EEE4022S/F Topic template

Student proposed?	*N*	
ID:	**SP21-06S**	
SUPERVISOR:	**Stephen Paine and Robyn Verrinder (co-supervisor)**	
TITLE:	**LoRa Based Communication System for Radiosonde Applications**	
DESCRIPTION:	A radiosonde is a battery-powered telemetry instrument carried into the atmosphere usually by a weather balloon that measures various atmospheric parameters and transmits them by radio to a ground receiver. Modern radiosondes measure or calculate the following variables: altitude, pressure, temperature, relative humidity, wind (both wind speed and wind direction), cosmic ray readings at high altitude and geographical position (latitude/longitude). Radiosondes measuring ozone concentration are known as ozonesondes. A nice video illustrating the application can be found here: https://www.youtube.com/watch?v=pcLkkoR2LS4  One of the difficulties with these balloon systems is that the systems are not intended to be recovered and therefore need to be as low cost as possible. This means that the weight and therefore power is a major limitation. These weight and power constraints mean that the transmitter needs to be as efficient as possible to be able to communicate with the ground station from >350 km away. Currently, the radiosondes are operated in the internationally allocated upper-air telemetry bands of 400.15 to 406MHz and 1668.4 to 1700MHz that use dedicated, in-house receiver systems. The current system requirements are: - Bandwidth: 1200 to 4800bps - Range up to 100 km - Altitude: 35 to 38 km - Temperatures: environment down to -90°C, but scope for an amount of internal warming.	

	The goal of this project is to investigate LoRa technology as an option to use as a transmitter in these systems. Data compression and balloon tracking should be investigated as part of the system as this will allow lower data rates (longer transmission) to be used along with ground station antenna steering. Once a suitable system has been designed, localised tests will need to be performed to test the performance and tracking abilities of the proposed design to assess its feasibility as a system. Note: we will use existing LoRa modules for this work so you will not be designing one from scratch.
DELIVERABLES:	**Literature Review:** A comprehensive literature review of LoRa based systems and competing technologies. **System Design:** A complete LoRa system needs to be setup and tested using various parameters to determine the feasibility of the system for the given application. Optimal LoRa spreading factors, data compression and tracking algorithms need to be investigated and max data rates vs distance need to be determined for a given power budget. **Experimental Results:** The system needs to be demonstrated using field tests. **Report:** Comprehensive report detailing each step, along with suggestions for future work and improvements.
SKILLS/REQUIREMENTS:	RF systems, signal processing and basic electronic and embedded systems knowledge.
GA 1: Problem solving: *Identify, formulate, analyse and solve complex* engineering problems creatively and innovatively*	The student needs to demonstrate their ability to perform complete systems engineering processes as they will be developing a complete functional package that can meet the given requirements. Creating a viable solution to meet the given requirements is a complex engineering problem that requires a creative engineering solution.
GA 4: Investigations, experiments and analysis:** *Demonstrate competence to design and conduct investigations and experiments.*	The student needs to demonstrate the ability to design appropriate acceptance test procedures (ATPs) in order to validate their solution. The student will need to demonstrate the system working as intended through a number of carefully designed experiments and tests. This is an iterative process that will require careful design choices be made by the student to achieve the design goals.
EXTRA INFORMATION:	- Radiosonde: https://en.wikipedia.org/wiki/Radiosonde#:~:text=A%20radiosonde%20is%20a%20battery,radio%20to%20a%20ground%20receiver. - Radiosonde video: https://www.youtube.com/watch?v=pcLkkoR2LS4 - LoRa: https://lora-developers.semtech.com/library/tech-papers-and-guides/lora-and-lorawan/ - Why LoRa: https://www.semtech.com/lora/why-lora - LoRa record distance: https://www.thethingsnetwork.org/article/lorawan-

	distance-world-record#:~:text=TheThings%20Network&text=On%2013th%20of%20July%202019,766%20km%20(476%20miles)
BROAD Research Area:	RF systems and electronic engineering
Project suitable for ME/ ECE/EE/ALL?	All

***NOTE: Complex engineering problems** require in-depth fundamental and specialized engineering knowledge and have one or more of the characteristics:

- are ill-posed, under- or overspecified, or require identification and refinement;
- are high-level problems including component parts or sub-problems;
- are unfamiliar or involve infrequently encountered issues;

and their solutions have one or more of the characteristics:

- are not obvious, require originality or analysis based on fundamentals;
- are outside the scope of standards and codes;
- require information from variety of sources that is complex, abstract or incomplete;
- involve wide-ranging or conflicting issues: technical, engineering and interested or affected parties.

****NOTE: GA 4:** The balance of **investigation and experiment** should be appropriate to the discipline. Research methodology to be applied in research or investigation where the student engages with selected knowledge in the research literature of the discipline. An **investigation differs from a design** in that the objective is to produce knowledge and understanding of a phenomenon and a recommended course of action rather than specifying how an artifact could be produced.