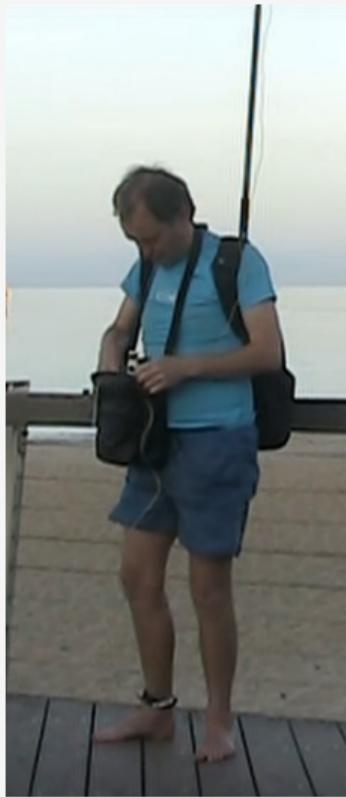
- Substitute VARA by Mercury (still lacking gear-shifting and a robust ARQ design) - HERMES will be 100% Free Software!
- New Portable / WideBand HERMES version (sBitx-based)
- Integration to SMS and other messaging services  
(<https://github.com/Rhizomatica/hermes-messaging/>)
- Sensors data acquisition and transmission - binary data using paq8px compression  
(<https://github.com/Rhizomatica/hermes-sensors/>)
- “Online” GPS calibration of the Si5351 offset (using a 8-port output Si5351A)
- Analog SSB support in the UI (<https://github.com/Rhizomatica/hermes-analog>)

# Future More Ahead

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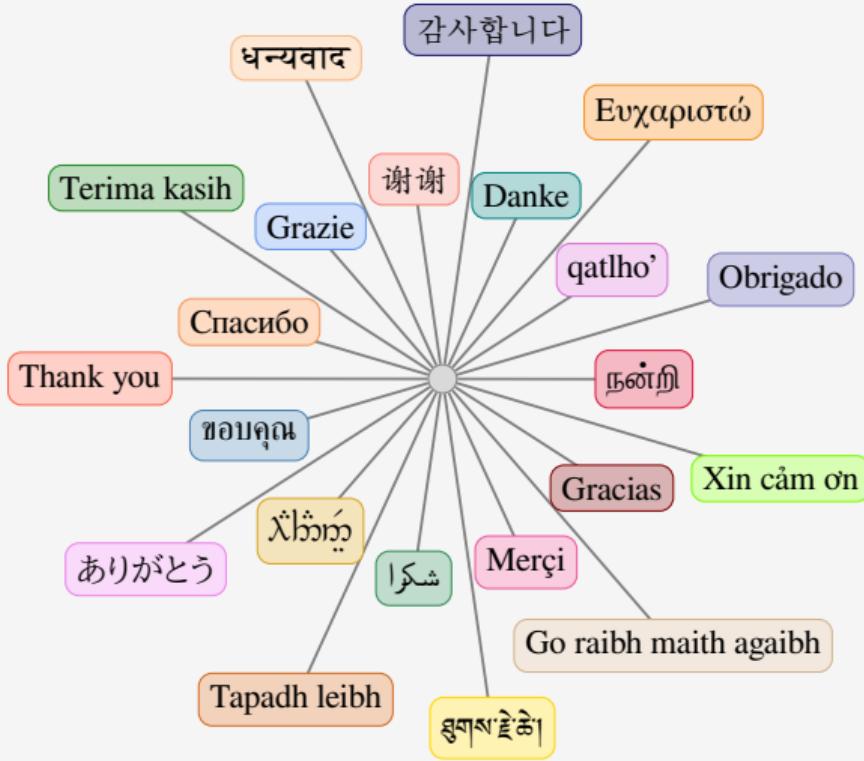
- NNCP for improved security
- Multiple users capable (beyond P2P) MAC
- Adaptive bandwidth and channels selection
- Support synchronous communication
- Telephony
- DRM reception
- DRM broadcast

# HF Mobile Telephony



## What you can do in today's conditions





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# Questions?