Engineering Notebook
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Senior Design - Autonomous Vehicle for Survival Detection: Communication Team
Fall 2024

Sprint 1:

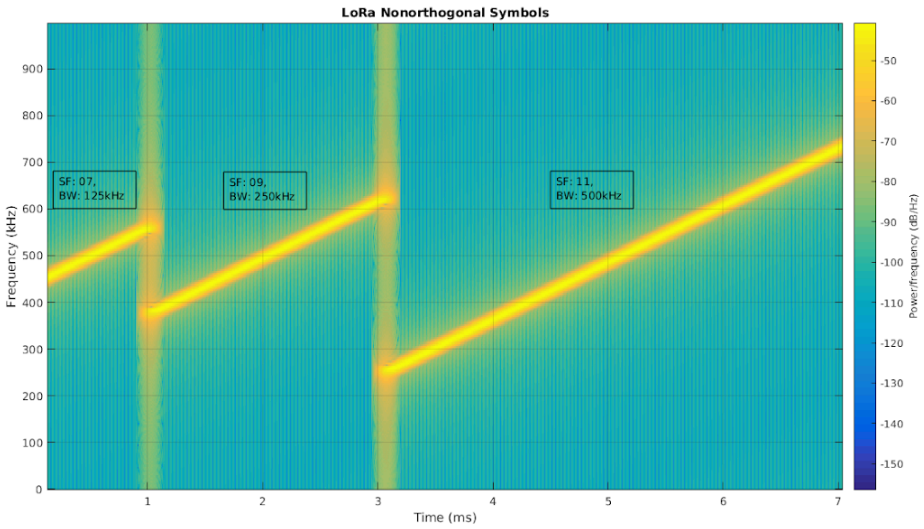
Week 1

1. Lit Review. All resources, citations, papers used in Lit Review are available on the team Github.
    a. Bibliography of references: https://docs.google.com/document/d/1N0dG5ggIYNqAYxFy4Y3gFA8iJIIVzb2reEV-PBrsIeg/edit?tab=t.0

Week 2

1. Research on modulation
    a. Wifi using raspberry pi 2.4 GHz SoC is a viable option
    b. Backup option: Lora Communications
        i. Proprietary radio communication (owned by Semtech); good for communicating at a long range, outdoors, in a place with limited access to WiFi, cellular, and other communications that require large infrastructure. Due to this, it is a good modulation technique to use for a disaster survival area, because it will be able to communicate over long distances in an area with little infrastructure available.
2. Research on radios
    a. RPI5 has 2.4 GHz WiFi SoC, added to parts list
    b. LoRa hat to place on top of RPi5's for LoRa communications
    c. Potential to use an SDR?

Example Lora Signal Plotted using MATLAB, with different Spreading Factors (7,9,11):

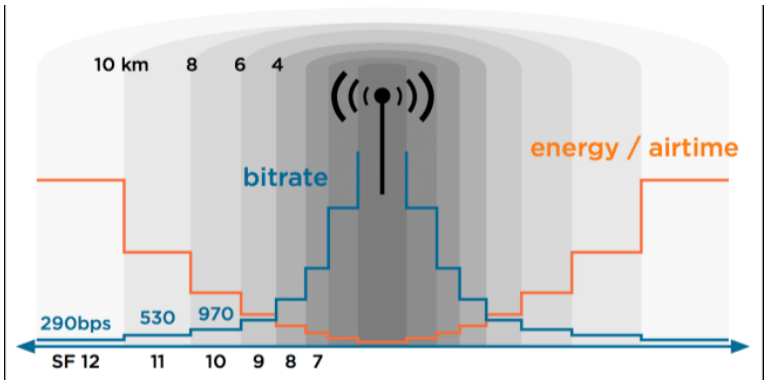


Sprint 2:

