



Welcome To A New Dawn In Amateur Radio

High speed digital mesh networking

Next generation data modes for mesh networking

Martin C. Alcock, M. Sc, MIEEE, VE6VH

Requirements for a new data mode



- Designed for amateur equipment, not repurposed commercial gear
- Able to operate on any band and modulation method
- Raise the bar on data rates
- Reduce retries by adding forward error correction
- Connect to any transceiver using:
 - Mic and Speaker connections on any radio
 - Discriminator/Modulator connections if equipped with a data port
- Able to participate in a mesh network

Orthogonal Frequency Division Multiplexing



- A spread spectrum technique using bundled carriers
- Used in many common data devices:
 - Cellular telephones (known as LTE)
 - Digital Subscriber Lines (DSL)
 - Cable Modems
- Occupied spectrum is divided equally between subcarriers
- All subcarriers transmit in parallel
- Carriers are modulated individually
- Efficient use of spectrum by full occupancy
- Can be used in point to point or point to multipoint

Introducing OFDM-AB for Amateurs



- OFDM in the audio frequency range (similar to DSL)
- Operates with any FM transceiver and frequency band
- Regulatory compliance achieved using standard FM
- Can be configured for 4 different audio bandwidths
- Data rate dependent on bandwidth and modulation (constellation)
- Automatic adaptation to different bandwidths
 - No handshaking required

OFDM-AB Bandwidths on 12.5KHz spacing



Mode	Bandwidth	Application	Radio Connection
Narrowband	2,625	Most FM radios using	Mic and speaker
Enhanced NB	3,656	Radios without sharp high end cut-off	
Wideband	5,766	Radios with direct modulator connections	Data Port
Enhanced WB	7,781	High end radios with extended passbands	

Tested with:FTM-3100, ICOM IC-2000H, Kenwood TK-760H, Kenwood TH-D74, Icom IC-2AT, Yaesu VR-120, TAIT TM-8100, Kenwood TK981, Kenwood TKR-901

OFDM-AB Data Rates



Constellation	Bits/Carrier	NB	ENB	WB	EWB
BPSK	1	2,426	3,353	5,294	7,147
QPSK	2	4,853	6,706	10,588	14,294
QPSK-8	3	7,260	10,059	15,882	21,441
QAM-16	4	9,680	13,412	13,412	28,588
QAM-32	5	12,132	16,765	16,765	35,735
QAM-64	6	14,520	20,118	31,765	42,882
QAM-128	7	16,940	23,471	37,059	50,029
QAM-256	8	19,360	26,824	42,353	57,176

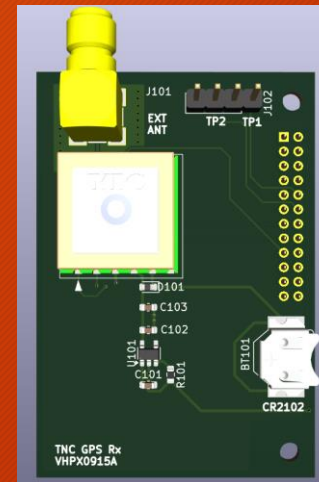
Advanced Mesh Network Controller

- Operates in a standalone mode or as a Pi HAT
- Powered by 12V or USB
- Two independent radio ports
- 12KHz audio bandwidth
- USB-C interface for UAR/T connection to PC
- UAR/T and SPI connections to Pi for higher speed data
- AX.25 KISS Protocol supported in both modes
- FPGA provides digital audio ports
- Menu operation for configuration and diagnostics
- Field upgradeable using serial port
- Full production Q4, 2026



Additional Optional Hardware

- GPS module adds position reporting
 - In development
 - Backup battery stores ephemeris data
 - Mounts on node debug connector
- Programming module for software development
 - Off the shelf ST-Link module
 - Supported by ST Micro CUBE IDE development system
 - Free download from manufacturer
- FPGA download and debug
 - FT2232 UAR/T module
 - Supported by FPGA manufacturer tools
 - Free download from manufacturer



