DSN Automatic Test Equipment Subsystem

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The Automatic Test Equipment Subsystem (ATE) described in this article is being implemented to provide the capability to adequately test existing and future modules to existing and future test criteria. The initial ATE will be implemented at the Deep Space Network (DSN) Maintenance Center (DMC), providing digital test capability for a cross section of DSN modules. A final ATE providing complete network support will be implemented at the DMC and all Complex Maintenance Facilities. This article presents a description of the ATE design and implementation.

I. Introduction

For quite some time, there has been an unmistakable trend toward the use of medium- and large-scale integrated circuits, hybrids, thick films, and other types of miniaturized large-scale arrays. Present test criteria and practices have become inadequate to cope with the complexity and miniaturization—not only in degree, but also in kind.

The increasing pin and function density of new printed circuit modules (brought about largely because of large-scale integration) requires a greatly increased size of test pattern, along with increasing speed. The test problems, described herein, reveal the need for a general-purpose Automatic Test Equipment Subsystem (ATE).

II. Implementation

A computerized test subsystem in response to the objectives of the DSN must be capable of change to meet the dynamic requirements described above and must also be compatible with present economic and practical constraints. A four-phase implementation plan has been developed:

(1) Phase I provides the DSN Maintenance Center (DMC) with a single automated digital test station and an automated test program generator station.

(2) Phase II provides each Complex Maintenance Facility (CMF) with an automated digital test station.

(3) Phase III provides the DMC with an automated analog test station.

(4) Phase IV provides each CMF with an automated analog test station.

The DSN will generate the functional and detailed technical requirements. The actual development will be done by a contractor.

III. Functional Description

The Deep Space Network Automatic Test Equipment Subsystem is composed of hardware, software, and maintenance personnel to provide on-line test and repair of DSN modules. The subsystem assembly functions and data flow are shown in Fig. 1. The ATE is totally modular in nature, and performs the following three main functions:

(1) Dynamic testing.

(2) Diagnostic testing.

(3) Fault finding.

A. Key Characteristics

The key characteristics of the ATE are as follows:

(1) Because of the present availability of a wide variety of programmable peripheral devices, 90% of ATE hardware will be commercial off-the-shelf equipment.

(2) The test software will be test-oriented, English-like programming language.

(3) 95% of all peripherals are programmable.

(4) Subsystem permits on-line generation and editing of test programs.

(5) Hard-copies of test results in a variety of formats.

(6) Comprehensive evaluation of test results to obtain diagnostic information.

B. Hardware

Analysis of the existing peripheral devices indicated that many problems associated with automatic test systems control (sequencing, timing, and housekeeping) are due mainly to standardization of these devices not having been realized. Other problems associated with programmable peripheral devices were identified, and it soon became evident that the workings of these devices had to be carefully examined and specified.

The basic requirements developed for the DSN ATE hardware are:

(1) The peripheral devices shall be capable of operating under computer control, and have a 32-bit word (serial and parallel) handling capability.

(2) The hardware interface between peripheral device and computer input/output (I/O) bus shall contain control logic which covers virtually every possible combination of logic required for all types of testing.

(3) The data switching employed shall allow subsystem stimulus and measurement devices to be applied to any pin or combination of pins on the unit under test. It shall be possible to simultaneously apply all such stimulus and measurement devices (whether analog or digital, or any combination thereof) to the unit under test.

(4) Although there is a large number of minicomputers available, a tradeoff analysis will be performed by the vendor, and at this time he will be aware of the DSN current and future requirements. Some of the basic requirements are as follows:

(a) Test program entry shall be via cassette tape.

(b) Controlled transfers shall be provided to and from up to 60 peripheral devices and on expandable priority interrupt system.

(c) Word size: 16 bit; memory: 64K bytes; mass storage: 5M bytes.

(d) Indirect addressing with up to N levels of nesting.

(e) Instructions to permit control of memory protection or lockout.

(f) Direct addressing of entire memory.

(g) Hardware-assisted environment switching.

(h) Automatic traps for detection of error conditions.

(i) Buffered input and output for communication with external devices; once initiated, such I/O may continue without requiring further action by the computer.

C. Test Software

The programming language must be oriented toward the unit under test (UUT), rather than toward the test subsystem itself (with which the programmer never addresses a device in the test subsystem, but only describes the test to be performed on the UUT). With such a language, the user works only with a total

subsystem. He neither knows nor cares that he has a programmable pulse generator from one manufacturer and a pulse analyzer from another. Since the DSN ATE will utilize a UUT-oriented language, the user need not have a detailed knowledge of the test subsystem. (The user need know only his own UUT.)

