

SAILINK

Bridging the hearts across the waves

ComFix 24'

Stage 2

By **ComKos**

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A Problem at the Sea

Sailors, particularly fishermen, often face challenges in maintaining communication with their loved ones while at sea. Existing communication solutions are predominantly high-tech and expensive, making them inaccessible to many local fishermen.

The current lack of affordable and efficient communication options poses significant obstacles for fishermen who need to stay connected with their families and seek assistance during emergencies. While some technological solutions exist, they remain out of reach because of many reasons like cost constraints.

Probable Solutions

1. **Satellite-Based VoIP Communication Systems**

(Ex: StarLink) - The SL Navy is currently considering a satellite communication system for boats. However, this comes with a large initial and recurring cost.

SAILINK - cost-effective

2. **HF communication**

Acquiring and establishing a private ground station by a sailor is virtually impossible given the cost and the legislative requirements. And also if we try to use a new channel they have to buy new hardware.

SAILINK - does use the existing hardware.

3. **Blue Tracker**

BlueTracker is a hardware solution that was given to fishing boats by the Sri Lankan government, SL Navy and Fisheries. It is supposed to track every fishing boat currently on the sea. Fishing boats cannot go fishing without this device on their boats.



This device is capable of providing a platform for a text-based communication system.

SAILINK - Doesn't need any special mobile application to be installed on the receiver's end. Can send normal SMS messages.

- capable of voice communication

4. **SAILINK**

The all-in-one, optimal solution.

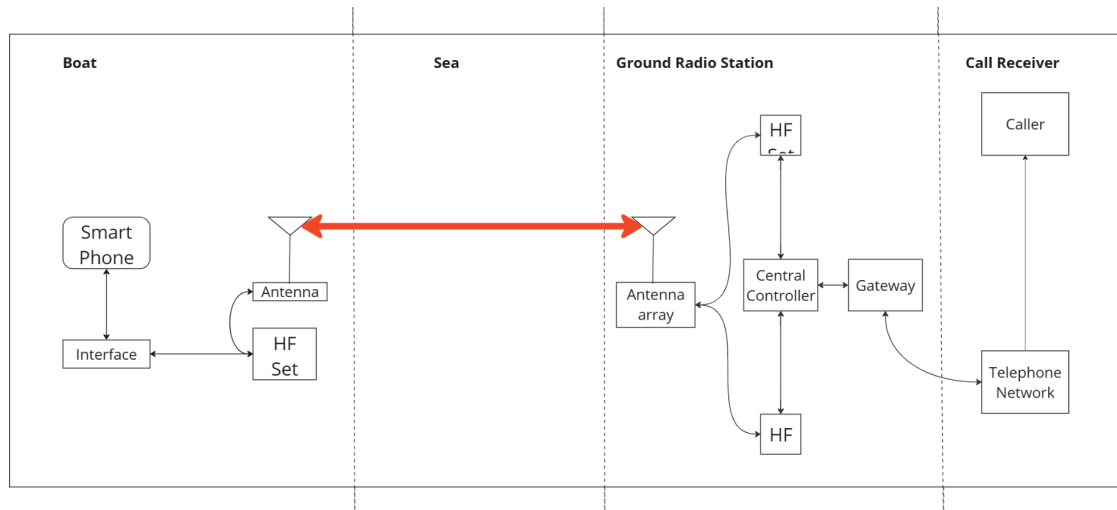
Our Solution

We propose a solution with a telephone router (gateway) at each ground station around the nation along with a mobile application for the sailors to interface with our system. The proposed solution uses the existing communication hardware already present in the boats. The basic process of the call is as follows.

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How does it work?



1. The sailor initiates a phone call by dialing a desired telephone number on their smartphone application.
2. The audio signal from the smartphone is modulated for transmission and sent via a High Frequency (HF) antenna on the boat. (Phase 1. Additional middleware between the HF System and Mobile app will be required for additional features.)
3. The modulated signal is transmitted from the boat's HF set to a ground station.
4. At the ground station, the signal is demodulated and transferred into the telephone network.
5. The call is routed through the telephone network to the intended recipient's phone number, connecting the caller and the receiver.

