Automatic Position Reports For Coast Guard Aircraft

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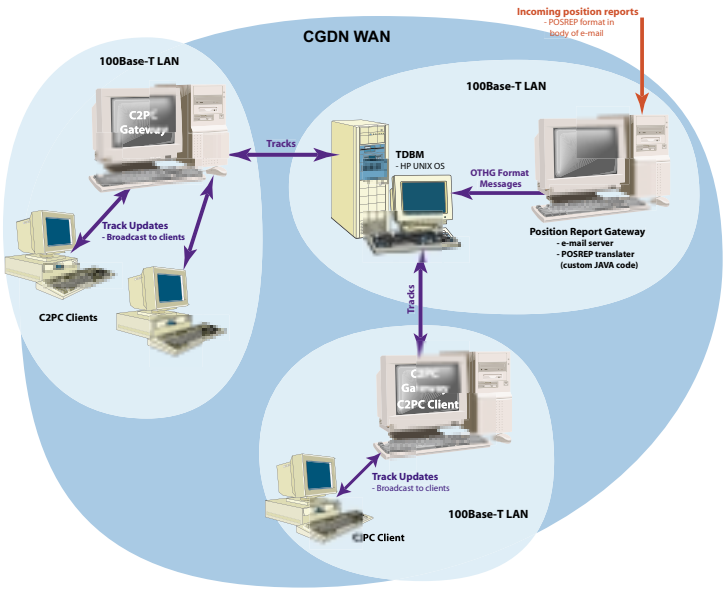
Abstract

Automatic position reporting for Coast Guard aircraft is valuable because it allows for aircrews to focus on their mission. Currently Coast Guard aircraft are limited to unreliable High Frequency (HF) communications systems that are not reliable and is user intensive. Standard aviation communications should provide both automated position reports for aircraft tracking and secure data capability for messages. A mix of commercial satellite communications (SATCOM) and HF Automated Link Establishment (ALE) is investigated to provide Coast Guard aircraft with a secure, reliable, and cost-effective method of relaying mission essential voice and data between Coast Guard units. SATCOM is also needed to improve interoperability between Coast Guard assets, DOD, and other government agencies and to provide broader bandwidth capability and an Over the Horizon (OTH) communications system on all Coast Guard aviation platforms. A system architecture to provide automatic position reports to Coast Guard operations center personnel has been developed and a prototype system using the ORBCOMM satellite system has been implemented. The primary goal of this project is the development of the infrastructure to integrate HF ALE (automated link establishment) into the position reporting system. The existing HF radio is modified or replaced to an ALE capable radio to which a HF data modem is connected to. Reports are sent using a combination of Coast Guard written software and commercial software (HF Messenger from Rockwell-Collins). HF Messenger provides the interface to the HF ALE radio acting as an e-mail server to send and receive e-mail via the HF data link.

Introduction

Commercial Satellite Communications (SATCOM) are needed to provide Coast Guard aircraft with a secure, reliable, and cost-effective method of relaying mission essential voice and data between Coast Guard units. SATCOM is also needed to improve interoperability between Coast Guard assets, Department of Defense, and other government agencies. There is an increased demand for broader bandwidth capability and an Over the Horizon (OTH) communications system on all Coast Guard aviation platforms. The current High Frequency (HF) radio systems do not meet Coast Guard's aviation communication needs. Standard aviation communications should provide both automated position reports for aircraft tracking and secure data capability for messages. The Coast Guard is looking to commercial satellite systems in addition to HF Automated Link Establishment (ALE) to meet these needs while gaining wider bandwidth and better reliability. Automated position reports will help track Coast Guard aircrafts in real time as well as allowing flight crews to focus on their missions. The sponsor for this project is the Office of Aeronautical Engineering (G-SEA).

Background



A prototype system was developed and tested using the ORBCOMM satellite system for automated reporting of aircraft locations. The system architecture consists of three sections. The first section included the aircraft components. The Stellar ST2500 ORBCOMM Data Communicator, installed on the aircrafts, was programmed to transmit the aircraft position reports to the satellites. This unit automatically reports the aircraft's position to a dedicated ground station at an interval of five minutes where it is sent via Internet to the Ground Gateway. This Gateway retrieves the reports, decrypts, and reformats them into the OTH Gold format. The information is sent to the network control center and then to the Internet where it is collected by the Position Report Gateway. This message is fed into the Track Database Manager (TDBM) which can be accessed by using the Command and Control PC (C2PC) software through the Coast Guard Data Network. A diagram of the shore architecture is shown.

Objective

This project analyzed the data position reports and compared it to the predicted system availability in order to determine whether the current system was performing to specifications. A prototype system was implemented in both the aircraft and ground stations and data was collected to determine system performance. The encryption of the position data reports was also implemented to provide security in the reports. The system did not include coverage of Alaska and Hawaii. HF ALE and alternative satellite systems will be investigated as another means of sending and receiving reports from Coast Guard units.

