Open Research Institute
Inner Circle Newsletter
July 2025

OPEN SOURCE HARDWARE AND SOFTWARE NEWSLETTER SIGNUP
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The Who What When Where Why

Open Research Institute is a non-profit dedicated to open source digital radio work on the amateur bands. We do both technical and regulatory work. Our designs are intended for both space and terrestrial deployment. We're all volunteer and we work to use and protect the amateur radio bands. You can get involved in our work by visiting https://openresearch.institute/getting-started

Membership is free. All work is published to the general public at no cost. Our work can be reviewed and designs downloaded at https://github.com/OpenResearchInstitute

We equally value ethical behavior and over-the-air demonstrations of innovative and relevant open source solutions. We offer remotely accessible lab benches for microwave band radio hardware and software development. We host meetups and events at least once a week. Members come from around the world.

The Microwave Link Mystery Solved

Four amateur radio operators (Alice, Bob, Carol, and Dave) are setting up 10 GHz microwave links. Each has a different antenna polarization: Horizontal, Vertical, Right-Hand Circular (RHC), and Left-Hand Circular (LHC).

Polarization Loss Rules

Same polarization: 0 dB loss
Cross-polarized linear (H vs V): 20+ dB loss
Circular to linear: 3 dB loss (either direction)
Opposite circular (RHC vs LHC): 20+ dB loss

The Clues

1. Alice can communicate with Bob with perfect signal strength (0 dB loss).

2. Alice gets terrible reception from Carol (20+ dB loss).

3. Alice receives Dave's signal at reduced power (3 dB loss).

4. Bob can barely hear Carol (20+ dB loss).

5. Bob gets a good but reduced signal from Dave (3 dB loss).

6. Carol receives Dave's signal at reduced power (3 dB loss).

7. One operator forgot to rotate their new IC-905 dish from its factory vertical polarization setting.

8. Bob notices that a 10 degree rotation resulted in a lot of signal loss.

Who has which antenna polarization?

Solution:
Alice: Horizontal
Bob: Horizontal
Carol: Vertical (IC-905 factory setting - forgot to rotate!)
Dave: Right-Hand Circular (RHCP)

From clue 1, Alice and Bob have 0 dB loss, therefore they have identical polarization.

From clues 2 & 4, both Alice and Bob get 20+ dB loss from Carol, so Carol has the orthogonal polarization to Alice/Bob. This 20+ dB loss could happen in two scenarios:

1. Alice/Bob are one linear polarization (for example, Horizontal), Carol is the orthogonal linear (for example, Vertical).

2. Alice/Bob are one circular polarization (for example, RHCP), Carol is the opposite circular (for example, LHCP).

From Clue 8, Bob has either vertical or horizontal polarization, as rotating the antenna results in noticeable loss. Rotating a circular polarized antenna doesn't result in much loss.

From clues 3, 5, & 6, Dave gets 3 dB loss from Alice, Bob, and Carol. Since 3 dB loss occurs between circular and linear polarizations, and we suspect Bob is linear, then Dave must be circular.

Dave can get 3 dB from all three is if Alice/Bob/Carol are all linear polarizations, and Dave is circular.
Then clue 7 (IC-905 vertical) helps us determine which linear polarizations they have.

From clue 7, someone has an IC-905 in vertical polarization. This some "one" must be Carol (since she's orthogonal to Alice/Bob). Only one operator forgot to rotate, so it can't be both Alice and Bob with vertical.

Therefore: Carol = Vertical,
Alice/Bob = Horizontal.
Since we have Horizontal (Alice/Bob), Vertical (Carol), and one circular (Dave), Dave must be either RHCP or LHCP. We are going to say RHCP, but it is arbitrary. LHCP is correct too.

🔊 Amateur Radio Band Sudoku

Fill each row, column, and 3×3 box with all 9 amateur bands

Rules: Each row, column, and 3×3 box must contain exactly one of each amateur radio band (160m through 70cm). Blue cells contain given clues to help you solve the puzzle.

	80m			15m			2m	
		15m			40m			10m
6m			80m			20m		
	40m			10m			20m	
20m				2m				160m
	15m				80m		6m	
		6m		80m		2m		
15m			2m				10m	
	2m	80m			15m			6m

📻 Amateur Radio Bands

160m — 160 meters, 1.8 MHz (Top Band)	80m — 80 meters, 3.5 MHz	40m — 40 meters, 7 MHz
20m — 20 meters, 14 MHz (DX Band)	15m — 15 meters, 21 MHz	10m — 10 meters, 28 MHz
6m — 6 meters, 50 MHz (Magic Band)	2m — 2 meters, 144 MHz	70cm — 70 centimeters, 420 MHz

📰 Solution Next Month!

The solution to this Amateur Radio Band Sudoku will be published in next month's ORI newsletter. Good luck solving it!

“Take This Job”

30 July 2025

Interested in Open Source software and hardware? Not sure how to get started? Here’s some places to begin at Open Research Institute. If you would like to take on one of these tasks, please write hello@openresearch.institute and let us know which one. We will onboard you onto the team and get you started.

Opulent Voice:

- Add a carrier sync lock detector in VHDL. After the receiver has successfully synchronized to the carrier, a signal needs to be presented to the application layer that indicates success. Work output is tested VHDL code.
- Bit Error Rate (BER) waterfall curves for Additive White Gaussian Noise (AWGN) channel.
- Bit Error Rate (BER) waterfall curves for Doppler shift.
- Bit Error Rate (BER) waterfall curves for other channels and impairments.
- Review Proportional-Integral Gain design document and provide feedback for improvement.
- Generate and write a pull request to include a Numerically Controlled Oscillator (NCO) design document for the repository located at https://github.com/OpenResearchInstitute/nco.
- Generate and write a pull request to include a Pseudo Random Binary Sequence (PRBS) design document for the repository located at https://github.com/OpenResearchInstitute/prbs.
- Generate and write a pull request to include a Minimum Shift Keying (MSK) Demodulator design document for the repository located at https://github.com/OpenResearchInstitute/msk_demodulator
- Generate and write a pull request to include a Minimum Shift Keying (MSK) Modulator design document for the repository located at https://github.com/OpenResearchInstitute/msk_modulator
- Evaluate loop stability with unscrambled data sequences of zeros or ones.
- Determine and implement Eb/N0/SNR/EVM measurement. Work product is tested VHDL code.
- Review implementation of Tx I/Q outputs to support mirror image cancellation at RF.

Haifuraiya:

- HTML5 radio interface requirements, specifications, and prototype. This is the primary user interface for the satellite downlink, which is DVB-S2/X and contains all of the uplink Opulent Voice channel data. Using HTML5 allows any device with a browser and enough processor to provide a useful user interface. What should that interface look like? What functions should be prioritized and provided? A paper and/or slide presentation would be the work product of this project.
- Default digital downlink requirements and specifications. This specifies what is transmitted on the downlink when no user data is present. Think of this as a modern test pattern, to help operators set up their stations quickly and efficiently. The data might rotate through all the modulation and coding, transmitting a short loop of known data. This would allow a receiver to calibrate their receiver performance against the modulation and coding signal to noise ratio (SNR) slope. A paper and/or slide presentation would be the work product of this project.

ORI's "Real and Complex Signal Basics" Article to be Published in QEX

The September/October 2025 issue of ARRL's QEX magazine features "Real and Complex Signal Basics" by Michelle Thompson W5NYV. The article provides a step-by-step mathematical explanation of how complex modulation works in digital radio systems.

The piece starts with simple single-carrier real signals and builds up to explain quadrature amplitude modulation (QAM). Using clear mathematical derivations, it shows how two real signals can be transmitted simultaneously using sine and cosine carriers that are 90 degrees out of phase, then separated at the receiver using trigonometric identities and integration.

