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Rogue QD

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1 Project Overview

The RogueQD project aims to supply a simple, clear, and efficient way for naval entities to communicate between one another. By utilizing ITU bands 4 through 6, and covering a frequency domain of 3 - 3,000 KHz, the RogueQD projects sends and receives messages between boats and naval weather buoys. Utilizing both satellite and VLF/LF/MF radio communication, a wide variety of signals can be sent. The RogueQD project also simulates error in message relay between naval entities.

Boats navigating the oceans will be able to use the RogueQD project to:

- Get accurate weather data.
- Send and respond to SOS distress calls.
- Determine its exact location via communication with GPS-equipped buoys.

2 Assumptions

1. Boats have AM radio transceivers that can transmit and listen along the 3 - 3,000 KHz band.
2. Weather buoys in the sea are equipped with a transceiver at least as capable as the one the boats are equipped with.
3. Weather buoys are also equipped with a SCU (Satellite Communications Unit), enabling a GPS unit and centralized relay.
4. Along the selected frequency domain band, a signal sent should always be received correctly if sent from within 250 km.
5. Buoys are equipped with weather tracking sensors.
6. Buoys cannot move.
7. Boats can move.

3 Technical Details

3.1 Technologies and Infrastructure

The RogueQD project is written in Java - a cross-platform and system-compatible programming language. Java is used heavily in computer systems around the world, and is arguably the world's most used programming language. Java can run on Windows, MacOS, Linux, and even *BSD systems!

The RogueQD project has taken on an OO (Object Oriented) approach, in order to simplify the architectural structure of the software system. This kind of methodology is particularly useful when modeling real-world entities, as the RogueQD project aims to do.

The project used a private repository on GitHub to keep track of the source code. The technology used here is Git - a world-renown system that sees much use in industry.

For compilation and testing, the Java 1.8.0_91 compiler was used, along with a custom makefile for automating compilation process.

This document was generated using LaTeX, a universal markup definition for cross-platform document creation. LaTeX utilizes a variety of packages to enable different features, such as indentation, colors, diagrams, and mathematical notation. A list of used packages is supplied in the appendix.

4 Internal States

4.1 Basic Technical Overview

The communication between boats and buoys are the primary function of the system. The frequency band 3 - 3,000 KHz must be shared between all open communication channels.

Boats communicate with one another along the 150 - 250 KHz range. Buoys communicate with one another along the 3 - 100 KHz range. Distress (SOS) signals are propagated along the 500 KHz frequency.

4.2 Definitions and Constants

We define the band 3 - 3,000 KHz as f_T.

We define Δ as a buoy, and Δ_i as the i^{th} buoy in the system. The system can handle I buoys. We define f_{Δ_i} as the frequency domain of the i^{th} buoy.

$$f_{\Delta^*} = \bigcup_{i=0}^{I-1} f_{\Delta_i}$$

Every buoy transmits and receives on its designated frequency, f_{Δ_i}. Every buoy also transmits and receives on 500 KHz, the distress call frequency.

Boats can listen and transmit at any frequency (i.e. in f_T).

Some constants are defined below, used in mathematical formulas later on:

$c = 188$

$\sigma = 0.3$

4.3 Full Technical Overview

A buoy Δ_i collects weather data M_ω and sends it on f_{Δ_i}. This is a periodic activity. Boats can listen in on this report and acquire M_ω.

Boats can send a distress signal on 500 KHz. All buoys that receive the signal send a satellite message M_{sos} to the centralized satellite via their SCU. The satellite then relays M_{sos} to all buoys. At this point all buoys broadcast M_{sos} on f_{Δ_i}. This process ensures that anyone listening to a buoy will receive notification of the SOS distress call.

A specific band is designated for boat-to-boat communications, that is 150 to 250 KHz. On this band there are no buoy interjections. Boats that have planned their journey can agree to speak on a certain frequency without fear of a buoy overlapping with their broadcast.

There are two important factors to consider when determining whether or not a signal is received or not:

- Distance
- Frequency delta

The farther away a receiver is, the less likely it is that the message will reach. Also, if the listening frequency differs from the bradcast frequency, chances are slim that the message will be caught.

The probability of a message M reaching its recipient can be modeled by:

$$p(M) = \frac{cS_bS_re^{(\frac{-(f_b-f_r)^2}{2\sigma^2})}}{\sqrt{d2\pi\sigma^2}}$$

Where S_b is the signal broadcast strength, S_r is the signal reception strength, f_b is the broadcast frequency, f_r is the reception frequency, and d is the distance in km.

The equation returns a number greater than 0.

- A result that is very close to 0 indicates that the message did not send.
- A result that is 1 or larger indicates that the message was sent with complete success.
- A result between 0 and 1 indicated that the message was sent, but not entirely successfully. The closer the number is to 1, the better the message quality.

Messages that sent with a $p(M)$ between 0 and 1 are scrambled and confused. They may contain static, cut out, or otherwise be damaged.

The equation represents the mathematical model for normal distribution, with some alterations.