The overall goal of this semester was the development of the infrastructure to integrate HF ALE into the position reporting system. This would increase the coverage of asset tracking for Coast Guard aircrafts to include the Alaskan and Hawaiian regions. The primary objective to meet this goal was the development of the Coast Guard written software that will generate the required 40 byte data format. The position reports will be obtained from an attached GPS receiver in NMEA 0183 format via the computer's serial port. This formatted position report will then be sent via HF Messenger through the HF data link.

A test bed will be created for the hardware consisting of the HF modem, antenna, and radio. This will test the hardware performance and determine the reliability of HF ALE at the Academy. Another goal is the migration of the current system from the Internet to the Coast Guard private network.

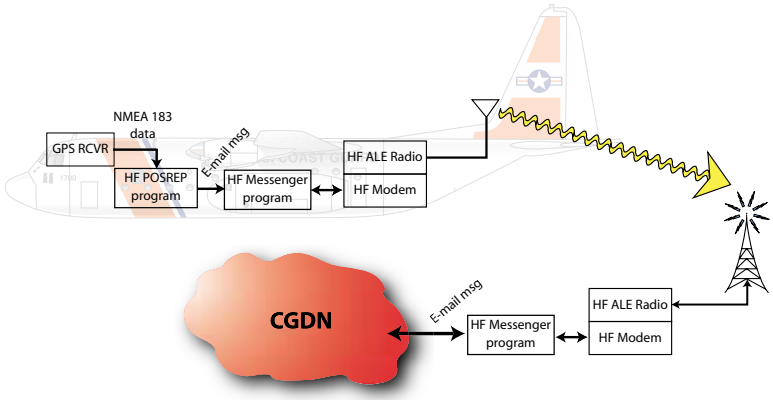
Technical Approach

To analyze the position report data, Excel was used to import the data text file. This analysis compared the hourly position reports to the five-minute differentials to observe any time differences between the aircraft, satellite, and the ground station.

The comparison of the position data to predicted system availability was to be accomplished through MATLAB. The tracks of each individual aircraft will be plotted using the Mapping Toolbox and compared to the system availability of the satellite during that period. By performing this analysis, the validity of the system performance can be established by the end of the semester.

To incorporate HF ALE into the project, an existing HF radio is modified or replaced to an ALE capable radio. An HF data modem is connected to the HF ALE radio. Reports are sent using a combination of Coast Guard written software and commercial software (HF Messenger from Rockwell-Collins) from a laptop through a serial synchronous card to the modem. HF Messenger provides the interface to the HF ALE radio acting as an e-mail server to send and receive e-mail via the HF data link.

The HF ALE aspect of the project was the main focus this semester. This portion of the project was divided into two phases. The first phase involved setting up and testing the HF system at the Academy. The antenna for the radio and modems for the computers was installed and primarily test will be conducted to validate that the system is operational. With the HF modem in operation, HF Messenger will be configured in two laptops to test the messaging capabilities of the complete system.



The second phase of the HF ALE involves the position reports. Last year, the software was developed for the ST2500 to send automated position reports and messaging. The HF gateway is established by connecting a computer running HF Messenger to both an HF radio and a terrestrial network. Position reports are sent via this channel across the Coast Guard Data Network to the POSREP Gateway. A similar type of program will be developed to capture data from the GPS unit onboard. This was divided up into a three-step process:

1. The first step will be making a program that will read GPS information into the computer. This will connect the computer to the GPS unit and listen to it for the position, course, and speed reports.

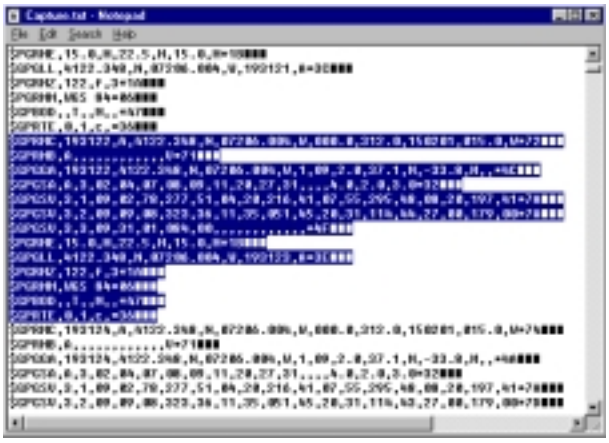
2. The second step will store the data and format it into the OTH-Gold format.

3. The third part of the program will then establish a connection to an e-mail server to send the message via e-mail over HF at an interval of five minutes.

Once the HF Modem has established communications with Rockwell-Collins, the system will be moved to an aircraft for further tests. Data will be collected and analysis performed to validate the system.

