TELEMETRY PLANNING IMPROVES SYSTEM RELIABILITY

Richard J. Fuentes William A. Gilbert

White Sands Missile Range National Range, N.M.: Telemetry Branch

ABSTRACT

Increased concerns for reducing cost and improving reliability in Telemetry systems have made proper evaluation and simulation of a proposed test of utmost importance. Using computer programs developed for planning analysis, a planner may review a proposed test and devise a support plan. This plan will provide the best RF tracking and receiving results quickly and accurately. Pre-mission simulation of Telemetry systems verifies the plan and minimizes possibilities of mission data loss. This paper will explore how a Telemetry Planner can improve on overall data collection of telemetry by utilizing computer programs and performing pre-mission testing.

INTRODUCTION

The primary mission of the Telemetry Planner is to develop the best possible support plan for collecting, relaying, and processing Telemetry data. In order to achieve this mission, WSMR Telemetry Planners use a variety of computer programs and field simulations, (based on IRIG 106-93 and The Telemetry Applications Handbook), to evaluate all possible scenarios. The computer programs provide theoretical information about transmission system parameters, ground station reception capabilities, and required data accuracy. The intent of this paper is to describe how these programs help WSMR Telemetry Planners evaluate a system, simulate it, and compare the results.

WHITE SANDS TELEMETRY SYSTEM

Located in southern New Mexico, White Sands encompasses an area of approximately four thousand square miles. To support this large area, White Sands Telemetry System consists of four fixed and five mobile telemetry systems placed in critical locations throughout the range (see figure 1). Each system is capable of acquiring and relaying all the telemetry formats shown in Table 1.

Time Division	Frequency division	Hybrid
PAM/FM, PAM/FM/FM	FM/FM, FM/FM/FM	PCM/FM + FM/FM
PCM/FM, PCM/FM/FM, PCM/PM		PCM/FM/FM + FM/FM

Table 1 Telemetry formats supported by the White Sands Telemetry System .

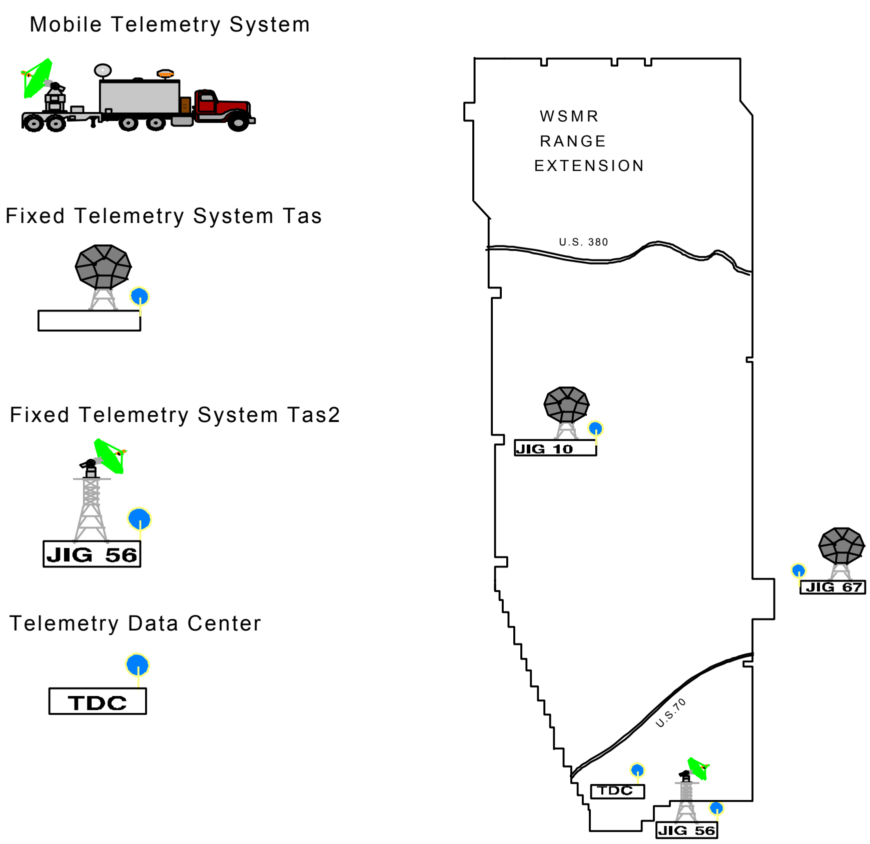

Figure 1 White Sands Telemetry System .

Additionally, all fixed sites have recording capabilities. Mobile systems use a special purpose van when they have a requirement to record. The following section will illustrate how the telemetry planner uses computer programs to place these systems in an optimal arrangement to provide the best overall support.

TRACKING SITE SELECTION PROCESS

Selection of tracking locations that provide continuous and reliable communications between the tracking site and the test vehicle is a must. Planners use two computer programs to evaluate selected sites. The first verifies line of sight between the test vehicle and tracking location for the flight profile. The program uses standard refraction, diffraction, and reflection calculations to determine their affects on the tracking systems. This information is used to draft a preliminary list of sites for possible test support.