This will be executed under four main phases. Currently, we focus on implementing phase one which directly addresses the problem statement and is of utmost significance for the sailors. Subsequent phases will implement more features to improve the quality of service, user experience, ease of use, and security features for improved privacy and optimizations. Execution plans and order may vary in phases 2-4 as our main focus is on phase 1. The four phases are as follows,

- Phase 1.1 - Gateway for telephone lines from the ground tower and Smartphone App
- Phase 1.2 - Secure SMS Gateway
- Phase 1.3 - Handling Multiple calls in one ground station
- Phase 2 - Smartphone Interface to HF Set on the boat
- Phase 3 - Digital Communication Scheme + Encryption

Phase 1.1

This phase will successfully demonstrate a system that will facilitate a single call from the boat to the receiver.

The sailor will begin by connecting a smartphone to the HF (High Frequency) set onboard the boat. They will tune the HF set to the nearest calling ground station frequency. Using a designated app on the smartphone, the sailor will initiate the call by sending a predefined analog audio signature to the HF set, which will then transmit it to the ground station.

The ground station will assess the availability of the calling channels. If the channel is free, the ground station will signal back to the boat. The sailor can then tune the HF set to the designated calling channel and proceed to dial the desired number.

Subsequently, the call will be established through the ground station to the intended receiver

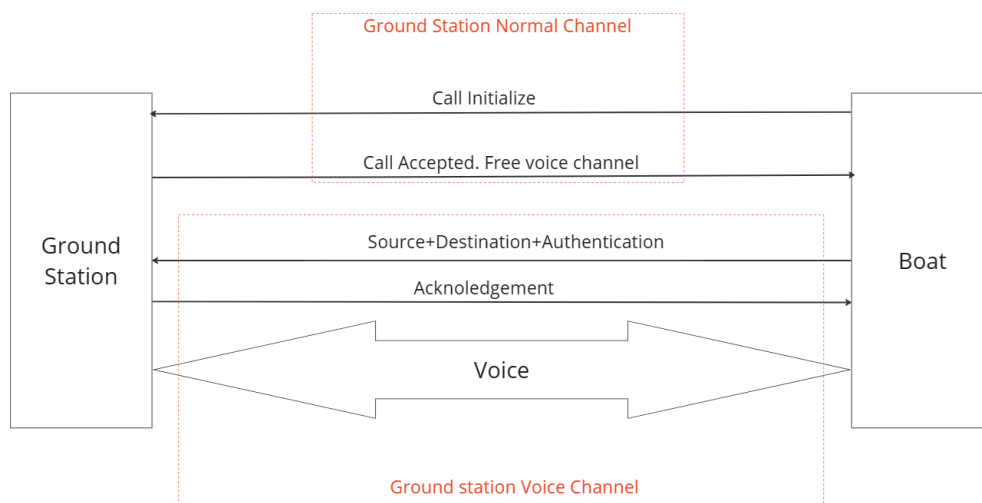


Diagram A - HF Channels and their data

Supportive information will be encoded into the audio signal using predefined tones. (ex-Dialing tones for numbers)



Diagram B - IC-M710 HF Set
Boats in Sri Lanka normally use IC-M710

- Call initialization
 - Signal the ground station that a call needs to be initiated.
- Call accepted.
 - The ground station will accept the call if a voice channel is free and send the voice channel data back to the boat
- SDA(Source Destination Authentication)
 - Then the boat will transfer to the free voice channel and send Destination mobile number and other necessary details for authentication encoded into the analog signal.
- ACK
 - Then the ground station will initiate the call and send an ACK to the boat.
- Voice.
 - Then the voice call will be established between the sailor and the recipient via the ground station.

