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A PROTOTYPE FOR SIMULATION OF THE SPACE-TO-GROUND ASSEMBLY/CONTINGENCY SYSTEM OF SPACE STATION FREEDOM

Final Report

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ABSTRACT

This project was a continuation of work started during the Summer of 1991 when techniques and methods were investigated for simulating equipment components of the Communications and Tracking System on Space Station Freedom (SSF). The current work involved developing a design for simulation of the entire Assembly/Contingency Subsystem (ACS), which includes the Baseband Signal Processor, standard TDRSS Transponder and the RF Group antenna assembly. A design prototype of the ACS was developed.

Methods to achieving "high fidelity" real-time simulations of the ACS components on IBM-PC compatible computers were considered. The intention is to have separate component simulations running on separate personal computers (PC's), with the capability of substituting actual equipment units for those being simulated when such equipment becomes available for testing. To this end, a scheme for communication between the various simulated ACS components was developed using the serial ports of the PC's hosting the simulations. In addition, control and monitoring of ACS equipment on SSF will be via a MIL-STD 1553B bus. The proposed simulation includes actual 1553B hardware as part of the testbed.

INTRODUCTION

The design of Space Station Freedom is constantly undergoing revision and change. The Communications and Tracking (C&T) Systems in particular have undergone extensive revisions. These will impact on testing and verification schedules if current timetables are to be maintained. Since simulations of the hardware can permit testing of various aspects of a system without having all of the hardware in hand, they can permit certain levels of system testing that might not otherwise be possible. Any simulator development and implimentation methods must be flexible to readily permit modifications as further changes are (inevitably) introduced. Last summer [1], techniques and methods for simulating C&T components were investigated, and a prototype for the standard TDRSS Transponder was developed that ran on a separate IBM compatible personal computer which contained a MIL-STD 1553B bus interface card. All simulations were written in Ada, and include interfaces to the 1553B card driver software which is written in the "C" programming language. This summer, the investigation was continued by considering methods of integrating and linking together the separate equipment simulations in such a way that if an actual item of equipment were available, it could be incorporated into the testbed by removing the PC running its simulation and using the actual equipment. Such a substitution should in principle be transparent to the rest of the system.

METHOD

Paradigms for simulating operating equipment has been developed [1,2] which can be used for elements of the Assembly/ Contingency Subsystem (ACS) of Space Station Freedom (SSF). Figure 1 [3] is a diagram of the current configuration of equipment for the ACS. As a result of the work of both summers, a prototype of the Baseband Signal Processor (BSP) simulation has been added to the Standard TDRSS Transponder simulation of last summer.

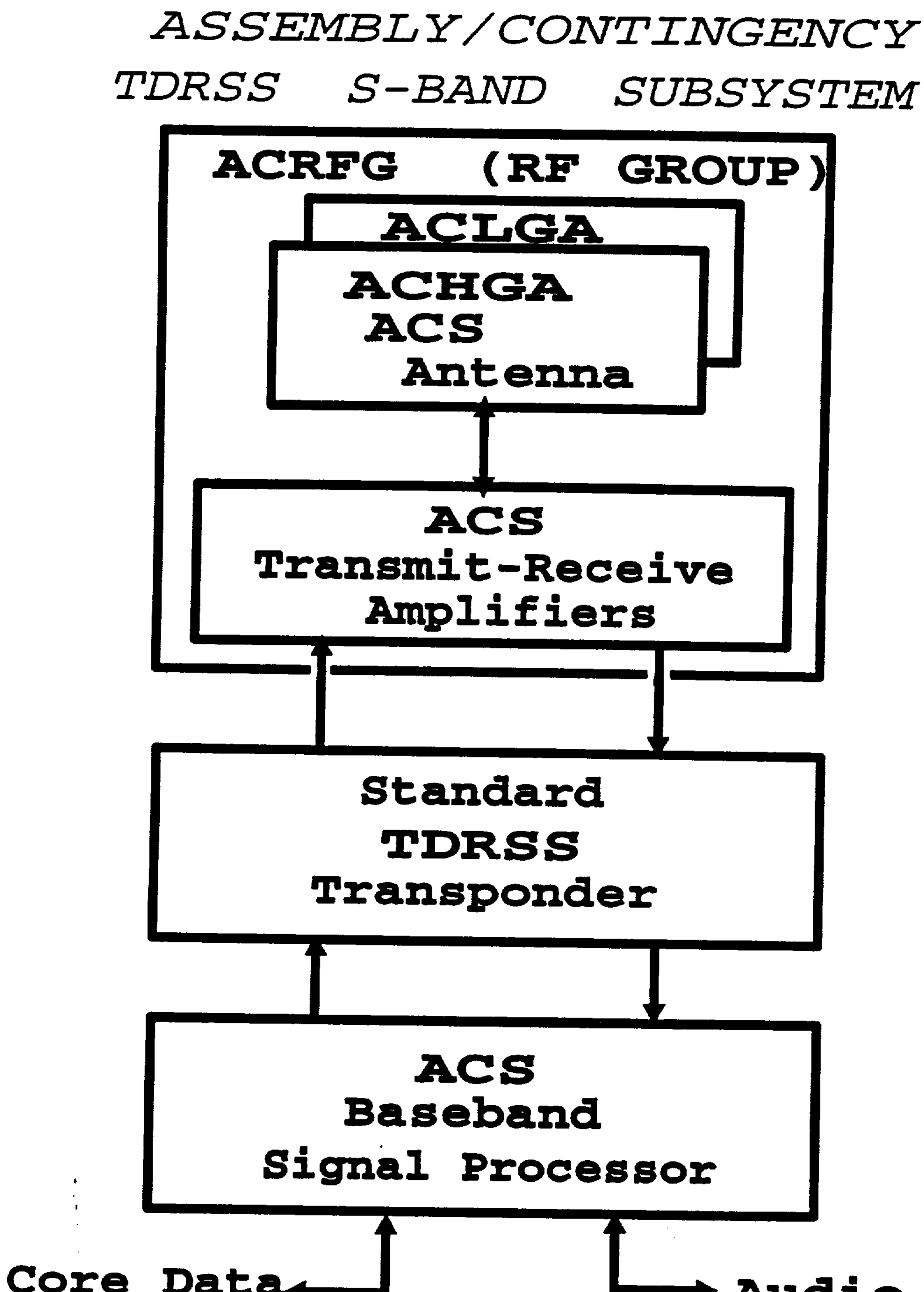
ASSEMBLY/CONTINGENCY
TDRSS S-BAND SUBSYSTEM
ACRFG (RF GROUP)
ACLGA
ACHGA
ACS
Antenna
ACS
Transmit-Receive
Amplifiers
Standard
TDRSS
Transponder
ACS
Baseband
Signal Processor
Core Data
Audio

