

DIFFERENTIAL GPS ENHANCES TEST CAPABILITIES OF DOMESTIC AND INTERNATIONAL PROGRAMS

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ABSTRACT

A system was developed using capabilities from the Range Applications Joint Program Office (RAJPO) GPS tracking system and the ACMI Interface System (ACINTS) to provide tracking data and visual cues to experimenters. The Mobile Advanced Range Data System (ARDS) Control System (MACS) outputs are used to provide research data in support of advanced project studies. Enhanced from a previous system, the MACS expands system capabilities to allow researchers to locate where Digital Terrain Elevation Data (DTED) is available for incorporation into a reference data base.

The System Integration Group at Veda Incorporated has been supporting Wright Laboratories in the ground-based tracking and targeting arena since 1989 with the design, development, and integration of four generations of real-time, telemetry-based tracking aids. Commencing in Q3 1995, Veda began developing a mobile, transportable system based on the RAJPO GPS tracking system. The resulting system architecture takes advantage of the front end processor (FEP) used in the three previous generations of interface systems built for Wright Laboratories, thus maximizing hardware and software reuse. The FEP provides a computational interface between the GPS tracking system and the display (operator) system.

The end product is a powerful, flexible, fully mobile testbed supporting RDT&E requirements for Wright Laboratories, as well as to other U.S. and foreign research organizations. The system is rapidly reconfigurable to accommodate ground-based tracking systems as well as GPS-based systems, and its capabilities can be extended to include support for mission planning tools, insertion of virtual participants such as DIS entities, and detailed post-mission analysis.

KEY WORDS

Global Positioning System (GPS), Air Combat Maneuvering Instrumentation (ACMI), Advanced Range Data System (ARDS), High Dynamic Instrumentation Set (HDIS)

INTRODUCTION

Advanced airborne technology research at Wright Laboratories has been a beneficial going concern for several years. Early in the program, researchers recognized a need to maximize control over as many variables as possible during research activities. Ground-based multilateration systems such as the Air Combat Maneuvering Instrumentation (ACMI) and Red Flag Measurement and Debriefing System (RFMDS) have provided reliable data to support these tests; however, they limit the geographical area available for testing because they require system hardware that is located at permanent installations.

Capitalizing on the freedom achieved via GPS/DGPS systems, research, development, test and evaluation (RDT&E) organizations can locate away from ground-based systems and locate their operations at a multitude of suitable locations. GPS/DGPS based systems also provide an opportunity to use the system for activities other than pure RDT&E. They may be used to provide tools for mission planning, performance monitoring, fault diagnosis, DIS and other virtual reality applications. Mission rehearsals and predictions can take place in a virtual environment and synthesized results stored in data bases for recall and detailed analysis. Once completed, data from actual missions can be merged with the synthetic data to provide a more realistic picture of how combat entities behave in different environments.

CHALLENGES AND REQUIREMENTS

Three primary challenges are encountered based on broad requirements: 1) develop a system that provides mobility; 2) maximize hardware and software reuse; and 3) retain previously existing capabilities. The remainder of this paper presents the features of the MACS design and its affects on system performance and utility.

SYSTEM ARCHITECTURE

Mobility is achieved by installing the system into a fully mobile, self-contained vehicle suitable for transport, setup, installation, and operation in the field. The vehicle selected for this application was the result of several months of specification development, vendor pre-selection (on-site) visits, and release of requests for proposals. Barth Specialized Vehicles was selected as the vehicle manufacturer to house the GPS tracking system and other tracking interface equipment. Growth was a contributing factor in the selection - the

vehicle needed to be sufficiently flexible to allow other research activities well past the maturity point of the current program. The resulting subsystem is termed the Mobile ARDS Control System (MACS).

Since the on-range GPS ground station is likely to be located remotely from the aircraft staging area, a second vehicle is needed to support the airborne instrumentation subsystems. These systems consist of the High Dynamic Instrumentation Set (HDIS) attached to the aircraft via commonly used missile “pod” attachment techniques. The vehicle for staging activities near the aircraft needs to support pod storage, testing, reconfiguration, and maintenance activities. The ARDS Pod Operation and Maintenance (APOM) facility is towed by a heavy duty tandem pickup which doubles as local transportation during deployments (APOM is not discussed in detail in this paper).