Working Principle

Router State Diagram

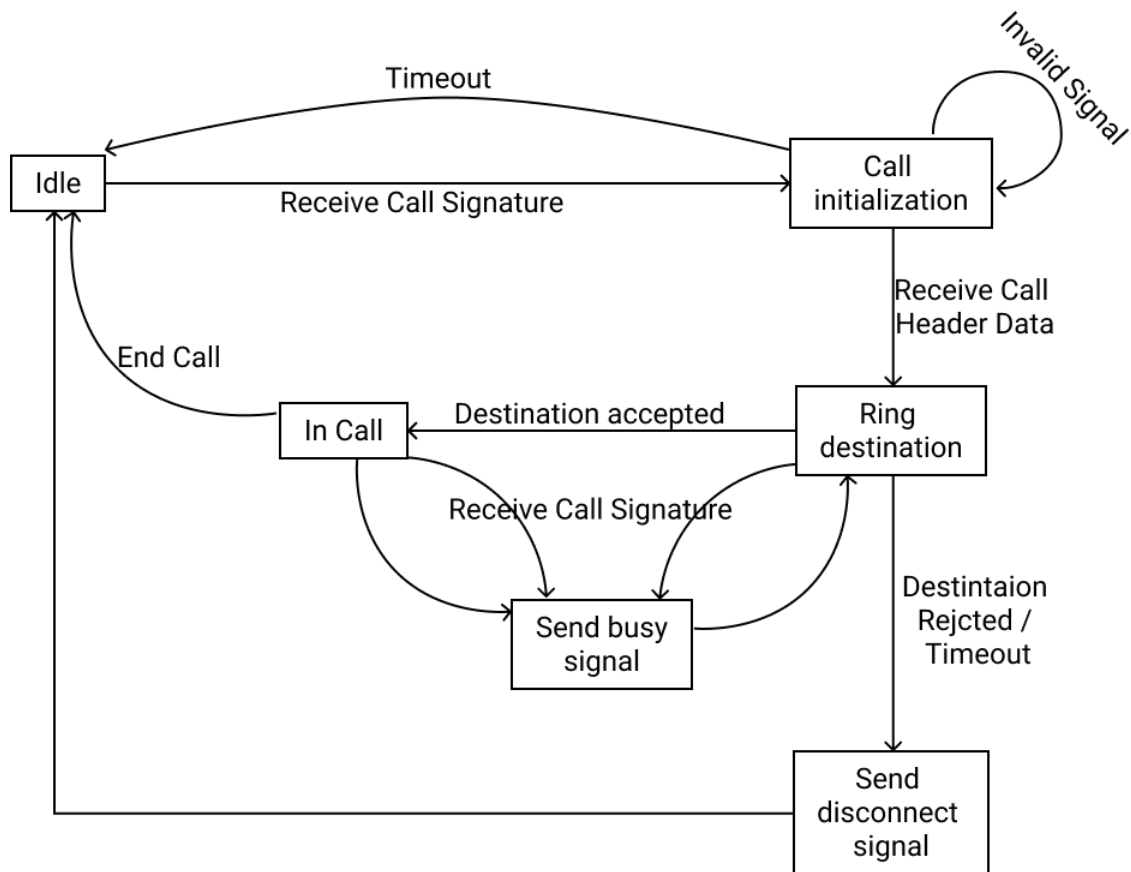


Diagram C - Router state diagram

Mobile App State Diagram

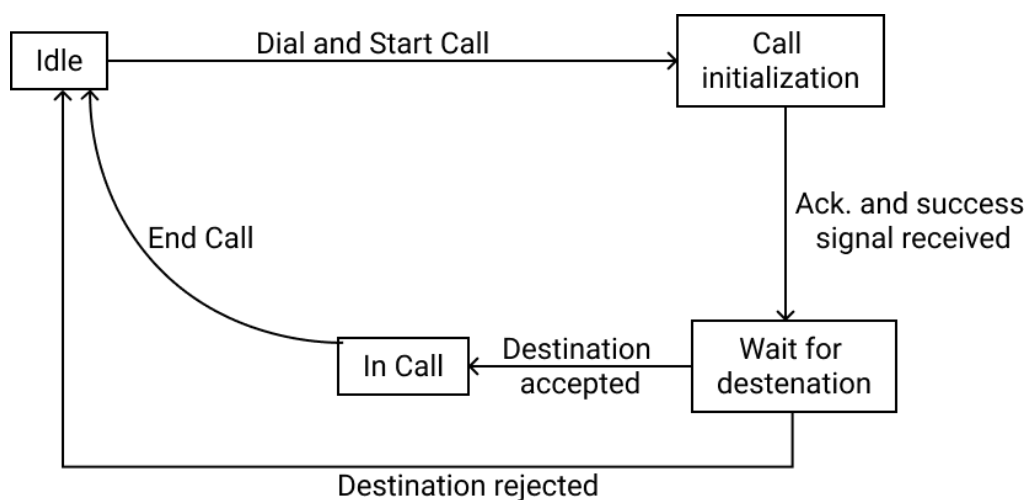


Diagram D - Mobile application state diagram

- The router is connected in parallel with the existing set at the ground station. During normal operation, the router is in its idle state and has no effect on the normal workflow at the ground station. However, the router is listening for a signature (sent from the mobile app) to identify the initiation of a call.
- Upon receiving a call initiation signature from a boat the router sends an acknowledgement along with a success message. In this State, the router waits for the initiator to send the header data which contains the receiver's mobile number, the sender's mobile number, and other information.
- Then the router initiates a call to the receiver through the normal telephone network and waits for the receiver to accept. If the receiver rejects the system goes back to the idle state. Upon successful acceptance by the receiver. The router relays the voice signals between the two ends.
- When in this state if another boat initiates a call the router sends a busy signal which will reject the call from the second boat continuing the previous call.
- Calls may be time-limited as the channel is in high demand, hence calls may disconnect after a warning signal.
- Ending the call takes the whole system back to the idle state.