Figure 7-1

Each simulator is written in Ada and resides on a PC/AT level (or higher) personal computer with a MIL-STD 1553B [4] interface card installed. Driver software, in C, for the cards was supplied by the manufacturer [5,6], and the Ada programs interface with these drivers. Commands are sent to the simulated equipment via the 1553B bus that connects the various PC's together in a bus "network" of the type that will exist on the space station. The form of the commands, taken from current documents [7], is the same as is anticipated to actually be used. The simulation software responds to the commands in a manner simular to that which the actual equipment would, based upon the (limited) information available at this time. The software is capable of being readily modified as more information about the actual equipment characteristics becomes available, so that the fidelity of the responses, and therefore the entire simulation, can be fine-tuned. Once an actual unit of equipment is available, it should be possible to disconnect the PC simulating that unit from the 1553B bus, and connect the unit in its place. Such a replacement should ideally be transparent to the rest of the elements on the bus.

One of the issues that had to be addressed was the need to "transmit" signals between the various pieces of equipment. In particular, if the Baseband Signal Processor is passing data to to the Standard TDRSS Transponder and the BSP fails, then this would cause the data flow to cease. The interconnection between the Transponder and the BSP must therefore also be simulated. Each of the PC's hosting a simulation was equipped with two serial ports, and it was decided to use each of these two-way ports as the means of passing "signals" between connected pieces of equipment. This means that if an actual piece of equipment is substituted for its simulation, then the 1553B bus connection will be made to the equipment, but the PC (with appropriate substitute software), will still be connected to the serial ports of the other PC's to maintain the semblance the communication string being simulated. The simultaneous use of the serial ports and the 1553B bus interface thus appears to be a viable means of achieving the signal flow emulation.

DISCUSSION and CONCLUSIONS

The major goals of this project were:

a) To establish whether a PC programmed using Ada could be used to simulate a piece of ACS equipment with sufficient fidelity, and
b) To demonstrate the capability of testing actual equipment on a testbed by substituting it for its simulation.

Although firm conclusions cannot be drawn on the basis of work done thus far, there is as yet no indication that either of the above goals cannot be met. That is, the work thus far indicates that both goals are viable using the methods described above. The main unanswered question is one of "sufficient fidelity." This will only be resolved when more information is obtained about the specifications of the various equipment. It is expected that this project will be ongoing, and that firmer answers can be made in the near future as the operational characteristics of the simulations are further developed and tested.

References:

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3. Adapted from "B1 Prime Item Development Specification Assembly/Contingency Subsystem (ACS)", Specification No. 10033098, Revision 4, GE Aerospace, Camden NJ 08102, May 9, 1991, P. 16.

4. "MIL-STD-1553 Designer's Guide, Third Edition", ILC Data Device Corporation, Bohemia NY 11716, 1990.

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7. "Software Interface Requirements Document (Communications and Tracking System Firmware-- Orbital Replacement Units and 1553 Local Bus", IRD No. GE 10033288, McDonnell Douglas Space Systems Co., Space Station Division, March 1992.