Subjects covered include:

- How real signals create symmetrical frequency domain images
- The transition from 4-level amplitude modulation to 16QAM using I and Q coordinates
- The mathematical basis for quadrature mixing at both transmitter and receiver
- Why complex modulation eliminates unwanted frequency images
- How this approach enables higher data rates without requiring finer amplitude resolution

The article emphasizes the practical advantages of complex modulation. You get increased spectral efficiency, easier filtering due to single-sided transmission, and the flexibility to implement any modulation scheme through software-defined radio techniques.

This mathematical foundation underlies much of ORI's digital radio development work, including the Opulent Voice protocol and other broadband digital communications projects.

The full article is available to ARRL members through QEX magazine. Want to publish it in your club newsletter? Article is available on request from ARRL from `qst@arrl.org`

Looking to Learn more about IQ Modulation?

Basics of IQ Signals and IQ modulation & de-modulation – A tutorial by W2AEW

https://www.youtube.com/watch?v=h_7d-m1e-hoY

Software Defined Radio For Engineers (free PDF from Analog Devices)

https://www.analog.com/en/resources/technical-books/software-defined-radio-for-engineers.html

These resources will get you well on your way!

ORI's FCC Comment on Proceeding 25-201

Opposition to AST & Science LLC (AST SpaceMobile) Request for Amateur Radio Band Usage
July 21, 2025

Executive Summary

We respectfully submit this comment in strong opposition to AST & Science LLC's (AST SpaceMobile) request to utilize the 430-440 MHz amateur radio band for Telemetry, Tracking, and Command (TT&C) operations for their planned 243-satellite constellation. We urge the Commission to deny this application and direct AST SpaceMobile toward established commercial satellite frequency allocations that are much more appropriate for their commercial operations.

Background and Technical Concerns

First, we have currently unauthorized operations going on. AST SpaceMobile currently operates five Bluebird commercial satellites launched on September 12, 2024, using amateur radio frequencies at 430.5, 432.3, 434.1, 435.9, and 439.5 MHz with 50 kHz bandwidth for telemetry links. This existing operation has already demonstrated the potential for interference with legitimate amateur radio operations.

The scope of the proposed expansion is a problem. AST SpaceMobile seeks to expand this usage to a 243-satellite constellation, with each TT&C beam supporting command and telemetry channels with bandwidths between 64-256 kHz. This massive expansion would fundamentally transform the character of the amateur radio band from experimental and emergency communications to commercial satellite operations.

Amateur Radio uses this band and is important. The 430-440 MHz band serves a variety of critical Amateur Radio applications including amateur space communications, weak-signal SSB, digital television, data communications, repeaters and other applications. The amateur radio service in this band supports:

Emergency Communications: Amateur radio operators provide vital public service during disasters when commercial communications infrastructure fails.
Space Communication: Educational and experimental satellite communications that advance the radio arts.
Technical Innovation: Experimentation and development of new communication technologies. Where do we think new engineers come from? Many of them come from amateur radio.
International Coordination: The proposed constellation will cause interference to amateurs worldwide. This is opposed by a wide variety of international amateur radio organizations.

Regulatory and Precedential Concerns

This is a very inappropriate band allocation. The 430-440 MHz band is allocated to the Amateur Radio Service, not commercial satellite operations. ITU study groups investigated potential TT&C frequency allocations in the frequency ranges 150.05–174 MHz and 400.15–420 MHz, specifically excluding the amateur allocation at 430-440 MHz. Permitting a commercial satellite constellation to operate in amateur radio spectrum sets a dangerous precedent that could lead to further commercial encroachment on bands reserved for experimental, educational, and emergency communications.

Frequency coordination frameworks exist. Satellite frequency coordination, particularly in these frequency bands, relies on a global regulatory and technical framework maintained by the International Telecommunication Union (ITU). AST SpaceMobile should utilize this established framework rather than seeking unauthorized access to amateur spectrum. ITU study results are clear. ITU study groups conducted sharing studies in various bands which yield that no new allocations are suitable for small satellite TT&C on a co-channel sharing basis. Proper commercial allocations exist that would not interfere with amateur operations.

Proposed Alternative Solutions
We recommend the Commission direct AST SpaceMobile to utilize appropriate commercial satellite frequency allocations:
1. S-Band Operations: Migrate TT&C operations to established S-band satellite allocations (2025-2110 MHz and 2200-2290 MHz)
2. X-Band Implementation: Utilize X-band frequencies (8025-8400 MHz) which offer excellent propagation characteristics for satellite communications
3. Ka-Band Adoption: Consider Ka-band frequencies for high-capacity operations
4. Proper ITU Coordination: Work through established international coordination procedures for legitimate commercial satellite spectrum

Technical feasibility is not an issue. Modern satellite technology readily supports operations in these higher frequency bands. The primary frequency bands of S, X, and Ka are more advantageous than using the UHF band, which has a higher probability of local interference.

Economic and Public Interest Considerations
Protecting Public Service is important. Amateur radio operators provide critical emergency communications during disasters. Interference from commercial satellite operations could compromise this vital public service capability. The amateur radio service serves as a proving ground for new technologies and provides STEM education opportunities. Commercial encroachment limits these important societal benefits and harms our national competitiveness.

Precedential impact is negative. Approving commercial use of amateur spectrum without compelling technical justification would invite similar requests from other commercial operators, potentially destroying the character of amateur radio allocations.

Conclusion and Recommendations: We respectfully urge the Commission to:
1. DENY AST SpaceMobile's request to operate in the 430-440 MHz amateur radio band
2. DIRECT AST SpaceMobile to utilize appropriate commercial satellite frequency allocations in S, X, or Ka bands
3. REQUIRE proper ITU coordination for international satellite operations
4. REAFFIRM the Commission's commitment to protecting amateur radio spectrum for its intended non-commercial, experimental, and emergency communications purposes

The amateur radio bands serve critical public interest functions that would be compromised by large-scale commercial satellite operations. Abundant alternative spectrum exists that is specifically allocated for commercial satellite TT&C operations. We urge the Commission to preserve the amateur radio bands for their intended purposes and direct AST SpaceMobile toward appropriate commercial spectrum.

References: FCC DA 25-532 (June 20, 2025), AMSAT-UK Technical Analysis, ITU Radio Regulations and Study Reports, and NASA Small Satellite Guidelines

ORI's Contribution to FCC Technological Advisory Council

Open Research Institute contributed to the US Federal Communications Commission Technological Advisory Council final report for the 2024-2025 term. A summary of ORI's final draft contribution to the report is presented here.

We describe how spectrum sharing models must evolve to meet growing demand, particularly focusing on terrestrial-satellite integration. The core thesis suggests we're experiencing a crisis in current spectrum management that requires transitioning to a new "Era 4" model incorporating AI/ML automation and market-based mechanisms.

Historical Evolution of Spectrum Management

We identify three distinct eras of spectrum management.

Era 1 (1890-1912): Unregulated Model - A "loudest-served" system with no regulatory oversight, which collapsed following the Titanic disaster due to communication congestion.

Era 2 (1927-1981): Command-and-Control Model - Centralized FCC authority making static allocations based on "public interest." This system struggled with emerging technologies like FM radio and cellular networks.

Era 3 (1993-present): Market-Based/Flexible Use Model - Introduced spectrum auctions and flexible licensing, but now showing signs of regulatory overload and crisis.

Evidence of Current Crisis

Several indicators suggest Era 3 regulatory models are failing.

219 MHz Band Limbo: Years of regulatory deadlock between amateur radio, commercial, and federal interests with zero amateur activity despite allocated rights

C-Band Aviation Disputes: $81 billion auction created interference concerns with radar altimeters, requiring presidential intervention

Inter-agency Conflicts: NTIA and FCC reaching opposite conclusions on identical technical evidence (Ligado case)

Reallocation Resistance: Broadcasting industry claiming all "low hanging fruit" has been picked from spectrum repacking

Technical Challenges in Terrestrial-Satellite Sharing

We highlight complex coordination requirements across multiple services in bands like 7.125-8.4 GHz, including Fixed Satellite Service, Mobile Satellite Service, and various terrestrial services. The SiriusXM situation exemplifies ongoing interference challenges between satellite and terrestrial broadband services.