Phase 1.2

This also uses the infrastructure for the voice call and the SMS data will be encoded into the audio wave and will be transmitted as voice. The voice channel will have minor disturbances while an SMS is sent. However, this is much more effective than voice calls since text sequence requires minimum up time on the channel.

Phase 1.3

This upcoming phase will involve the deployment of additional voice channels, thereby enabling an increase in the number of concurrent calls per ground tower. The integration of this phase into the current system will be executed seamlessly, ensuring continuity and compatibility with existing infrastructure.

Phase 2

In prior phases, sailors had to manually tune to specific channels to initiate and sustain calls. The upcoming implementation of phase 3 will notably enhance this process through the integration of HF Radio Set controls with smartphones. The tuning process will be done automatically in both call initialization and continuing processes. This integration will streamline communication procedures, enabling sailors to efficiently manage and initiate calls directly from their smartphones. By eliminating the requirement for manual channel tuning, this advancement is expected to significantly enhance the efficiency and speed of communication operations onboard.

Also, this phase will enable automatic control of transmission power hence enabling the usage of more channels.

Phase 3

The implementation of digital communication methodologies within the system will enable high-speed data transmission and incorporate encryption schemes to enhance user privacy and security in phase 4. This adaptation will leverage modern digital technologies to facilitate rapid and secure communication, ensuring the confidentiality and integrity of user data during transmission.

Feasibility Analysis

Development and Technical Feasibility

This project uses the existing hardware infrastructure thus most of the analog communication is already handled. Most of the fishing boats in Sri Lanka use the IC-M710 HF set. Furthermore all (according to our research) HF sets have additional audio inputs which we can directly connect to a smartphone's 3.5mm AUX port. Hence, the development of the boat communication system is mostly on the mobile application at least for Phase 1, which is very much feasible with the expertise of our team.

On the other end, developing the router at the ground station may pose some challenges. However, we hope to overcome them by seeking assistance from industry experts such as university lecturers and navy technical officers (we are already working with the Sri Lanka Navy regarding technical details).

Economic Feasibility

We aren't able to have a good estimate on the budget for the router at this early stage. However, it is required only for 17 ground stations around the country and will be used by thousands of boats.

The fact that we use the existing HF sets in the boats along with a mobile application (In Phase 1), sailors need to buy only one AUX cable per boat. Which will cost around Rs 250. This one-time cost is extremely bearable given the great benefits they get out of it. SMS and audio calls may cost slightly above the normal rate, again which outweighs the benefits of the system.

Challenges

Phase 1

- Eavesdropping Vulnerability:
 - During the initial transmission phase, communications are susceptible to interception or eavesdropping.
- Limited Concurrent Calls:
 - The capacity for simultaneous calls is constrained due to channel availability.
- Poor Voice Quality:
 - Voice clarity over maritime radio communications is often compromised by factors such as distance, atmospheric conditions, and radio equipment quality.
- Bandwidth Constraints:
 - Bandwidth is a finite resource in maritime radio communications, necessitating efficient management to prevent interference and ensure reliable communication.
- Regulatory Compliance:
 - Maritime communication operates within regulated frequency bands, requiring obtaining necessary licenses and permissions from relevant authorities

It is important to note that despite the above problems Phase 1 itself is a significant improvement on the current system that is worthy of implementing without additions from Phases 2-4. However, these problems will be addressed in phases 2-4. (Currently, the only way sailors contact their home in an emergency is by requesting the officer at the ground station to get their family member to the station to talk with them which poses all of the above problems despite all the inconveniences.)

- Limited Technical Expertise:

- The specialized knowledge required for maritime communication systems, encompassing radio frequency (RF) propagation, and regulatory compliance, is not widely available.

Phases 2-4

- Risk of Misuse with Encrypted Media
 - The Encrypted medium of communication can be misused by criminals.

References

- We had meetings with the Sri Lanka Navy and gathered many useful insights and technical details.
- [Introducing the IC-M510 VHF/DSC Marine Radio with Smartphone Control - YBW](#)
- Blue Traker - [BlueTraker](#)

*“Love's message, whispered on the breeze,
travels far over the sea to reach your waiting heart”*