U.S. ARMY YUMA PROVING GROUND TELEMETRY SUPPORT CAPABILITIES WITH APPLICATIONS TO GPS TESTING

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ABSTRACT

This paper presents an overview of U.S. Army Yuma Proving Ground Telemetry acquisition facilities as they relate to developmental tests of the GPS system. These systems utilize the latest state-of-the-art in telemetry tracking systems, receivers, and employ a unique scheme for frequency and space diversity combination and signal selection.

The telemetry systems presently used can accomodate two simultaneous aircraft in various parts of the range. Through acquisition of telemetry and subsequent reduction, actual real-time differences in X, Y, Z location between three station laser derived position solution and GPS satellite solution can be displayed and recorded.

In addition, a summary of latest facility expansion involved in the enhanced support of the GPS testing at the 1600 square mile U.S. Army Yuma Proving Ground will be presented.

INTRODUCTION

The telemetry acquisition facilities at U.S. Army Yuma Proving Ground (USAYPG), Arizona, are used to support a number of major test programs. One of the more predominant support roles of these facilities is for the Global Positioning System (GPS).

MAJOR SITES

The major telemetry receiving facility is located at Site 4, USAYPG. This facility has the capability of two simultaneous receptions of either L or S Band telemetry data in any of the various standard formats. Unique UART formats have also been accomodated but have required special hardware/software modifications. Telemetry is received and recorded at

the Site 4 station and simultaneously relayed in real time by microwave to the USAYPG Range Operations Center (ROC). At the ROC, the data is introduced to computers for further analysis and display as required.

Until recently, the majority of telemetry transmissions could be adequately received by the Site 4 facility. Aircraft flight scenarios involved rather close-in, moderate altitude transmissions. However, with the advent of the GPS program into Phase II, a substantial enhancement and expansion of our facilities became a real requirement.

NORTHERN EXPANSION

Flight geometries and altitudes for GPS Phase II would at times, prohibit adequate reception of telemetry at our Site 4 facility. The concept of operations requires testing in heretofore completely undeveloped areas of our vast 1600 square mile Proving Ground. Based on instrumentation optimization of laser tracking as well as telemetry requirements, the Northern locations of Sites 16 and 18 were determined. Activation of the sites has been slow due to extreme remoteness. For example, the nearest power and telephone facilities are some 20 miles from the new sites. Excavation was done, roads were graded and a mountaintop was leveled for installation of a microwave relay that connects the new sites to the ROC. Because installation of firm power was not economical, generators are being utilized. In short, considerable facility and civil engineering challenges have now been overcome to include total site integration with wideband duplex microwave links that carry voice, data, telemetry and video as required.

OPERATIONAL CONCEPTS

A GPS satellite receiver is located in any one of a number of different kinds of aircraft. Through the GPS system, the X, Y, Z positions of the aircraft is determined. Simultaneously, the test aircraft is tracked with three or more laser tracker systems located at different locations on the USAYPG range. By using the appropriate software algorithms, atmospheric modeling/refractive correction techniques and filtering, differences between the GPS designated location and actual laser solution can be determined in X, Y, Z to a precision typically within one meter.

FREQUENCY DIVERSITY TECHNIQUES

The airborne GPS telemetry package transmits on two S-Band frequencies which provide a measure of frequency diversity. Airborne antennas are placed at different locations on the aircraft to insure a more successful ground reception when banking or performing other maneuvers.

At our Site 4 facility, a separate RF receiver is used for each of the two S-Band frequencies. A diversity combiner is used in conjunction with the receiver pair which outputs the signal with best quality. This, in turn, is microwaved to the Range Operations Center for further computational analysis and display.

The above paragraph depicts operations where the telemetry signal can be received totally at the Site 4 facility. When aircraft are operating in or transitioning to the northern areas of the Proving Ground, particularly at lower altitudes, receiption at Site 4 becomes lost or is marginal. At that time, reception at our Northern Site 18 becomes realistic.

UNIQUE EQUIPMENT APPLICATIONS/SPACE DIVERSITY TECHNIQUES

At Site 18, two RF streams are received and processed through a diversity combiner where the best quality signal is selected. That TM video signal, as well as the DC AGC signal amplitude is transmitted back to Site 4. What happens next is rather unique. In another specially modified diversity combiner at Site 4, TM video from Site 18 and that from one of our two receiving systems at Site 4 is <u>again</u> compared and the best of these is microwaved to the ROC for computer analysis. What this means is that TM video received at the ROC will be the best obtainable quality when an aircraft flies from Site 4 area to Site 18 area of the range. Data coverage will be continuous during aircraft transitions and during various mission geometries throughout the complete range.

One more fact makes the total TM operation rather unique. Site 18 TM facility is unmanned and is controlled from Site 4 via microwave. Frequency selection, positioning the two-axis tracking system for acquisition and operational follow-up and status is all controlled by a single operator at our master TM facility at Site 4.

CONCLUSIONS

The telemetry acquisition systems at USAYPG consists of some of the latest state-of-the-art tracking systems, receivers, and diversity combination equipments. Some equipments have unique one of a kind modifications installed in order to insure continious data reception, even though aircraft may be flying in anyone of a multitude of mission geometries and altitudes. Although driven in our design and implementation of these telemetry facilities by the GPS testing, major enhancement and improvement in telemetry capability at our Range has been realized.