The second program determines whether the selected sites provide adequate RF coverage. Using the vehicle's attitude, trajectory, antenna orientation, and transmission information, the program calculates the received power levels at the tracking sites. The program uses this value along with a calculated value for receiver sensitivity to determine the RF link margins. Once the program calculates the link margins for all sites, the program plots individual link margins vs. time and produces a best source plot based upon all sites (see figures 2 and 3). The planner may then use these plots along with the line of sight plots to assemble an effective tracking support plan.

OPTIMIZING THE TRANSMISSION AND RECEPTION SYSTEM

One of the desired goals of the planner is to configure the ground station receiving equipment for optimal performance. To achieve this, a program was developed that computes the transmitter deviation and the minimum receiver IF bandwidth required to maintain the desired data accuracy at system threshold. The program has the capability of calculating these values for all the transmission systems previously covered. To ensure the validity of the program values, actual system parameters will be simulated. Both data sources will be compared and the planner will plan the ground station alignment for best overall system performance.

Often, the telemetry system designer is unable to set the transmitter deviation for best performance. In these cases, the planner will use the computer program to evaluate what affects this will have on range system performance. These results along with field simulation will determine range system trade-offs that can be adjusted to provide the data accuracy required.

HARMONIC DISTORTION ANALYSIS

In any RF Transmission system with two or more frequencies, intermodulation products created by nonlinearities in the transmission or reception equipment is of great concern. To analyze the affects, the planner uses a program that inputs the frequencies and determines second and third order harmonic frequencies. Questionable frequencies are simulated in the field and exposed to receiving equipment. After evaluating both sets of data, the planner may make recommendations to the system designer about the selected frequencies. Possible mission data interruption caused by intermodulation interference is effectively eliminated prior to flight at the range.

OPERATIONAL PLANS DOCUMENT

To support a test of a moving vehicle usually requires the use of several receiving stations. Each station requires information describing vehicle transmission characteristics as well as site configuration. The telemetry planner uses an operational plans document to provide this information. Below is a list of the information provided:

Transmission System. The transmission parameters contain information describing the transmitter frequency, output power, and modulation scheme.

Receiving System. Receiver parameters contain the bandwidth requirements for the intermediate frequency as well as the low pass filter setting.

Recording. Recording information includes track assignments, pre-detection and post-detection recording, recording speeds, and tape signature requirements.

Relaying Assignment. There are three basic relay systems available at White Sands. These systems are digital fiber optics, digital microwave, and analog radio. The planner decides which transport system provides the most efficient means of data transfer and makes assignments. By providing the information described above, the telemetry planner obtains optimum readiness for mission support.

REALTIME PACKAGE SIMULATION

To tie together all the planning and testing, Project package simulation is required. Telemetry utilizes standard BER techniques to verify system readiness but goes one step further by actual radiation of the customer's package. For most PCM packages, an EMR 8336 simulator is used. For complex packages, a test tape is requested from the Project, and verified at the Telemetry Data Center (TDC). EMR 8336 data is transmitted to Jig 67 or complex data tapes are sent to Jig 67. At Jig 67, the data is radiated (True FM) at the projects frequency, received at all tracking sites, and relayed to the TDC for evaluation. A tape signature is usually made at the beginning and end of the tapes at all recording sites for later alignment.

