**Characterizing and Optimizing Primary Radar Performance**

Radar was a top secret British invention from WWII and was probably one of the major factors that helped the country survive the Nazi air assault during the Battle of Britain. Since then radar has become a primary tool to track and manage aircraft in the skies for both the military and civilian governments. However the loss of Malaysian Airlines flight MH370 illustrates weaknesses in radar technology that most people never consider. In this project you will mathematically analyze how radar works beyond the trivial explanation usually offered in schools and textbooks and then consider and describe ways to improve radar systems based on your analysis.

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| **TL;DR**   1. Teams of 3 2. Based on the lecture and your own research each person must mathematically analyze at least one aspect of radar performance. 3. From the results of item (2) above, each team must propose the most important aspect worth improving with better technology and mathematically justify their selection. 4. Each team will deliver an assertion-evidence slide deck explaining their work. All team members will share in the grade. 5. You will be given 2 weeks of class time and 1 week of homework time for this project. |

**Introduction:**

The usual explanation of radar says that the distance to an object can be determined by transmitting a radio pulse and waiting to receive the radio echo, and dividing the echo-time by twice the speed of light. The application of this idea usually involves having you the student solve some basic plug-and-play problems to determine echo time and distance to target and little more.

However, applying this simple echo concept involves taking into account may real-world complexities and limitations. Just some of these complexities include

* Transmitter power and receiver sensitivity
* Radar energy loss due to the atmosphere, and reflectivity of the target
* The geometry of the real world, such as the inverse square law for light and curvature of the Earth
* Different definitions of distance and altitude
* Unavoidable issue of measurement precision related to mechanical and electronic components of radar system

These problems must be solved by engineers and mathematicians in order to make radar an effective air traffic management tool. You will define and solve some of these problems for this project.

**Teams**

You will be grouped into teams of three students. As a team you will discuss the general problem to improve your understanding and each of you will analyze radar technology and apply your mathematical knowledge to model and describe its behavior. For example, how does the curvature of the Earth impact finding the correct distance to and altitude of an airplane in flight? Each team member must tackle a different aspect of the challenge so that each team presents a radar model with three enhancements over the usual trivial explanation of radar. Collaboration is expected but each team member must be primarily responsible for their chosen aspect – they will be considered the expert in that area. Note that you are not limited to only one aspect per team member, you may each do more than one if you have time.

After you have completed your analysis, consider all the aspects your team has investigated and decided which aspects can be improved with more or better technology, and select the aspect you feel should take priority if only one enhancement can be made. You must mathematically justify or support your choice.

**Schedule**

You will be given two weeks of class time to work on this project and develop a rough draft of your deliverable (see below). You will then be given one week of homework time to develop the final draft of your deliverable. Please refer to the website for the detailed dates for the project.

**Deliverables**

Each group will develop a slide deck that complies with the Assertion-Evidence Presentation model described on my website. I will also provide a short lecture on how to write slides that comply with this methodology. See my website for more information in the interim.

**Grading**

This project will be graded as a group effort and will be weighted no more than a quarter of a test. That is, if a test is worth 100 points, this project will be worth no more than 25.