GLOBAL POSITIONING SYSTEM (GPS) FOR THE ARMY'S AIR DEFENSE OPERATIONAL TESTING

Mario Z. Parra
Dr. Robert G. McIntyre

ABSTRACT

The Office of the Under Secretary of Defense for Research and Engineering recognized the potential advantages of a GPS-based range tracking system. As a result, the Range Applications Joint Program Office (RAJPO) was established. [1] The RAJPO was formed to develop a family of NAVSTAR GPS range equipment for the tri-service national test range community. The Air Defense Artillery Test Directorate (ADATD) has supported the RAJPO in the potential use of GPS-derived time, space, and position information (TSPI) in operational testing environments.

INTRODUCTION

The NAVSTAR GPS is a space-based multilateration system that provides highly accurate three-dimensional position, velocity, and precise time to the test platform. The GPS has been designated a future source of TSPI data on instrumented vehicles operating on the Department of Defense (DOD) test ranges.

BACKGROUND

The GPS will become operational when a constellation of 18 satellites in 6 orbital planes provides an unlimited number of suitably-equipped users with precise position, velocity, and time.

The tri-service GPS Range Applications Steering Committee completed an evaluation of the applicability of GPS to DOD test range applications. [2] In support of the committee's activities, the Analytic Sciences Corporation performed an analysis of the technical and implementation issues involved in adapting GPS for test range applications and of possible resulting cost benefits. [3]

SHORT-TERM OPERATIONAL TEST REQUIREMENTS

Within the next 18 months, the ADATD will be required to provide track information for 10 rotary-wing aircraft and 13 ground players. In this timeframe, we expect to upgrade our present Multiple Target Tracking System (MTTS) to interface with the GPS equipment to ensure compatibility, growth, and support of our ADA mission.

LONG-TERM OPERATIONAL TEST REQUIREMENTS

Within the next 3 years, the ADATD will be required to track up to 117 players with a mix of ground players and fixed- and rotary-wing aircraft. These capabilities will be firm requirements to perform Forward Area Air Defense (FAAD) command, control, communications, and intelligence (C^3I) operational type testing. Figure 1 depicts a typical scenario involving different types of players.

Rotary-wing aircraft will be using terrain masking to fly their pop-up missions. These techniques make it virtually impossible for a number of sensors to keep valid tracks on the helicopters. On the other hand, GPS will provide the required TSPI to determine rotary-wing unmasking to any particular fire unit.

Fixed-wing aircraft will be flying nap-of-the-earth profiles. Again, these profiles will heavily tax radar or ground multilateration systems and will not be able to provide the necessary TSPI information for a valid operational test. The GPS, with the aid of additional specialized equipment, * will be able to provide TSPI at the required accuracies and sampling rates.

Ground players will comprise different ground equipment such as: the Non-Line-of-Sight (NLOS); Line-of-Sight-Forward-Heavy (LOS-F-H); Avenger; battery and platoon command posts (CP); Ground Based Sensor (GBS); Army Airspace Command and Control (A^2C^2); and Battalion Technical Operations Center (BNTOC). All these ground players will be at their different locations mandated by tactics and doctrine. The area of coverage will be large and diversified, which makes it virtually impossible for conventional tracking systems to provide the required TSPI for the FAAD C^3I operational test. Not only is the GPS the most capable system of providing TSPI data for this scenario but also the most cost effective. As a byproduct of using RAJPO equipment, the ADATD will also be compatible with other test ranges DOD wide.

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*NOTE: The RAJPO has developed a suite of equipment that fits on an AIM-9 pod to ensure provision of TSPI at high dynamics and data rates.

GPS ADVANTAGES

Low Altitude Coverage.

Modern tactics and doctrine for air operations require terrain screening to avoid detection of unfriendly radar-controlled surface-to-air missile (SAM) sites. The GPS, with its proposed data link having player-to-player relay, affords the possibility of instrumenting the participants even when flying in remote valleys to obtain terrain screening. It thus expands the tracking area.

By design, the GPS requires sites for data communications purposes not for player position location. Few prepared sites may be required. The system is portable and it does not require to be surveyed. It is conceivable to install data relay sites on trucks making them more cost effective than stationary surveyed towers. Also, high-flying aircraft can be used for data relay purposes and could be used as data link remote stations.

Accuracies.

The GPS position accuracies have been demonstrated [(4)] to be on the order of 6 ft and 1.7 ft/sec horizontal and 12 ft with 2.7 ft/sec vertical when differential GPS is used. With GPS, position and velocity are computed onboard the player equipment; therefore, the inherent accuracy is not dependent on data link dropouts caused by terrain or any kind of masking. With ground-based multilateration as used in the ADATD, a radar altimeter for aircraft must be used to obtain the required vertical accuracy at low altitudes since the geometry of the tracking stations is in a plane. The GPS does not require an altimeter.