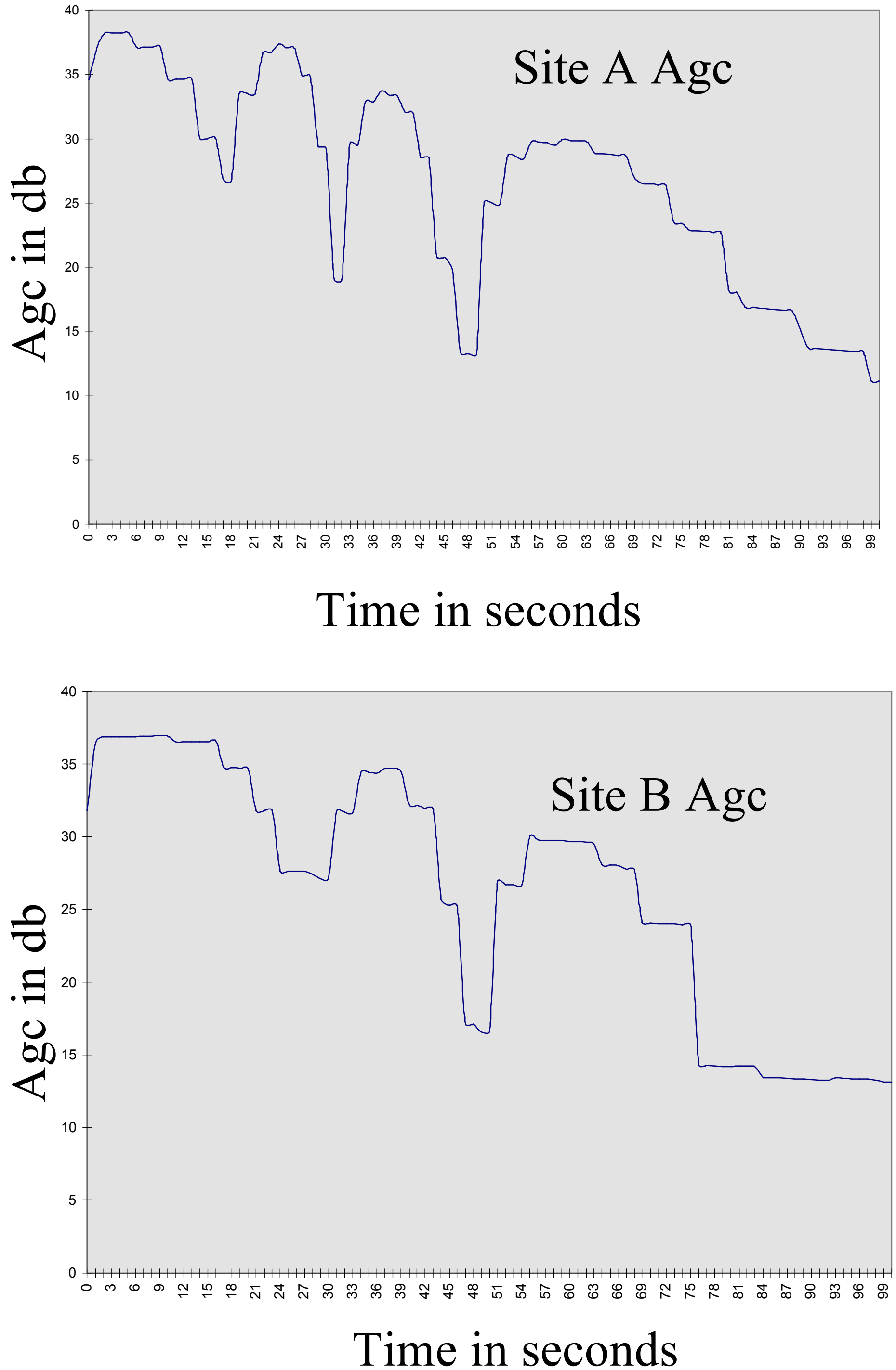

Figure 2 Site A and B Agc's versus time.

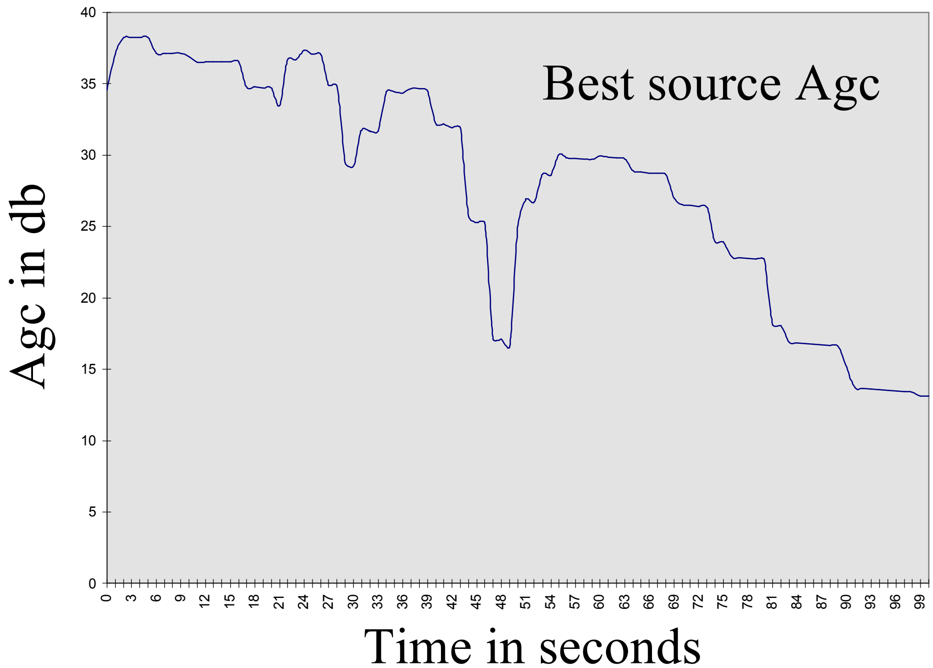

Figure 3 Best source Agc versus time.

Evaluation at the TDC is determined by acquisition of a true frame synchronizer lock for PAM and PCM decommutators and valid data descrimination for FM/FM systems. Upon verification, the system is validated for pre-flight conditions. The entire system has been statically verified and other than actual flight dynamics, all major variables have been identified and tested.

CONCLUSION

The development of these computer programs improves the planning process by the use of proven IRIG methods for evaluating systems. Time is saved, and calculation accuracy improved to the benefit of both the planner and the test program. Simulation of all the test parameters ties together and validates the system plan to provide the best possible Telemetry plan for the customer.