AI/ML Enhanced Spectrum Management

The report positions AI/ML as essential for Era 4, comparing it to sophisticated air traffic control for the electromagnetic domain. Key capabilities include real-time spectrum sensing and occupancy analysis, dynamic allocation based on interference patterns, pattern recognition for optimization, and automated coordination at scale beyond human regulatory capacity

However, the report recommends against mandating specific AI/ML technologies, favoring technology-neutral approaches.

Proposed Era 4 Solutions

Band Managers and Spectrum Bucks: Government exits direct allocation, appointing non-governmental band managers who negotiate usage using a "Spectrum Bucks" currency system. This would enable both commercial and non-commercial users to coexist through market mechanisms.
Amateur Radio Model: Highlighted as a successful example of dynamic spectrum sharing through self-regulation, technical excellence requirements, and community governance. Amateur satellites demonstrate effective secondary service operations and have pioneered numerous technologies later adopted commercially.

Regulatory Sandboxes: Supplemental Coverage from Space (SCS) is the first terrestrial-to-satellite spectrum leasing framework, creating economic incentives for cooperation rather than just technical coordination. This hybrid model enables spectrum reuse in the same geographic areas.

Key Recommendations

Improve Spectrum Sensing: Establish independent measurement networks through citizen science projects, public-private partnerships, and dedicated monitoring systems to provide transparent occupancy data.

Create More Regulatory Sandboxes: Use controlled environments to test new sharing models before broad deployment, building on SCS and amateur radio examples.

Optimize Satellite Uplink Sharing: Prioritize sharing arrangements for uplink services while providing separate allocations for downlink services, recognizing the different interference characteristics.

Develop HetNet Principles: Create coordination algorithms that leverage satellite orbital mechanics and optimize handoffs between terrestrial and non-terrestrial networks.

The report concludes that the complexity and scale of modern spectrum management demands a paradigm shift toward automated, AI/ML-enhanced systems that can handle what human regulators cannot, while maintaining proven principles from successful sharing models like amateur radio.

[*We'll share full versions of all the charter items when the final report is approved by the TAC. This should be in early August 2025. -Michelle Thompson*]

What is the ESA FutureGEO Project?

The FutureGEO project is an ESA (European Space Agency) initiative to develop a future amateur radio payload for a geostationary satellite. The aim is to identify potential partners who would like to actively participate in the definition and development of a new amateur radio payload for a future geostationary satellite.

ESA proposed the idea of a geosynchronous satellite back in December of 2023. Frank Zeppenfeldt, PD0AP, of ESA, secured €250,000 in funding to investigate the possibility of an amateur satellite or payload in geostationary orbit. The announcement was made in a presentation at the AMSAT-UK Colloquium.

Proposals Submitted

Following ESA's initiative, proposals were received from AMSAT-UK, AMSAT-Canada, and AMSAT-DL.

AMSAT-UK Proposal (December 2023): A proposal was submitted to the European Space Agency (ESA) by AMSAT-UK, the British Amateur Television Club (BATC), and AMSAT-NA, with input from members of the UK Microwave Group for a geostationary microwave amateur payload

AMSAT-DL published an extensive proposal for a Geostationary Microwave Amateur Radio Payload in March 2024.

Technical Specifications

The proposed payloads include sophisticated amateur radio capabilities. Two 5.6 GHz uplink and 10 GHz downlink transponders (Mode C/x) – one 250 kHz wide with 20 watts of output for narrowband modes such as SSB, CW, and narrowband digital modes and one 1 MHz wide with 20 watts of output for wideband modes, including amateur television. Additional experimental features including 24 GHz receivers, millimeter wave beacons, and educational cameras.

Coverage Area

The footprint of the satellite is expected to cover eastern European countries and large portions of eastern North America with the western limit including Ontario and points east.

AMSAT-DL did not "win" a traditional grant from the ESA for FutureGEO, but they have established a cooperative partnership with ESA. AMSAT-DL is now leading the project coordination and has invited Open Research Institute to participate.

Currently, AMSAT-DL is in the partnership development phase, having recently issued a Request for Expression of Interest (RFEI) to amateur radio associations, AMSAT organizations, and other experts Deadline for feedbcak was June 30th, 2025

The project represents a collaborative approach rather than a traditional grant award, with AMSAT-DL serving as the primary coordinator working with ESA to develop requirements and gather international support for this ambitious amateur radio satellite project.

Continue on to read Open Research Institute's response to the RFEI.

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Greetings all,

Please confirm Open Research Institute's interest in the futureGEO project.

Please find attached:

1. A short Draft Proposal (maximum of 2 pages) outlining:
a) The organization's potential contribution to futureGEO.
b) Lessons learned from previous missions such as QO-100 or others.
c) Ideas for specific payload elements, experiments, technologies, or educational outreach.

2. Indication of involvement in the upcoming Workshop:

a) The first futureGEO Workshop will be held on 19 September 2025, during the AMSAT-DL Symposium and Bochumer Weltraumtage (19–21 September) at the Bochum Observatory, Germany:

Yes, in person

b) Please indicate if you are interested in giving a presentation and/or contributing to technical and strategic discussions:

Yes

3. Forum Participation:
a) Would your organization like to take an active role in the futureGEO online forum for ongoing collaboration and idea exchange? The forum will be accessible at https://forum.amsat-dl.org for registered users in a closed area.

Yes

4. Contact Details:
a) Please include the name, email, institutional affiliation, and mailing address of your primary contact person.

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Here are Open Research Institute's answers to the questionnaire kindly sent 21 May 2025.

Organization Overview

Open Research Institute (ORI) is a US 501(c)(3) non-profit organization dedicated to advancing open source digital radio space and terrestrial communication systems.

Founded to democratize access to advanced communication technologies, ORI has established itself as a leader in technical and regulatory open source digital radio development. We are the organization that obtained clarity for public domain communications satellite work being free of ITAR and EAR. Details can be found at https://github.com/OpenResearchInstitute/documents/tree/master/Regulatory in the ITAR_EAR folder.

1. Primary Area of Expertise

Open Research Institute's primary expertise lies in open source digital signal processing and software-defined radio systems for space communications. Our core competencies include the following.

Digital Communication Protocol Development: Design and implementation of modern, efficient protocols optimized for satellite and terrestrial environments. Work in all projects and categories can be found at https://github.com/OpenResearchInstitute

Modem Architecture: Our modem module approach implements useful modularity for FPGA digital communications design. All of the components are available free to the general public at no charge from ORI GitHub. Modularity is achieved through combining the building block repositories as submodules in an integrated design. Please see https://github.com/OpenResearchInstitute/pluto_msk for one example of an integrated modem module design for minimum shift keying.

Open Source Hardware/Software Integration: Creating complete, reproducible communication systems with full design transparency.

Microwave Systems: Development of high-frequency communication solutions for next-generation satellite applications means microwave. The vast majority of our work is microwave or above.

Educational Technology Transfer: Bridging the gap between cutting-edge research and practical amateur radio implementation is our core mission.