SUMMARY

The potential benefits of GPS as a source of TSPI has been clearly established, and DOD has accelerated efforts to effect a timely integration of GPS into the test ranges. By adopting today's GPS tracking techniques for air defense operational testing, the requirements can be satisfied in a cost-effective manner.

REFERENCES

(1)Hoefener, Carl E., "DOD Plans for GPS on Test and Training Ranges," Defense Systems Review, February 1984.

(2)George, Kingston A., et al., "GPS Range Applications Study Final Report," Tri-service GPS Range Applications Steering Committee, Western Space and Missile Center, Vandenberg Air Force Base, CA, January 1983.

(3)Jones, Harold L., McDonald, T.J., et al., "GPS Range Applications Study Final Report," Report No. WSMC TR 82-3, Western Space and Missile Center, Vandenberg Air Force Base, CA, December 1982.

(4)Kaatz, G. T. Kido, C. Richmond, and R. Snow, "Test Results for the High Dynamics Instrumentation Set (HDIS)" presented to the Institute of Navigation Satellite Division Technical Meeting, Proceedings of ION GPS-89, 27-29 September 1989, pp 87-102.

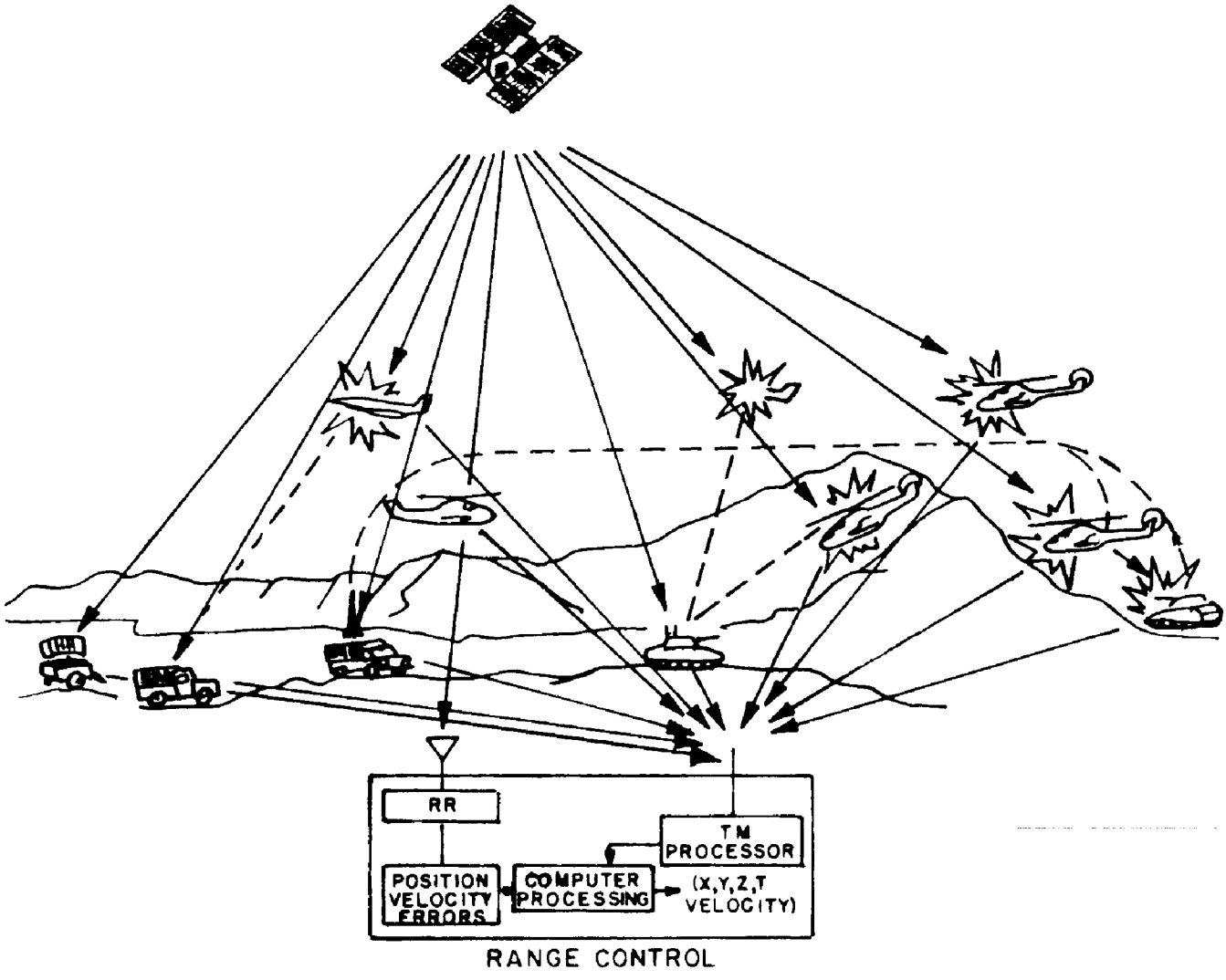

Figure 1. FAAD C ^{3}I Operational Testing