Hardware reuse is achieved by retaining the platform originally developed to support ground-based multilateration tracking system interfaces (see reference 4) originally referred to as the ACMI Interface System (ACINTS). In the MACS architecture, hardware components have been added which expand the ACINTS capabilities. Now the system can interface to GPS based tracking systems (specifically the RAJPO GPS tracking system - see reference 1), and acts as the host range facility. The simplified block diagram shown in Figure 1 depicts the MACS architecture. MACS system components collectively make up what is termed the Host Range Interface Processor (HRIP), and consists of the FEP, Monitor and Control Display, and Enhanced Graphics Display.

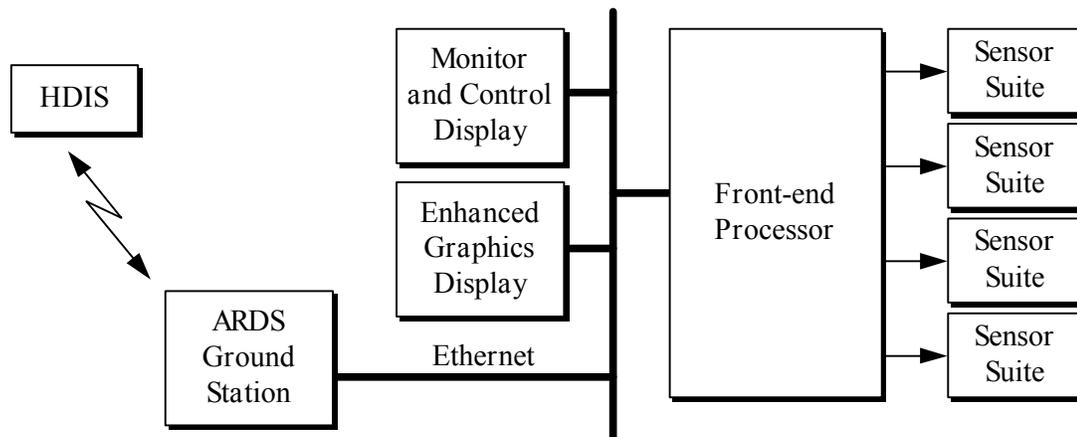


Figure 1. The MACS system architecture (shown simplified) features elements of the RAJPO GPS Tracking System, a front-end processor, and High Dynamic Instrumentation Set to conduct vehicle tracking, mission monitoring, and analysis. The MACS ground station elements include Hardware Configuration Items from the RAJPO GPS Tracking system.

Software reuse is achieved by migration of the FEP hardware platform and modifying only those Computer Software Components (CSCs) required to realize the new functionality. Figure 2 depicts a block diagram of the core CSCs and Computer Software Units (CSUs) as developed under the original system with modified units shown in reverse colorization. Four of the five original functions (Control, Range, Sensor Suite Interface, and XTERM) are retained. The Record CSC remains optional since recording functions have been migrated to the GPS tracking system. Eighty to ninety percent of newly developed software relates to new graphics processor components.