2. Previous Work Experience

The volunteers at ORI have extensive experience in all of the areas in the questionnaire.

a) Hardware and Software Development - Extensive Experience
- Complete open source transceiver designs from baseband to RF
- FPGA-based digital signal processing implementations
- Microcontroller and embedded Linux system development
- Multiple payloads in orbit in amateur and commercial settings

b) Transponder Development and Design - Significant Experience
- Phase 4 Ground transponder development and testing (Interlocutor, Postlocutor, and Locutus projects)
- Regenerative transponder architecture design (Haifuraiya project)
- DVB-S2/S2X downlink implementation and optimization
- Opulent Voice uplink protocol implementation and optimization

c) Software Defined Radio (SDR) Systems - Core Expertise
- GNU Radio flowgraph development and optimization
- Custom SDR hardware design and implementation
- Real-time signal processing algorithm development
- Multi-platform SDR software architecture (Linux, Windows, embedded)

d) High Frequency (HF), VHF/UHF, and Microwave RF Design - Advanced Capabilities
- 10 GHz amateur band transverter design and implementation (phae 4 ground)
- 5/10 GHz dual band feed design published, implemented, and tested
- 24 GHz and higher frequency system development
- 10/24 GHz dual band feed design published, implemented, and tested
- Phase-locked loop and frequency synthesis systems experience
- Opulent Voice at VHF/UHF has flown twice with the RockSat-X NASA program.
- High radiation resistance HF antenna design (Dumbbell project)

e) Antenna Design - Comprehensive Experience
- Dish antenna optimization for EVE communications for DSES (photogrammetry for RMS results)
- Phased array antenna system development (Kerberos at 915 MHz, 5 GHz patch)
- Feed horn design for microwave applications (5/10 and 10/24)
- Antenna modeling and simulation using industry-standard tools (Dumbbell project)

f) Launched Satellite Missions - Active Participation
- Successful collaboration with multiple CubeSat missions including ORSAT, CATSAT, and FOX.
- Commercial launched satellite experience by ORI members includes Globalstar, Viasat, L3 Harris, Millenium Space Systems, Velastra and others.
- Technical advisory roles for multiple satellite communication systems since 2019.

g) Ground Stations or Networked Reception Systems
- We have experience with SatNogs and Globalstar Ground Stations.
- We have experience with IS-95, 4G LTE, 5G NTN, and several other networked, mesh, and ad-hoc receiver systems.

h) Link Budget Planning and Simulation Professional Capability
- Advanced link budget modeling software development through MATLAB and Python Jupyter Notebooks.
- Statistical analysis of satellite communication performance achieved by understanding the modeling and simulation environment, and performing those functions through MATLAB and Python Jupyter Notebooks
- Real-world validation and correlation with operational systems has been achieved by ORI volunteers (multiple commercial project experiences, Remote Labs testing, and the ongoing EVE project)

3. Resources and Capabilities ORI Can Contribute

a) Laboratories and Test Facilities: Available through ORI Remote Labs
- Digital signal processing development (FPGA-centric) provided by Remote Lab West (https://github.com/OpenResearchInstitute/documents/tree/master/Remote_Labs)
- Antenna test ranges and measurement facilities are available to us in San Diego, CA through volunteer-provided resources

b) Environmental Testing Facilities: Limited Direct Access
- Collaborative arrangements with local university testing facilities
- Industry partnerships potentially possible for thermal-vacuum testing
- Vibration testing through aerospace industry contacts
- EMC/EMI testing facility access (not free to us, but available at a discount)

c) Ground Stations: In Development
- Ground station design is Interlocutor (https://github.com/OpenResearchInstitute/interlocutor)

d) Hardware and Software Development Tools: Professional-Grade Capabilities
- FPGA development tools (Xilinx Vivado full license, MATLAB full license, zc706, zcu102, PLUTO SDR, SR-1)
- RF simulation software (all MATLAB toolboxes available)
- Software development infrastructure (Remote Lab West CHONC virtual machines provide any OS connected to any test equipment or development platform we have)
- 3D printing and mechanical prototyping capabilities (on-site 3D printers, CNC, Voltera circuit

printer, and lathe)

e) Students and Educational Resources: Academic Partnerships
- University collaborations for student development (University of Puerto Rico)
- Graduate student research projects (Northwestern University, San Diego State University)
- Educational curriculum development (in progress)
- Training workshops and technical conferences (offered throughout the year)

4. Legal Status and Public Presence

a) Legal Status: Registered 501(c)(3) Non-Profit Organization
- California-headquartered charitable organization
- Federal tax-exempt status
- Board of directors governance structure
- Transparent financial reporting and accountability
- Ethical operation is the highest priority and this is ensured through an enforced code of conduct and developer and participant policies that clearly communicate how and why ORI is a safe place to volunteer

b) Public Presence: Comprehensive Digital Presence:
- Website is https://openresearch.institute
- Active Twitter (X), LinkedIn, FaceBook, YouTube channels
- Technical Forums: include GitHub repositories and issue trackers, mailing lists, Slack workspace
- Documentation: Extensive technical and project documentation on GitHub and on the website
- Publications: Regular conference presentations are made. Technical papers generally published through ARRL QEX. At least four articles will be in QEX for 2025. ORI publishes a newsletter roughly monthly called The Inner Circle. Archive available https://www.openresearch.institute/newsletter-subscription/

5. Space Agency Collaboration Experience
- NASA: Advised NASA on open source communications satellite regulatory relief. ORI has repeatedly inquired about opportunities. We applied for two NASA SBIR grants and made the final round for one of them. NASA seems devoted to commercial crew, and has very limited attention for amateur radio in space outside of astronauts on the ISS communicating with students at school-based events.
- Commercial Space: We were heavily involved with the Millennium Space Systems Phase 4B payload development. Many volunteers have professional commercial space backgrounds at a variety of companies.
- International Amateur Satellite Organizations: working with Libre Space Foundation, Open Source Satellites (UK), IARU, JAMSAT, AMSAT-CANADA (defunct), AMSAT-UK and AMSAT-DL have all been very good collaborative experiences.
- Academic Institutions: University research partnerships with space programs at University of Puerto Rico, Portland State University, University of Arizona, and Virginia Tech.

- Industry: Formal technical advisory role at Velastra.

Note: While ORI has not previously worked directly with ESA, our technical leadership has extensive European connections and we actively seek international collaboration opportunities. Our volunteers come from all over the world and our first regulatory task was to certify that open source communications satellite work was free of ITAR and EAR. This was done in order to restore international amateur radio satellite collaboration.

6. Technical, Educational, and Scientific Goals for futureGEO

Primary Technical Objectives

1. Open Source Payload Architecture Development
- Design and implement a fully open source software-defined payload architecture
- Create modular, reconfigurable communication systems that can be updated in-orbit
- Develop standardized APIs enabling third-party application development
- Demonstrate containerized applications running on space-qualified Linux systems

2. Next-Generation Protocol Implementation
- Our goal here would be to offer and optimize Opulent Voice, a modern digital communication protocol, for GEO satellite environments. Opulent Voice delivers high-fidelity voice at 16 kbps with integrated voice, text, control, and data communications using standard Internet protocols (TCP, IP, UDP, RTP). The voice quality is substantially higher than anything in amateur radio at this time.
- Implement adaptive coding and modulation based on real-time link conditions, using machine learning if necessary.
- Create seamless integration between amateur and professional communication standards and advance the radio arts whenever and wherever we can.

3. Ground Segment Democratization
- Design cost-effective, open hardware ground station solutions such as Interlocutor. Interlocutor is deployed on a Raspberry Pi and delivers Opulent Voice protocol frames over Ethernet to an SDR, computer, or any other device that can understand Ethernet. This allows remote operation and the use of a very broad class of modems and computers.
- Require the user interface to be accessible to people with visual, hearing, mobility, and cognitive challenges
- Develop software packages enabling existing amateur equipment to access new payload capabilities
- Implement cloud-based ground station networks for global access (enabled by our Ethernet interface)

Educational Mission Goals

1. STEM Education Enhancement
- Provide remote access to advanced ground stations for personal and professional development through open source work. ORI already provides very similar access to development stations

through Remote Labs. The test benches are available 24 hours a day 7 days a week. When Interlocutor ground stations are added to Remote Labs, then this will indeed provide remote access to a functional ground station.
- We help train the next generation of space communication engineers through the carrying out of frameworks such as developed through the IEEE IWRC process. ORI was a participant in IWRC 2023 and carries forward the aims and purposes of personal and professional development through open source project involvement.

