

# Current Status of the HAL/S Compiler on the Modcomp Classic 7870 Computer

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*This article presents a brief history of the HAL/S language, including the experience of other users of the language at JPL. The current status of the compiler, as implemented on the Modcomp 7870 Classic computer, and future applications in the DSN are discussed. The primary applications in the DSN will be in the Mark IVA network.*

## I. Introduction

HAL/S is the NASA standard high-order real-time programming language for avionics applications. Its most significant use to date has been the production of NASA Space Shuttle flight software. Approximately 85% of the Shuttle software is coded in HAL/S: a body of 2 million lines of comments, data declarations and executable lines of code. NASA installations using the HAL/S compiler include Johnson Space Center, AMES, Goddard, Langley, Marshall and Jet Propulsion Laboratory.

## II. History of the HAL/S Compiler

HAL/S was designed by Intermetrics, Inc., in 1972. Compilers became available in 1973 and have been in regular use by NASA and NASA contractors since that time. Host compiler systems have been implemented on an IBM 360/370, Data General Eclipse, and the Modcomp IV/Classic computers. Table 1 shows the target-host relationship.

In 1978, JPL contracted with Intermetrics to develop HAL/S compilers for the ITEK ATAC 16M, RCA 1802 and Modcomp II/IV computers hosted on an IBM 360/370, and a Modcomp II/IV compiler hosted on a Modcomp IV. The ATAC and 1802 compilers were planned to be used for the Galileo Project, and the Modcomp compilers for the Deep Space Network and the Automated Optical Navigation Project.

The Galileo Project is developing a major portion of its software for the ATAC 16M on-board flight computer in HAL/S. Development of the Galileo software is being done on an IBM 370 and the code is being downloaded to the flight computers.

The Automated Optical Navigation Project started developing software in HAL/S on a IBM 370 two years before the Modcomp compiler was completed. Their software system consists of approximately 7000 lines of HAL/S code, a few hundred lines of Fortran and no assembly language. They currently are in the process of downloading and interfacing the real-time tasks to a Modcomp IV computer.

### **III. Current Contractual Status**

All contracted HAL/S compilers have been delivered and accepted by JPL. A maintenance service for the Modcomp compiler has been operational since May 1981. HAL/S training courses are planned for the near future. These courses will be taught by Intermetrics until JPL can provide the courses.

### **IV. Current Operational Status**

The Deep Space Network has an operational HAL/S compiler hosted on a Modcomp Classic 7870 computer under the MAX IV operating system. A Time-Sharing Executive (TSX) transaction processor is used to create a simple multiuser environment. The configuration of this system currently has inputs for up to 10 HAL/S software development programmers.

Since the HAL/S-Modcomp compiler was accepted in April 1981, there have been over 20 discrepancy reports filed on the compiler. Recently, Intermetrics personnel corrected the seven most critical of these as part of the maintenance effort. It is anticipated that most of the discrepancies will be fixed before any major project uses the HAL/S-Modcomp compiler.

### **V. Future Applications**

There are four projected users of HAL/S in the DSN. These projects are the Test Support Assembly (TSA), Antenna Control Assembly (ACA), Link Monitor and Control (LMC), and the Complex Monitor and Control (CMC). The TSA project will consist of up to 75% of HAL/S code, up to 80% for ACA, and up to 90% for both of the LMC and CMC projects. The ACA project will have approximately 25,000 to 40,000 lines of software; 12,000 to 20,000 lines for the TSA project, 10,000 to 35,000 lines for the LMC project, and 16,000 to 35,000 lines for the CMC project.

### **VI. Summary**

HAL/S is useful in applications such as the Mark IVA network project. This language is appropriate for a good portion of the software required, although some assembly language will be needed for I/O handlers and interrupt drivers. In the future, the Data Systems Section intends to provide a software programming environment, including such tools as a screen editor and Development Version Control System (DVCS), to enhance the productivity advantage of coding in a high-level language.

**Table 1. HAL/S target-host relationship**

Target	Host		
	Eclipse	Modcomp IV	IBM
IBM 360/370			X
IBM AP-101	X		X
Sperry 1819A/1819B			X
Data General Nova			X
Data General Eclipse	X		X
CII Mitra 125			X
Modcomp II		X	X
Modcomp IV		X	X
NASA Std. Spacecraft Computer-1			X
NASA Std. Spacecraft Computer-2			X
ITEK ATAC 16M			X
RCA CDP 1802 COSMAC			X