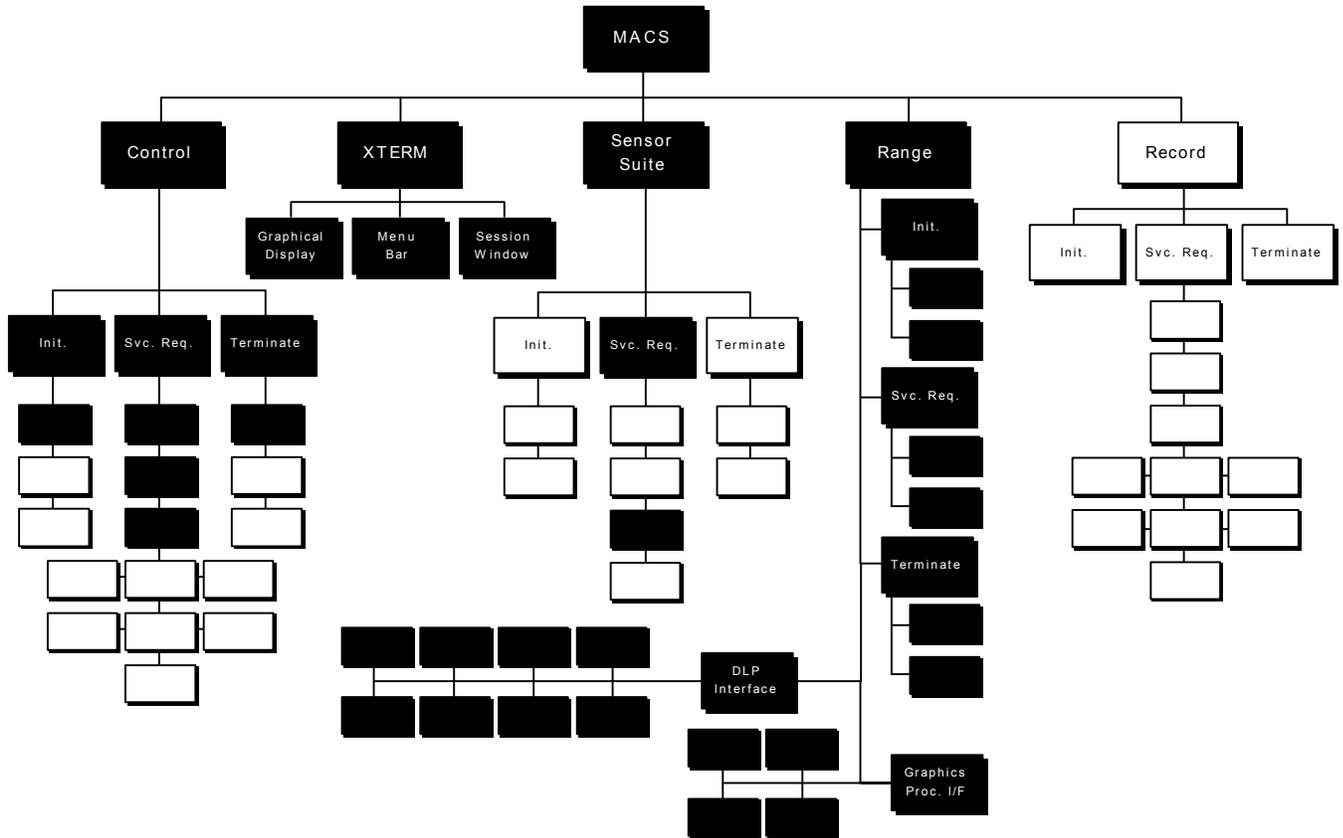


Figure 2. The MACS Software reuse scheme reduces development time, errors, and controls costs. Modified CSUs are shown in reverse colorization (CSUs shown represent actual units with titles removed for diagram clarity).

Retention of existing capabilities is achieved by segregating the previous functions as stand-alone CSCs that interact with the ACMI hardware. The new hardware/software CSCs account for the older configurations and allow operation of the system with the new FEP hardware elements.

New hardware and software was added to the system to achieve the GPS tracking capability leading to the system's mobility. The GPS tracking system (ground components) consists of a Reference Receiver/Processor, Master Remote Ground Station, Data Link System Processor, and Host Range Interface Processor - see reference 1. The graphical

interface and mission monitoring is the most significant of the MACS enhancements. It accommodates the separation from reliance ground-based multilateration systems and provides critical mission-specific data to the primary control function. The hardware platform consists of a Silicon Graphics Indigo² High Impact graphics processor with 250 MHz processor, 32 Mbytes of RAM, and enhanced graphics engine. This processor is responsible for all terrain database development and display processing for pre-mission setup and real-time mission monitoring. The database application program consists of a Coryphaeus toolset (Easy-T, Designer's Workbench, and Easy Scene, all registered trademarks of Coryphaeus Software Incorporated).

SYSTEM FUNCTIONAL CHARACTERISTICS

Control Interface

The MACS control interface function oversees incoming tracking data, recording, aircraft selection, and bus access arbitration via interfaces to the range, display/user, recording, and sensor suite handing routines. The control function maintains the MACS and sensor suite calibration data via central configuration files, accessed during system setup, operation, calibration, and modification. The control function prevents out-of-bounds operations on parameters passed between the various MACS tasks, including erroneous user inputs such as entry of real numbers into integer fields during calibration, or entering out-of-bounds calibration data.