GPS Module



Programming Module

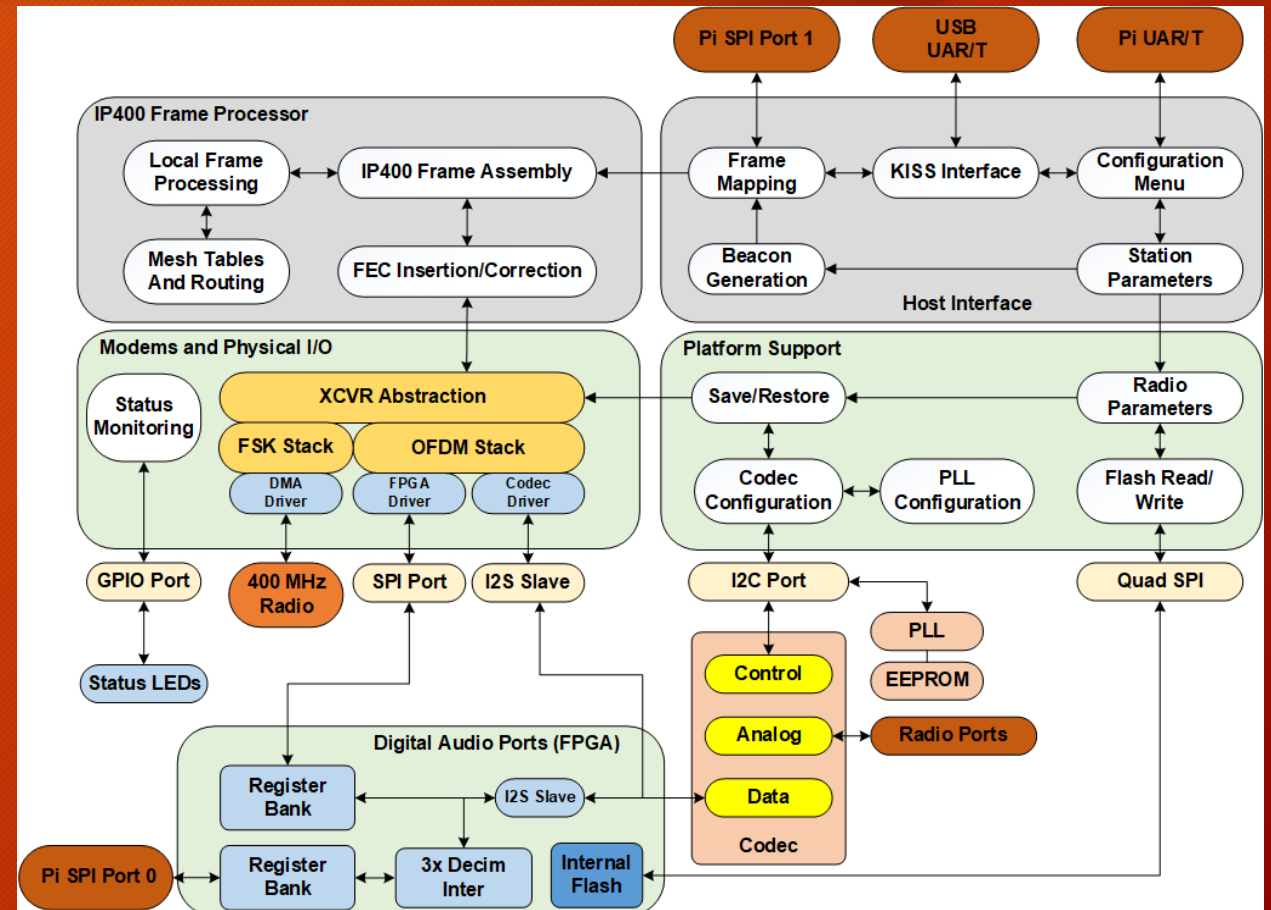
Upgrading an Allstar Repeater for Data



- Simple hardware addition of a HAT to existing Pi
- AMNC provides digital audio path, replaces CM-108 USB module
- Custom Allstar driver replaces USB radio module
- Audio path provides 8KHz PCM from either radio port
- Data and voice modes can co-exist or operate separately
- Two modem data paths:
 - Pi UART can be used for AX.25 KISS operation
 - Pi SPI provides a higher speed path for UDP frames up to 1500 bytes
- Dual operation enables repeater and link modes
 - One port for repeater audio/data, and the other for a data link

