

# **Flight Test Results from C-Band Missile Telemetry Project**

## **ABSTRACT**

Over the past few years, papers have been presented relating to the design and development of a telemetry section used to compare the performance between S-Band and C-Band telemetry links. In addition, the flight test plans to make this comparison have been discussed. Captive Carry Test Flights (on a F-18 fighter jet) over the NAVAIR Sea and Land Ranges at Point Mugu and China Lake were conducted during the April-July 2014 timeframe. In addition a Live Fire Test Flight over the Land Range of the specially outfitted missile was performed in July 2014 as well. This paper will discuss these series of flights tests and provide a performance assessment of the data quality between the C-Band and S-Band telemetry data links. In addition, lessons learned from the various test flights will be included as well. Due to publication deadlines, the results will be summarized at the actual conference.

## **KEY WORDS**

Augmentation, C-Band, and Missile Telemetry

## **BACKGROUND**

Due to the National Broadband Initiative (NBI), the federal government will be auctioning off frequency spectrum traditionally used for airborne telemetry (more specifically defined as the 2200 MHz to 2290 MHz frequency range). These platforms include military planes, drones, and missiles. Much work has been performed in the area of telemetry for military planes, but up until now no study has been conducted on the performance of missile telemetry operations in the lower- and mid- C band (4400 - 4940 MHz and 5091 - 5150 MHz) frequency range. This project funded by the Office of Secretary of Defense for Science and Technology (OSD S&T), is the first and only effort so far to compare the performance of telemetry operations in the S- and C- Bands.

## **REVIEW OF DESIGN/DEVELOPMENT EFFORT**

As described in earlier papers, the design effort involved taking two existing missile telemetry (TM) units and modifying them. Most of the existing components were removed but only the S-Band transmitter, the GPS Receiver, the GPS/TM antenna, and a few assorted cables were retained. A C-Band

transmitter and a low data rate S-Band transmitter (to relay the GPS TSPI (Time, Space, Position, Information) data to the ground) were added to the modified TM unit. A power supply was added to provide power to the three transmitters and GPS receiver. In addition, a C-Band antenna had to be designed and fabricated to operate with the newly added C-Band transmitter to assess link and tracking performance.

## **ORIGINAL FLIGHT TEST OBJECTIVES AND PLANS**

The primary flight test objective of the C-Band Missile Telemetry Test Project is to compare the link performance for a telemetry data stream transmitted in the C-Band with the data stream transmitted in the S-Band. The secondary objective is to compare the ground based tracking performance between the C- and S-Bands. A total of three captive-carry flights and one missile air-launch will be conducted as part of this baseline study.

The original flight test plans included the following five Phases:

**Phase I - Static Testing:** Test Objective to ensure all tracking assets, instrumentation systems, data receiving and recording equipment are functioning properly prior to conducting flight testing.

**Phase II - Captive Test, Land Range:** The test objectives are to assess general tracking and link performance over land at both high and low altitudes relative to the tracking antennas systems and to assess the integrity of the tracking loop when slewing up to 90% of the maximum angular rate of the antenna.

**Phase III - Captive Test, Sea Range, General Tracking and Link Quality Assessment:** The test objective is to assess general tracking link performance over the sea range at various altitudes.

**Phase IV - Captive Test, Sea Range, Low Signal to Noise Ratio and Low Grazing Angle Tracking:** The test objective is to assess tracking performance when receiving very weak signals in the presence of multi-path and to determine the link margin improvement when utilizing LDPC forward error correction.

**Phase V - Missile Live Fire:** The test objectives are to perform an actual live fire demonstration of a short-range air-to-air missile employing a C-Band telemetry data link and to compare the tracking performance of the antenna systems modified for C-Band reception to S-Band counterparts. As a byproduct of this demonstration, the C-Band data link performance will also be compared to the S-Band data link transmitting the same data from the same platform.

## **ACTUAL CAPTIVE CARRY AND LIVE FIRE TEST FLIGHTS**

Since the modified TM unit had the same weight and center of gravity as the original unit, attaining the F-18 flight clearance went quite smoothly. However the Test Plan approval of the various Phases listed in the last section took much longer than expected. Therefore as a risk mitigation effort, two C-12 flights were conducted (one at the Sea Range and the other at the Land Range). The C-12 aircraft was stationed at Edwards AFB and was equipped with both a S-Band and C-Band transmitter. The TM tracking vans were located in the same location as they would be for the actual test flights and the C-12 flights were exercises in tracking an airborne vehicle using C-Band. In addition, they provided valuable data in the calibration of the equipment used for the C-Band test flights. The C-12 aircraft was used since it did not require a Navy Test Plan and the flight was accomplished as an Air Force operation. As a cost saving effort, the C-12 flights were used to conduct Phase IV (listed above). The results of the Sea Range C-12 test flight were presented at the 2013 ITC Symposium.

Due to the logistics of transporting the C-Band Tracking Antenna Pedestals from both Edwards AFB and China Lake, the Sea Range captive carry flight (Phase I & Phase III) was conducted first at Point Mugu on 22 April 2014. After the successful completion of this flight, all of the assets were moved to the Land Range at China Lake and repeated (Phase I & Phase II). The Land Range flight was conducted in the June 2014 timeframe. Then in July 2014, the Live Fire Test Flight (Phase V) was held. Once again it should be noted due to publication deadlines, the results of all of these tests will be presented at the actual conference.

## **SUMMARY**

The successful completion of the Live Fire Test Flight concludes the 2½ year S&T project to determine what steps need to be accomplished in order to augment telemetry operations into the C-Band frequency range. Although this may be the end of this project, it is just the start of providing the government test ranges the information needed to procure the ground equipment needed to support future airborne test operations in the C-Band frequency range.

## REFERENCES

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