Range Interface

The range interface function establishes a communication protocol with the GPS tracking system. Tracking data are passed to the MACS via ethernet. Basic tracking data are displayed on the MACS user console as a reference for test vehicle selection during data collection and test observation. The range interface function performs validity checks on incoming data to ensure data integrity. This function is the most affected by insertion of the new GPS tracking system, and must accommodate an entirely new set of tracking parameters and system status checks.

The range interface function is the most critical due to the impact of the GPS tracking system on the data required to derive geometric relationships between the GPS tracked target and the sensor suite or other data collection devices. Tracking data is extracted from various messages, and system health data is extracted from other embedded messages to determine the quality of received data. All range data is made available to other system CSCs via shared memory.

Sensor Suite Interface

The sensor suite interface function oversees the data communication between the MACS, the GPS tracking system, and sensor suite tracker/controller processors. Once incoming tracking data are received, the sensor suite interface function resolves the spatial relationship between the sensor suite and the on-range aircraft. These data are formatted and passed to the sensor suite tracker port via an RS-232 interface. The data path is simplex, requiring no acknowledgment of message receipt, freeing the sensor suite processor to perform independent data processing tasks.

XTERM Interface

The XTERM interface function provides the user access to the control function to establish operating parameters for a given mission. Two display modes are inherent in the MACS: 1) primary control and 2) graphical interface and mission monitoring. In the primary control mode, the display/user interface provides a control dialogue to MACS users. System-level control and monitoring functions are performed through an X-terminal/OSF Motif environment. A 900 square mile God's eye view of the range area is generated to provide a reference to establishing the GPS reference position and the relevant Defense Mapping Agency (DMA) data used to observe on-range aircraft positions relative to sensor suites. A series of pulldown menus and interactive dialogues provide the user with selection and control of MACS functions. System health checks are performed by the host. Status changes or error conditions are transmitted across the local area network to the user terminal for further operator action or acknowledgment. All essential control functions are executed at the main display, and include system setup and shutdown, participant (test article) definition, test article selection and deselection, tabular data display controls, and tracking kinematics display control.

OPERATIONAL CONSIDERATIONS

To initiate a mission scenario, the user logs on to the system and is presented with the main control menus. The user must define a local range area based on a reference latitude and longitude in close proximity to the area where the mission will occur. This action spawns a task to derive a local tangent plane coordinate system from the inputs, and after establishing the geographical area the system loads the terrain database for the area of consideration. The user further defines the mission profile including vehicle type(s) to be tracked, HDIS ID, and other tracking configuration data. Once these data are entered, the mission will be initiated automatically by the GPS tracking system. When real-time data begins to be passed to the system, the MACS processes and displays tracked target data on the appropriate screens. At this time the user can manipulate the displays and data routing to drive sensor suites or provide live or virtual inputs to a device under test. All

data can be recorded via SVHS tape (including audio and other aural cues) for post-mission review and analysis. High accuracy digital tracking data can be recorded via the GPS tracking system recording function. Differential GPS is used (either method 1 or method 2 corrections are available via the DLSP) to maintain tracking accuracy and consistency among mission participants.

DEPLOYMENT SCHEDULE

The MACS is scheduled for initial deployment to support an exercise in the Southeast United States early Q3 1996, with final acceptance testing and full operational capability to be achieved late Q3 1996. After acceptance, the MACS will be used to support a variety of advanced sensor system concept studies and will be available for reconfiguration as required to support expanded research activities.

CONCLUSION

The MACS extends experimentation capabilities by taking advantage of previously developed hardware and software without jeopardizing current capabilities. The MACS is fully capable of supporting a variety of platform interfaces including the ACMI, Red Flag Measurement and Debriefing System (RFMDS), and Navy Tactical Aircrew Combat Training System (TACTS), Joint Tactical Combat Training System (JTCTS), and other GPS-based tracking systems. The FEP open architecture and VME bus form factor provides a robust, easily expandable and flexible system platform for GPS/DGPS based experimentation.

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