Week 1

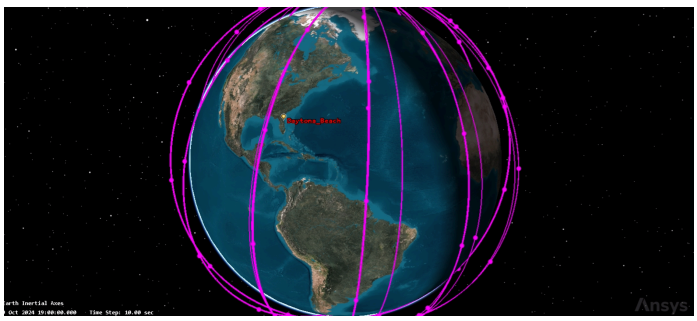
1. Additional research on LoRa
    a. LoRa contains spreading factors (SF) from 7-12. Only SF 7-10 is legal in North America due to restrictions.
        i. We may want to use a higher SF (8,9, or 10) since we are simulating a disaster area. Higher spreading factor = slower data rate, but more reliable communication. LoRa with a SF of 12 can even be demodulated when the SNR is -20 dB! (that means the noise is 100x stronger than the signal power)
    b. LoRa communicates in ISM bands. We will have the option to use the S-band ISM band (preferred) or UHF ISM band.
2. Scope location for testing of rover
    a. LB 274 is inadequate. Why?: Indoors, small area, no terrain, too many people inside the room, tables are in the way
    b. Potential locations for testing:
        i. If we must stay on campus, we could use one of the fields across the street or by O'connor dorms.
        ii. Backyard (cookout) with testing rover movement and detection (preferred); required to take off campus

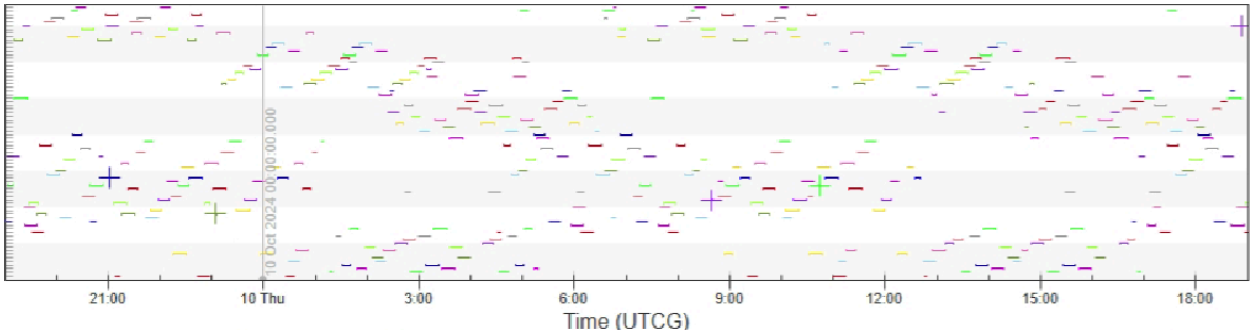
Illustration of different LoRa spreading factors data rate vs. time:



Week 2

1. Our project got completely changed. It is now a requirement (?) to do satellite comms. So I made an STK simulation of both Iridium satellite constellation and Starlink satellite constellation to verify we have appropriate 24 hr coverage in the Daytona Beach area.





What this graph is showing: Each of the Iridium sats are on the left hand side. The lines are showing when each sat has access to the DB area. With a constellation of 80 satellites, we have full coverage to the Iridium constellation. The constellation is in LEO so we're only going to have a few minutes of coverage per satellite as you can see in the graph. However, with 80 satellites these add up to amount to a full coverage.

Sprint 3:

Week 1

1. Our project completely changed (again). It is no longer a requirement to do Sat Comms (?) so we will be using WiFi or LoRa as that is easier and makes more sense anyways.
    a. Anyways we need to make a decision on the modulation. For now we will use WiFi because we are using 2 RPi5's to communicate. We will also have a LoRa hat as a backup, in case the project changes (again again) and we have to have a long range communication (WiFi is a LAN so not gonna work for long range).
2. Finalized parts list and sent to Dr. T. We will only have 2 radars so only 240 degrees coverage instead of 360……
    a. Still working with the hardware team to decide where we will mount it (high up on a pole, or in the front of the vehicle?)

Week 2

1. Ground station decision.
    a. We're just going to have our own DIY ground station. We may need antennas to send/receive if the RPi5 or LoRa hat antenna isn't enough, but those can always be fabricated.
    b. The Micaplex has a GS which I use for research, if we needed to use it we could ask permissions from Dr. Rojas. However, this is unlikely because it would overcomplicate things, its ITAR, and also it was damaged in the hurricane so it will take some weeks to become operational again. It's just a backup option.