2. Knowledge Transfer and Documentation
- We publish all designs, software, and documentation under open source licenses approved by the Open Source Initiative. All of our work has always been available to the general public at no cost through our GitHub website.
- Continue to create detailed technical tutorials and educational materials. Please see our github and youtube channels for examples.
- Continue to establish mentorship partnerships that connect students with industry professionals
- Continue to document lessons learned for future mission development

Scientific Research Objectives

1. Advanced Communication Research
- Continue to investigate AI/ML applications in satellite communication optimization. Our article on AI/ML RTTY communications receivers will be in QEX soon, and we expect to produce more work in this area. We know how to use machine learning in the radio frequency environment and look for opportunities to demonstrate successfully application of this particular technology.
- Research adaptive beamforming and interference mitigation techniques.
- Study propagation characteristics at millimeter wave frequencies.
- Continue to develop new modulation and coding schemes optimized for satellite channels, such as Opulent Voice.

2. Technology Demonstration
- We believe "it doesn't work until it is shown to be working over the air". This guiding principle is how we carry out our work.
- Prove feasibility of commercial-grade open source space systems.
- Demonstrate cost-effective approaches to advanced satellite payloads.
- Validate open development methodologies for space applications.
- Create reference implementations for future amateur satellite missions.

Long-Term Vision

ORI sees futureGEO as a crucial stepping stone toward a future where advanced satellite digital communication capabilities are accessible to educators, researchers, and amateur radio operators worldwide. Our goal is to help create a sustainable, open ecosystem that continues to evolve and serve the global amateur radio community for decades to come.

ORI is committed to making futureGEO a technical success that demonstrates the power of open source development while advancing the state of the art in amateur satellite communications. We bring unique technical capabilities, educational mission alignment, and a proven track record of delivering complex open source communication systems.

Anshul Makkar, Director ORI
Keith Wheeler, Secretary ORI
Steve Conklin, CFO ORI
Michelle Thompson, CEO ORI
Matthew Wishek, Director ORI

https://www.youtube.com/@OpenResearchInstituteInc


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Matthew Wishek Wins 2025 ARRL Technical Innovation Award

We are thrilled to announce that Matthew Wishek NB0X has been awarded the prestigious 2025 ARRL Technical Innovation Award by the American Radio Relay League (ARRL) Board of Directors. This distinguished honor recognizes licensed radio amateurs who develop and apply new technical ideas or techniques that advance the state of amateur radio technology.

Matthew received this recognition for his innovative contributions to amateur radio digital communications, specifically his development of an open source minimum shift keying (MSK) implementation for software-defined radio.

Matthew's primary achievement centers on his work with the pluto_msk project, a sophisticated MSK modem implementation designed for the Analog Devices ADALM-Pluto SDR platform. This project represents a significant advancement in efficient digital communications for amateur radio, particularly for the Opulent Voice (OPV) digital voice and data protocol.

MSK modulation is a type of continuous phase modulation that eliminates phase discontinuities, resulting in superior spectral efficiency compared to traditional FSK and other binary modulations. Matthew's custom hardware description language (HDL) implementation targeting the AMD Zynq 7010 system on chip, maximizes performance and resource utilization. The design has multiple sophisticated components including numerically controlled oscillators (NCO), Proportional Integral (PI) controllers, power detectors, and exponential moving average filters.

Equally significant is Matthew's pioneering modem module approach to HDL design. This architectural approach makes a large positive difference in how digital signal processing systems are designed and implemented in FPGAs. The modem module approach is the systematic creation of reusable, well-defined building blocks that can be combined for a variety of communication protocols. While many projects and people pay lip service to modularity, Matthew's execution and leadership in this area have supercharged ORI's work.

All components are freely available, fostering collaboration and continued innovation in the amateur radio community

The ARRL Technical Innovation Award recognizes not just technical achievement, but also contributions that benefit the broader amateur radio community. Matthew's work exemplifies both criteria

Matthew's innovations in modular HDL design and MSK implementation provide a solid foundation for future developments in amateur radio digital communications. His work demonstrates how modern software-defined radio platforms can be leveraged to implement sophisticated communication techniques that were previously the domain of commercial and military systems.

The amateur radio community benefits enormously from contributions like Matthew's, which not only advance the technical state of the art but also provide practical, implementable solutions that enhance our communication capabilities.

Congratulations to Matthew Wishek on this well-deserved recognition of his outstanding technical contributions to amateur radio!

The American Radio Relay League (ARRL) is the national association for amateur radio, connecting hams around the U.S. with news, information and resources. The ARRL Technical Innovation Award is presented annually to recognize exceptional technical innovation that advances amateur radio.

Highlights from the New Interlocutor Installation and Operator Manual

A Human Radio Interface for Opulent Voice is ready for you to try out at https://github.com/OpenResearchInstitute/interlocutor

Overview

Interlocutor is the human-radio interface component of the Open Research Institute's Opulent Voice digital communication system. Think of it as the "radio console" that transforms your computing device (such as Raspberry Pi or a laptop) into a sophisticated digital voice and data terminal. While traditional amateur radio digital modes often sacrifice audio quality for bandwidth efficiency, Interlocutor enables very high-quality voice communications with seamless integration of keyboard chat, file transfer, and system control messages.

What Does Interlocutor Do?

Interlocutor provides high-quality digital voice communication using the high-bitrate open source Opus voice encoder. It enables keyboard chat that integrates seamlessly with voice, handles file transfer and system control messages, and offers both command-line and web-based interfaces. Interlocutor manages audio devices with sophisticated conflict resolution and implements priority-based message queuing (voice always wins)

It acts as the bridge between human operators and radio equipment. It processes voice, text, and data into properly formatted frames that can be sent to any Opulent Voice-compatible modem via Ethernet, enabling remote operation and modular system design.

On first run, you'll be prompted to:

1. Select audio input device where you choose your microphone.
2. Test audio input where you speak to verify microphone works.
3. Select audio output device where you choose your speakers/headphones
4. Test audio output where you listen for test tone.

Where to Send Your Frames?

After Interlocutor does all the work required to gather your voice and text input and create Opulent Voice Protocol frames, those frames are then sent to a modem or other program that can make use of them. How does this work? If frames are sent to a modem then it turns the frames into a modulated signal. This signal is then sent out over the air. The current implemented target modem is the PLUTO SDR from Analog Devices.

Or, the frames can go to a computer or conference server over the Internet. In other words, frames can be sent to another computer, a modem for radio transmission, a conference server (repeater) receiver, and more. If it has an IP address, and if it understands what to do with the frames, then you are ready to communicate.