Unified Firmware Platform

- Next generation mesh node with OFDM-AB
- Host interface supports SPI for high speed data
- UAR/T supported by USB or Pi Serial port
- Built-in beacon generation and mesh table
- Integrates OFDM-AB transceiver
- Backwards compatible with previous 4FSK modes
- Runs on AMNC or Mini-node hardware
- Open Source

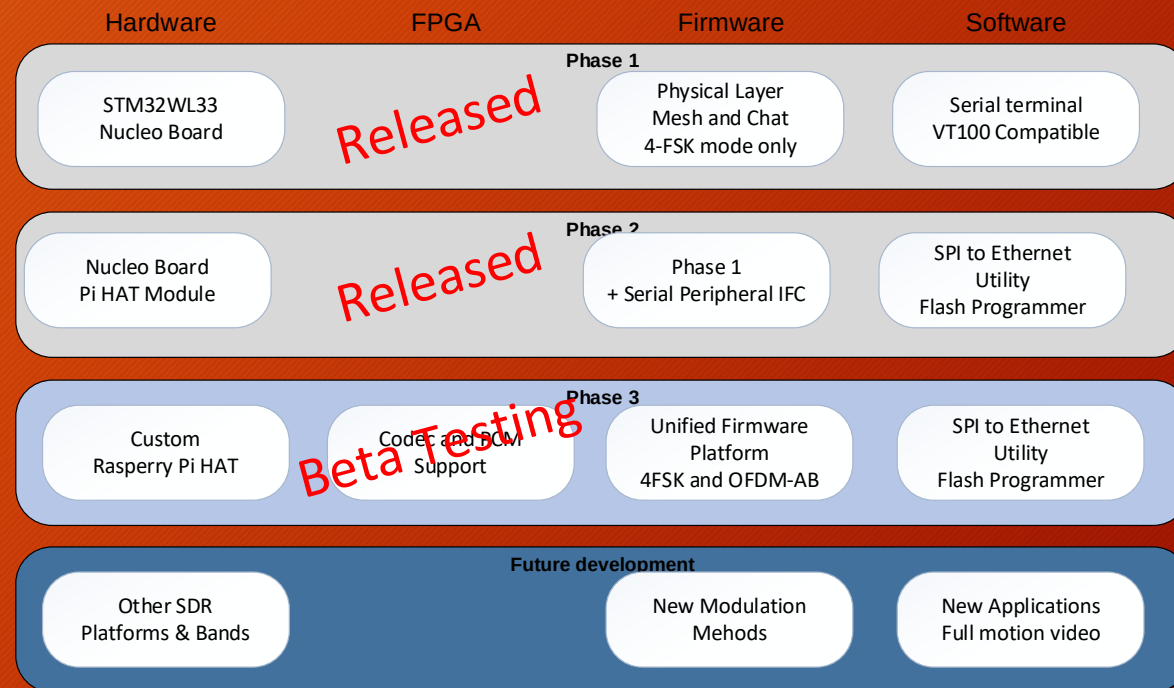


UFP Development Road Map



- Phase 1 on Nucleo Board
- Phase 2 on Pi HAT (“mini-node”)
 - 4FSK Only
 - Pi Zero form factor
- Phase 3 new hardware module
 - OFDM-AB mode
 - Full size Pi HAT
 - Allstar compatibility
 - Standalone mode
- UFP supports all phases

IP400 Node Development Roadmap



Planned UFP Releases



Release Date	Version	Features
Q3, 2026	2.0	UFP for Mini-node with KISS, SPI, 4FSK mode
Q4, 2026	2.1	Add AMNC with KISS, SPI, OFDM-AB up to QAM-64, all BW, CRC only
Q1, 2027	2.1a	FPGA upgrade and addition of custom driver for Allstar and FPGA
Q2, 2027	2.2	Add QAM-128, QAM-256 and FEC using Trellis coding

Summary



- New OFDM data mode for amateurs called OFDM-AB
- Connects to any FM radio, band independent
- Enables mesh networking in any band from 10m to 1296MHz
- Initial firmware released now, future upgrade path planned
- Backward compatible with previous 4FSK modems
- Open source
- Advanced Mesh Network Controller module
- Dual port, standalone operation or as Pi HAT
- Adds data mode to existing repeater systems
- Module in full production Q4, 2026
- Contributions welcomed