Results

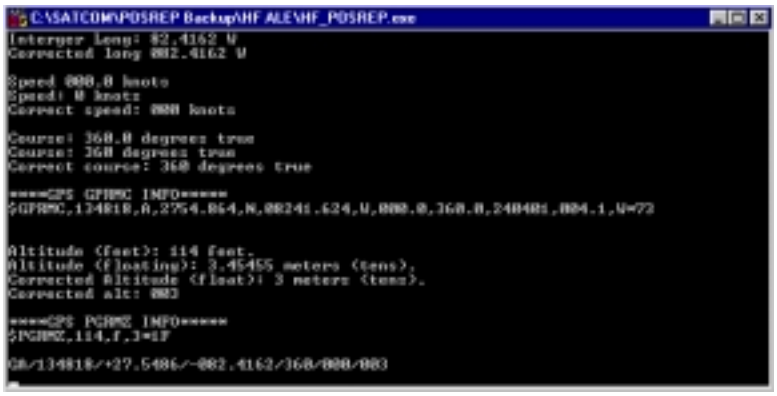
The analysis phase has consumed a large portion of the project first semester. In the data analysis, there have been irregularities in the data that needed to be investigated and be accounted for. The position times from the aircraft have not been consistent through out the data analysis. The irregularities may be attributed to errors in many places including the incorrect position time stamp from the aircraft to the Gateway system being offline for software updates. The primary work done last semester was the analysis portion of the position report data. There were initial errors in converting the text file to Excel, but once that was completed, the rest of the data manipulation was fairly straightforward. There was some problem with subtracting the two different times however, because of the difference in hours, minutes, and seconds. This was corrected in the spreadsheet. Beyond this irregularity, the average time for the transmission ranged from six minutes to eight minutes. Originally, I believed MATLAB was a good medium to plot the track lines from the database. This was used to determine the satellite coverage with that found from Satellite Toolkit. This proved to be unnecessary because the user can plot the track of Coast Guard assets using the C2PC program.



The focus was on the HF ALE side of the project in the spring semester. The project was broken down into two aspects: hardware and software. I worked on the development of the program to capture, format, and transmit the position reports. Elizabeth City sent an actual GPS receiver from a C-130, with the antenna and amplifier. This unit was not compatible with the computer. The connections to establish the link to the GPS information would have been another project. To simulate the proper GPS data a GARMIN III Pilot GPS was purchased. It was later learned that a GARMIN type unit was installed on all the C-130s. This allows for the program to work on all Coast Guard assets with this unit. After creating a DB-9 cable connection to the computer from the GARMIN, I used HyperTerminal to establish and determine how the GPS information was being formatted. The screen capture to the right has the thirteen types of NMEA string highlighted.

I developed a program (HF POSREP) in C++ which opened a serial connection to a GARMIN III Pilot GPS receiver. Once the serial interface was established, a function was created to capture the two NMEA lines of code with the necessary information for the OTH Gold message format. This captured the GPRMC and PGRMZ string from the unit. Right now, the program is

capable of collecting and formatting data. Establishing an interface with the computer to the serial port took up most of the semester. I encountered coding problems such as not including a library file, not setting up the function correctly, as well as basic C++ coding. Once these difficulties were corrected, the programming became easier with greater results. The software component of this HF project is almost complete except for sending the formatted message through an email server. A third function will have to be created to send the formatted message to the Gateway via HF ALE. This will be done by making a connection to the email server (Rockliffe MailSite) though port 25. Once completed, this program will transmit the position of the aircraft every five minutes.



The hardware part of the project is still being set-up. On the hardware side, two laptops loaded with the HF Messenger program would have been tested to ensure that the program is functioning properly. The HF radio link was to be established to Rockwell-Collins in Cedar Rapids, IA to test the messenger program over HF. The Academy already has an HF ALE capable radio which was recently connected to the HF antenna installed on the top of McAllister Hall. The HF modems for the computer will be tested as well with HF Messenger through the synchronous serial card. Most of the hardware for the project came in during the past few weeks. I expected to test the HF radio and establish communications with Rockwell-Collins to determine the quality of the data link.

Once the program to capture GPS data is completed, a test system will be set up in order to troubleshoot any problems involving both the hardware and the program. The system will be moved onboard an aircraft to test it in the field. Once the data is starting to be collected, the position reports will be analyzed to validate the system's performance.

Conclusions

This paper has summarized the work performed to date on Coast Guard asset tracking. The architecture for automatic position reporting has been designed and established to allow for multiple users to monitor the aircraft positions. This was accomplished by using the ORBCOMM system. In order to increase coverage of our assets, HF ALE was investigated as a means to transmit position reports. The actual implementation of this system was not accomplished, but the concept to integrate HF ALE into asset tracking should not end. Future software development and testing will provide the Coast Guard with another means to monitor the locations of all aircrafts and eventually all cutters.

References

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