The Basics of Running Interlocutor

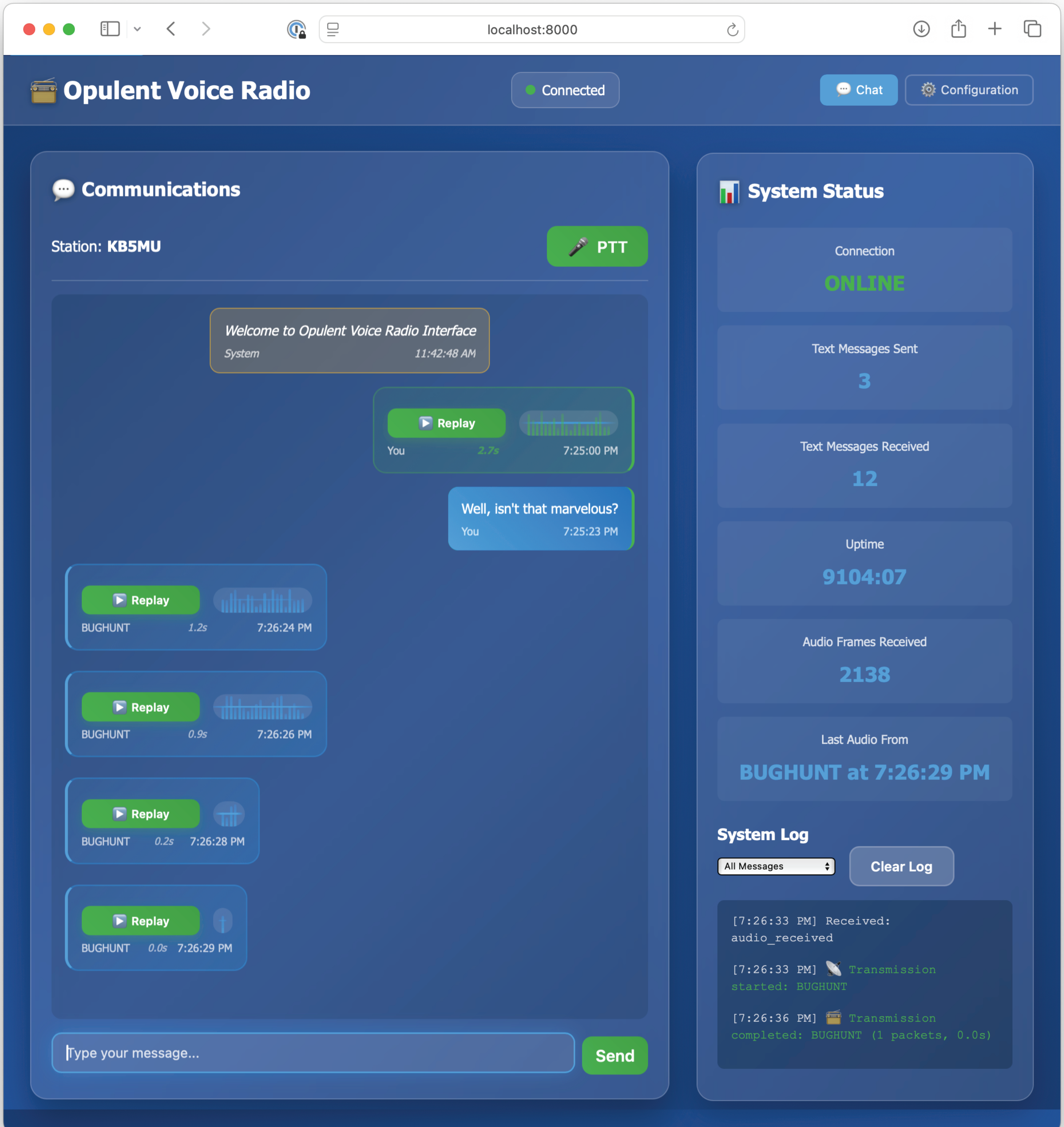
See the online manual for detailed installation instructions.

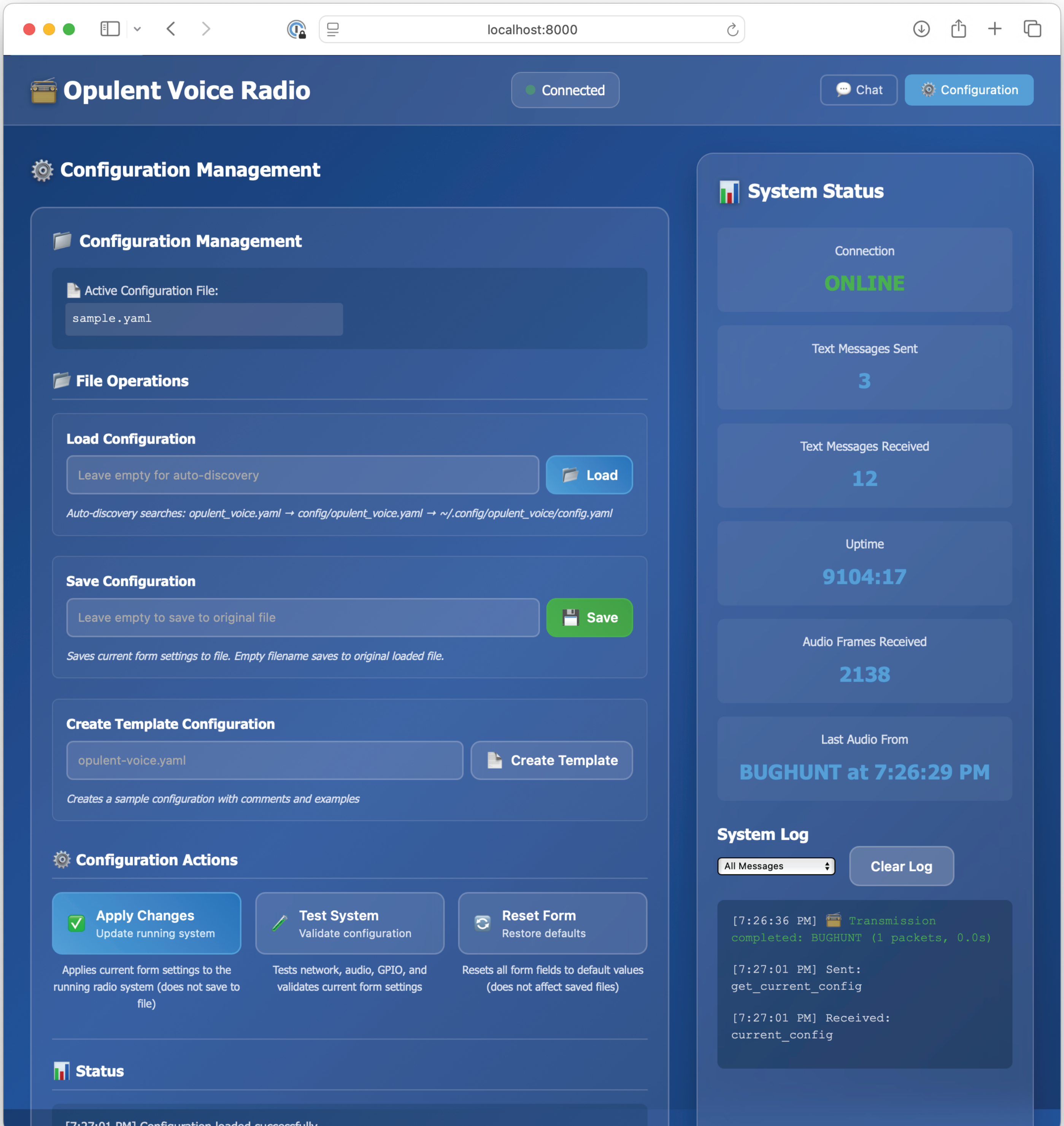
```
# Launch with web interface
python3 interlocutor.py YOUR_CALLSIGN --web-interface

# Launch with a specific config file
python3 interlocutor.py YOUR_CALLSIGN -c myconfig.yaml --web-interface
```

You'll need to configure network targets to tell Interlocutor where your Opulent Voice data frames need to be sent. Modify the network target configuration through the web interface in the Target IP Address box or use the command-line argument like this:

`-i <IP address>`

as needed.


localhost:8000
Opulent Voice Radio
Connected
Chat
Configuration
Communications
Station: KB5MU
PTT
Welcome to Opulent Voice Radio Interface
System
11:42:48 AM
Replay
You
2.7s
7:25:00 PM
Well, isn't that marvelous?
You
7:25:23 PM
Replay
BUGHUNT
1.2s
7:26:24 PM
Replay
BUGHUNT
0.9s
7:26:26 PM
Replay
BUGHUNT
0.2s
7:26:28 PM
Replay
BUGHUNT
0.0s
7:26:29 PM
Type your message...
Send
System Status
Connection
ONLINE
Text Messages Sent
3
Text Messages Received
12
Uptime
9104:07
Audio Frames Received
2138
Last Audio From
BUGHUNT at 7:26:29 PM
System Log
All Messages
Clear Log
[7:26:33 PM] Received: audio_received
[7:26:33 PM] Transmission started: BUGHUNT
[7:26:36 PM] Transmission completed: BUGHUNT (1 packets, 0.0s)


localhost:8000
Opulent Voice Radio
Connected
Chat
Configuration
Configuration Management
Configuration Management
Active Configuration File:
sample.yaml
File Operations
Load Configuration
Leave empty for auto-discovery
Load
Auto-discovery searches: opulent_voice.yaml → config/opulent_voice.yaml → ~/.config/opulent_voice/config.yaml
Save Configuration
Leave empty to save to original file
Save
Saves current form settings to file. Empty filename saves to original loaded file.
Create Template Configuration
opulent-voice.yaml
Create Template
Creates a sample configuration with comments and examples
Configuration Actions
Apply Changes
Update running system
Test System
Validate configuration
Reset Form
Restore defaults
Applies current form settings to the running radio system (does not save to file)
Tests network, audio, GPIO, and validates current form settings
Resets all form fields to default values (does not affect saved files)
Status
[7:27:01 PM] Configuration loaded successfully
System Status
Connection
ONLINE
Text Messages Sent
3
Text Messages Received
12
Uptime
9104:17
Audio Frames Received
2138
Last Audio From
BUGHUNT at 7:26:29 PM
System Log
All Messages
Clear Log
[7:26:36 PM] Transmission completed: BUGHUNT (1 packets, 0.0s)
[7:27:01 PM] Sent: get_current_config
[7:27:01 PM] Received: current_config

