Senior Design Project in Electrical & Computer Engineering

Study of Electronic Navigation Vulnerabilities in a Post-9/11 Environment

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Project Background

Prior to September 11, 2001, Congress had seriously considered phasing out LORAN-C as an available method for navigation. GPS had proven to be a much more effective method of navigation due to its availability, and accuracy within 20 meters. Also, several augmentations to GPS, including Differential GPS (DGPS) and the Wide Area Augmentation System (WAAS), increased that accuracy even further, making LORAN-C's .25 nm accuracy obsolete. However, the events of 9-11 created a level of awareness among both the electronic navigation community and Congress that GPS would not be enough. The low power signal of GPS is easily jammed or blocked by either signal radiation or the military's selective availability. The concern becomes that enemies of the U.S. can either prevent the use of GPS, or use GPS against the U.S. forcing selective availability to be turned back on.

If these concerns become reality, then an alternative method of navigation must be available in order to allow continuous accurate navigation. The maritime and aviation communities have become heavily dependent on GPS accuracy, and this accuracy must be available when GPS is not.

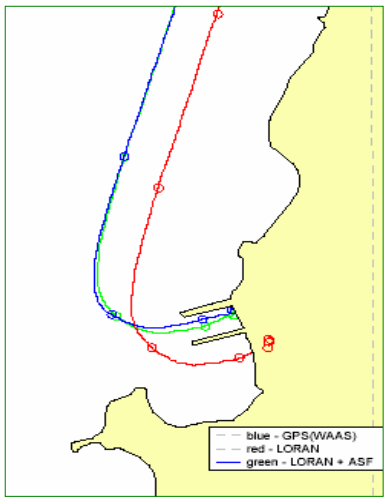
Project Plan

There have been several immediate responses by the government to aid this end. First of all, LORAN-C has been extended in order to allow for its development and expansion. Second, multiple branches of the government have been employed to research the problem of making available highly accurate positioning methods without the use of GPS. Our project will focus mainly on researching the maritime domain, and the affects on the Harbor Entrance and Approach phase of marine navigation.

GPS satellites transmit data to users from thousands of miles away. The satellites' signals are low power, and can be blocked using a hand held jammer.

Project Goals

- **Research DGPS Vulnerabilities**
  - **Find major gaps in harbor navigation accuracy that could be caused by the loss of a DGPS station**
  - **Research possibility of using DGPS stations to broadcast D-LORAN corrections**
- **Research WAAS uses for non-GPS navigation**
  - **Determine satellite positions and visibilities from different ports**
  - **Determine WAAS' uses should GPS be unavailable**
- **Research Loran uses for non-GPS navigation**
  - **Research possible "time of arrival" use of Loran Signal**
  - **Research possibilities of broadcasting LORAN signal corrections for D-LORAN**



Previous research has shown that Loran can produce GPS accuracy data when the "Additional Secondary Factors" are accounted for. Further research can lead to the development of methods for making these ASF corrections available to mariners.