Some of the test language characteristics are as follows:

(1) One-to-one correspondence between statements of the test language and test functions.

(2) Statement formats may be fixed field. However, ease of use is a prime requirement.

(3) The test operator shall have the capability, via the operator's console, to define or alter test functions and parameters.

IV. Summary

Advances in technology have brought about the need and, subsequently, the existence of several commercially available general-purpose automatic test systems. The DSN need to look beyond current test problems has been realized, resulting in the implementation of the Automatic Test Equipment Subsystem described in this report.

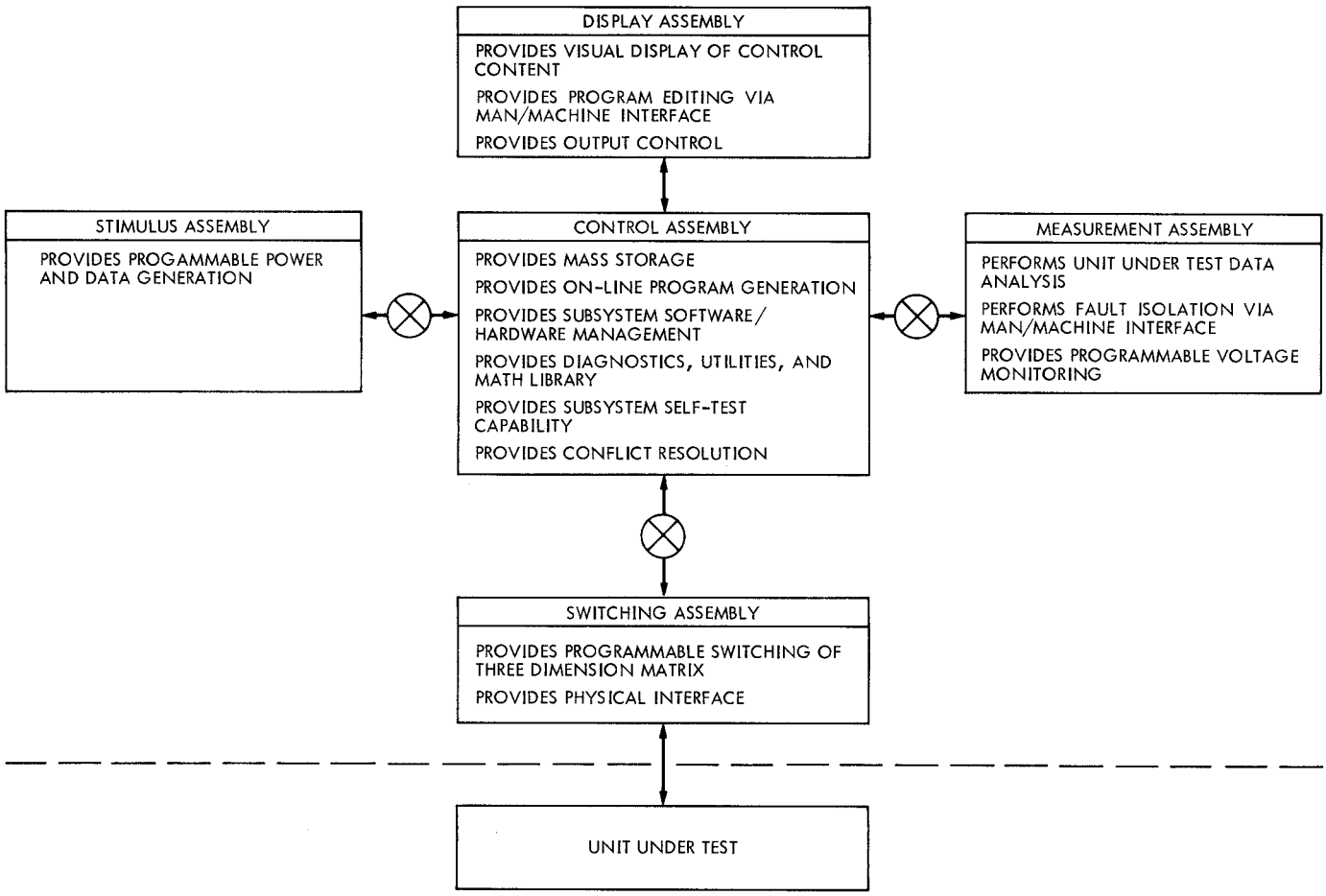

Fig. 1. Automatic Test Equipment Subsystem assembly functions and data flow