The web interface is available at http://localhost:8000 on the device running interlocutor.py.

Interlocutor features a modern glassmorphism-styled web interface for operation and complete system configuration. All configuration items are available at the command line or in the web interface.

The purpose of the Configuration System is to create, validate, and save one or more configuration files so that an operator can start the radio in a fully defined state.

Operational Modes

First, let's talk about the command line interface (CLI) mode. This offers traditional terminal-based operation with full keyboard chat capabilities.

The simplest way to invoke this mode is by typing:

```
python3 interlocutor.py YOUR_
CALLSIGN
```

In CLI mode, real-time voice transmission is done with a hardware PTT button. There is a keyboard chat interface. Voice has priority, with control messages second highest priority, and keyboard chat third. Debug output and system status are shown as text on the screen.

Second, let's explore the web interface mode. The web interface is a modern browser-based interface with visual controls.

It is invoked by adding the --web-interface argument to program start.

```
python3 interlocutor.py YOUR_
CALLSIGN --web-interface
```

We find a detailed configuration management in Configuration tab, live status indicators, and real-time voice transmission with PTT control available in three different ways. First, as a hardware switch on designated GPIOs. Second, as a clickable button in the web interface. Third, the space bar when the message entry box does not have focus. Web interface has keyboard chat and shows system log, notifications for important events, debug output, and system status. Sent and received audio can be replayed from the message history window.

Dual-Mode Operation

Both interfaces can run simultaneously, providing flexibility for different operational scenarios or preferences. There are instant updates between command line and web interfaces via WebSocket communication.

Protocol and Network Configuration

Interlocutor implements the Opulent Voice protocol with sophisticated frame management. Here are the frame types and priorities.

1. VOICE (Priority 1): Opus-encoded audio, immediate transmission
2. CONTROL (Priority 2): PTT state changes, high priority queue, A5 messages
3. TEXT (Priority 3): Keyboard chat, normal priority queue
4. DATA (Priority 4): File transfers, low priority queue

External Network Ports:
57372: Network Transmitter port (configurable, connects to radio hardware, computer, or repeater). This is the only port you have to configure.

Internal Protocol Ports:
57373: Audio frames
57374: Text frames
57375: Control frames

These ports tell the receiver what kind of information it's receiving. These ports are in the UDP header in each Opulent Voice frame. The protocol is extendable. Future data types get the next port available.

All frames follow the Opulent Voice protocol format.

Opulent Voice Header: 12 bytes (sync word + station ID + type + sequence + length + reserved)
Payload: 122 bytes of data loaded up in 40 ms frames
Encoding: COBS (Consistent Overhead Byte Stuffing) framing
Transport: UDP over IP with RTP headers for audio, UDP over IP for control, text, and data

Network Integration

```
# Basic operation (connects to default target with default values)
python3 interlocutor.py YOUR_CALLSIGN

# Specify target IP and port
python3 interlocutor.py YOUR_CALLSIGN --target-ip 192.168.1.100 --target-port 57372

# Load specific configuration file
python3 interlocutor.py YOUR_CALLSIGN -c mystation.yaml
```

Audio System Operation

Push-to-Talk (PTT) Operation:
GPIO Button: Physical button connected to Raspberry Pi GPIO
Web PTT: Additional click/touch controls in web interface. There's a PTT button and the space bar activates PTT when the message entry box is not highlighted (does not have focus).

Audio Processing Pipeline:
1. Microphone input to PyAudio capture
2. Audio validation
3. Opus encoding (40ms frames, 16,000 bps bitrate)
4. Hardware audio callback
5. RTP header addition
6. UDP header addition
7. IP header addition
8. COBS encoding
9. Opulent Voice header addition
10. Network transmission

Chat Integration

Voice transmission has absolute priority. Text messages typed during PTT are buffered. Buffered messages transmit immediately when PTT releases. Control messages maintain high priority for system functions

Chat Modes:
Voice + Chat: Normal operation with seamless integration. Operators can choose voice or text as appropriate. This is the default mode.
Chat Only Mode: Keyboard-to-keyboard communication (similar to RTTY). This is set up with a command line argument
`--chat-only`

Automatic Reconnection System

Interlocutor implements intelligent reconnection logic for the web interface.

Reconnection Timing is as follows.
1. First retry: 1 second delay
2. Subsequent retries: Exponential backoff (1.5x increase)
3. Maximum delay: 30 seconds
4. Maximum attempts: 10 attempts
5. Total auto-retry time: 2-3 minutes

A manual retry button appears after auto-retry exhaustion.

Documentation Resources
Project repository: https://github.com/OpenResearchInstitute/interlocutor
Open Research Institute: https://www.openresearch.institute/getting-started
GitHub Issues for bug reports

Code contributions welcome via GitHub pull requests and filing issues. Documentation improvements welcome and encouraged. Testing and feedback valuable for development. Hardware testing on different platforms welcome and encouraged!

The system is actively developed open-source software, and features will evolve.

But Wait, There's More

Opulent Voice Demonstration Conference Server Beta Test Now Open

This project is called Locus, and the repository link, with manual and installation instructions, can be found here:

https://github.com/OpenResearchInstitute/locus

Key components of a fully implemented conference server (Opulent Voice repeater) are outlined below.

1. FDMA Uplink Channels Received at Spacecraft or Terrestrial Repeater
Multiple receivers monitoring different frequency slots simultaneously, each capable of demodulating and decoding the Opulent Voice protocol.
2. Conference Management Hardware and Software
This manages how stations can connect with other stations by maintaining lists of rooms or conferences. Conferences are logical groupings of stations.
3. DVB-S2 Downlink Multiplexer
This component takes all the conference data and creates a single high-bandwidth downlink stream.

Software modifications to Interlocutor, the human-radio interface for Opulent Voice stations, have been made in order to realize a simple repeater system. The Interlocutor repository can be found here:

https://github.com/OpenResearchInstitute/interlocutor

By targeting the IP address of opulent.openresearch.institute, anyone running Interlocutor can participate on ORI's demonstration conference repeater. This repeater is internet-only at the moment, but will have RF hardware in the next phase of work.

To configure Interlocutor for the conference server, here is an example invocation.

```
python3 interlocutor.py QUARTER --web-interface  -i 172.236.237.16
```

This sets up a station with ID QUARTER, running a web interface at 127.0.0.1:8000, and sends frames to opulent.openresearch.institute.

The next phase of work is to set up named conference rooms so that people can join based on event, subject matter, scheduled meetups, and other searchable categories. There will be a Conferences tab in the Interlocutor web interface that will populate whenever conferences metadata is received.

Key Features Unlocked in this Next Phase

Multiple simultaneous conversations are possible. Instead of traditional “one-at-a-time” repeater operation, users will have multiple conferences running simultaneously. A local weather net, an emergency coordinator channel, and a tech Q&A room are all active at once. Each of the voice transmissions and chat messages appear in the message history window of Interlocutor. The voice transmissions and chat messages are filtered by the receiving station based on the conferences from which the transmissions originated from.

Operators will browse active conferences and see things like participant counts, last activity, and have the ability to freely monitor any conferences.

Conference participation is straightforward. Operators have their station join a conference by transmitting in one. At that point, the station ID appears in the conference membership list. Before transmission to a Conference, the station ID would not appear in the list.

Conference lists are kept clean. Over time, a station ID that has joined a conference expires and is dropped off the list of stations in the conference. This is done after some configurable period of inactivity. The default in Locus is one hour. Conferences themselves, without active transmissions, can expire after some amount of time as well. This “time out” process emphasizes active conferences, reducing the amount of “empty rooms” that an operator would have to search through to find someone to communicate with.

Technical Implementation Strategy

Within Interlocutor, current conference server operation is essentially the same as if it was connecting directly to another station. If the target IP address is a conference server, then voice and text appear in the message history from all the stations that are transmitting. The Locus demonstration station at ORI simply forwards frames received. It has essentially one conference. This will change in the next phase. Current work is to continuously improve performance and user experience with the basic functions. Adding additional conference functions will follow shortly.

For this next phase, Interlocutor will have a third Conference Tab in the web interface. This will allow conference discovery and enable full participation. The banner on the Communications Tab will change to show when a server is connected, as opposed to a single directly connected station. This will be unobtrusive but clear.

We need to implement the frequency division multiple access (FDMA) receiver that manages multiple frequency slots on the uplink, and build the DVB-S2 Multiplexer for the downlink aggregation. Hardware for our open source HEO/GEO satellite project Haifuraiya has been demonstrated in the past, and these designs will be used for this project as well.

Discoverability Improves Engagement

In order to take advantage of the conference functions, individual stations use the Interlocutor program in essentially the same way as they would in a point-to-point contact. A fully implemented conference server will broadcast messages to be detected by Interlocutor receiver. These broadcasts list the conferences and the participants. Then, the web interface populates with the available conferences and exposes the controls for starting a new conference, joining an existing conference, or monitoring any conference. Operators join conferences by participating with a transmission. The repeater handles the complexity. The broadcast will be sent at the lowest priority level (data), as to not interfere with voice, text, or control frames.

The concept of conferences is central to the repeater experience. People playing a D&D game over the air would be in a game conference. That conference might be called “The Elven Empire”. People coming and going during drive time might join “I-15 Rollout”. An individual calling another individual for a one-on-one QSO would be in a conference too, which might be called “Ken’s Coffee Break” or “Everyone Welcome”.

Conferences become the fundamental organizing principle. This organizing principal shifts amateur radio from “everyone talks to everyone on one frequency” to “purposeful gatherings with context and discoverability.”

Traditional repeaters are like having one conference room where everyone shows up, takes turns to talk, and if you miss a transmission then that is just too bad. You missed it.

A conference-based system creates purposeful spaces. The D&D group doesn’t interfere with the emergency coordinators, and both can run simultaneously. If you missed a message, you can scroll up in the message history window. You can replay past audio transmissions from the UI Audio Bubbles or read the past chat message history. Both are in the message history window. Empty conferences time out and are removed, so that it doesn't look like a ghost town or give a false sense of activity.

Instead of “I hope someone interesting is on the repeater,” users can browse conferences in the past, present, and future. A list of past conferences, out to some point in the past, can be maintained to show the frequency and type of activity. Any conference can be monitored. Current conferences are joined by transmitting in the conference. Future conferences can be listed in a schedule. This is like the difference between wandering into a random tavern hoping for good company versus checking a bulletin board that says “Adventuring Party Seeking Ranger Meet by the Old Oak” or “Storytelling by the Fire in the Great Hall.” This type of radio experience has natural social dynamics.

An operator can make a casual discovery and meet new friend.

“Oh, there’s a Python programming discussion with 4 people - that sounds interesting!”

Operators can make and advertise planned events.

“Tech Book Club session every Tuesday at 7 PM - join us!

Emergency coordination can be greatly improved. Operators can quickly and easily create dedicated emergency conferences during disasters. With authentication and authorization functions, these conferences can be limited to people that have, for example, completed specific training. A system like this can provide realistic emergency training opportunities that do not interfere with normal operation. Mentoring conferences can be set up to provide friendly and welcoming alternatives for education and learning.

The conference server manages conference data. A goal is to keep this to the minimal required state. The conference server doesn’t decide who can listen to what, unless there is an authentication and authorization policy in place from the repeater owner.

Opulent Voice naturally scales up. Here are some anticipated use cases.

Simple Point-to-Point: Two or more people communicating point-to-point create the equivalent of a single conference. Whether the station is operating point-to-point or in a conference at a repeater, the program behaves almost identically. The only difference on the Communications tab is the heading color and title.

Local Repeater: Multiple conferences on one repeater system that is running a conference server.

Regional Network: Conferences can span multiple repeaters.

Satellite Integration: HEO satellites carry conference multiplexes to different continents

Internet Bridging: Conferences can include remote participants via internet gateways

The conference concept transforms amateur radio from “broadcast to everyone in range” to “purposeful communities of interest.” Conference discovery/joining is a different mental mode than active communication. Therefore, it gets a separate tab in the Interlocutor web interface. Three-tab architecture has the following structure.

Tab 1: Communications "I'm having a conversation"
We keep the current design
We use current message history and audio playback
Active conference indicator at the top: “Currently in: Morning Coffee Chat (4 people)”
Quick leave/switch button - minimal, non-intrusive
Focus stays on the actual conversations

Tab 2: Conferences "I'm choosing who to talk to"
New design to be implemented in the very near future
Conference browser and discovery
Create new conferences
Join/schedule conferences
Personal conference history and favorites
Block lists

Tab 3: Configuration "I'm setting up my radio"
We keep the current design
Configuration Tab moves from position 2 to position 3
New conference configuration items
Radio and system settings

This creates a clear progression in the operator’s mind:
1) “I want to join a conversation” Check conference server status
2) If connected browse and join conferences
3) If no conferences appeal then “I can still talk directly to someone”

The central idea behind the conference tab is the transition experience: User browses conferences, finds “Python Coding Discussion (3 people)“, clicks join, gets smoothly transitioned back to their familiar communications interface, but now they’re talking with Python enthusiasts instead of whoever happened to be on the repeater. Conference Servers feel like choosing your conversation rather than hoping for a good one.

Expect conference functionality to increase at the internet demonstration station over the next few months.

The Inner Circle
Sphere of Activity

If you know of an event that would welcome ORI, please let your favorite board member know at our hello at openresearch dot institute email address.

5 August 2025 - Final Technological Advisory Council meeting at the US Federal Communications Commission (FCC) in Washington, DC. The current charter concludes 5 September 2025.

7-10 August 2025 - DEFCON 33 in Las Vegas, Nevada, USA. ORI plans an Open Source Digital Radio exhibit in RF Village, which is hosted by Radio Frequency Hackers Sanctuary.

10 August 2025 - Submission deadline for Open Source Cubesat Workshop, to be held 25–26 October 2025. Location is Serafio of the Municipality of Athens, Greece. Submission status !!!AI

1 September 2025 Our Complex Modulation Math article will be published in ARRL's QEX magazine in the September/October issue.

5 September 2025 - Charter for the current Technological Advisory Council of the US Federal Communications Commission concludes.

19-21 September 2025 - ESA and AMSAT-DL workshop in Bochum, Germany.

25-26 October 2025 - Open Source Cubesat Workshop, Athens, Greece.

Thank you to all who support our work! We certainly couldn't do it without you.

Anshul Makkar, Director ORI
Frank Brickle, Director ORI (SK)
Keith Wheeler, Secretary ORI
Steve Conklin, CFO ORI
Michelle Thompson, CEO ORI
Matthew Wishek, Director ORI