An Introduction to Minicomputer Software Support

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This article discusses some problems associated with generating software for a possible Deep Space Station configuration with a multiplicity of computers, and briefly describes an effort underway to help reduce those problems. It is a general introduction to "The X930 Program Set for Sigma 5 Assembly," and "The SAPDP Program Set for Sigma 5 Assembly," which describe specific results from the development effort.

One of the likely computer configurations for the Deep Space Stations in the near future is that of a number of small computers, each one interfaced to a specific subsystem or assembly within the station, and each in turn interfaced to the other computers. Some evidence of this trend can be seen with the Data Decoder Assembly (Ref. 1) which is currently being installed in the stations, and with several additions in the RF Subsystem area that are currently in the advanced development stage. The envisioned configuration is not unlike that of the present station wherein XDS 910 and 920 computers perform antenna control, telemetry data handling, and station monitoring functions. The primary anticipated changes lie in the number of computer-interfaced functions, and in the number of distinct small computers which will reside in the station.

Developing software to run such a station could be a major problem. Trade journals, such as *Datamation*, along with their praises of minicomputers, have recently published warnings that the costs of developing software to implement a given function in a minicomputer may exceed several times the cost of the computer itself. The configuration of the typical control computer is in itself one of the contributors to this cost, since the peripherals necessary for convenient program generation are not required for the control application, and only a rudimentary assembler may be able to run in the storage available.

The answer to these problems lies in either supporting the control computer's software development on a larger machine, or acquiring the needed equipment for one control-computer installation to enable it to develop software conveniently for itself and the other installations of the same type. The first alternative has been found attractive enough to induce the development and marketing of several "cross-assemblers" for the more popular minicomputers. These, typically, provide the same features as the minicomputer's own assembler but can be run on an IBM S/360 or other medium-to-large scale machine. In some instances, the assembler of the larger machine has been used directly to support software development

for a minicomputer (Ref. 2). The primary advantage of this approach is that flexible data-definition and MACRO facilities are thereby made available to the minicomputer programmer. Such facilities, if properly used, can greatly reduce the amount of effort required to code and test a given function, and are seldom present in the minicomputer's own assembler. An attendant disadvantage is that the syntax and character set of the host assembler must be used. Having available at JPL a machine with a very flexible assembler (METASYMBOL on the XDS Sigma 5) and a need to generate minicomputer programs, this option has appeared worthy of further investigation.

The Klimasauskas and Erickson articles[1] describe MACRO packages which allow the assembly of programs for the XDS 920/930 and the PDP-11 on the Sigma 5. The input to each MACRO package is a slight variant of the source-code input to each minicomputer's own assembler. Assembly is a three-stage process, utilizing in turn, METASYMBOL, the Sigma loader, and a specialized post-processor or secondary loader. The final binary output from either package is identical to the code produced by the minicomputer's own assembler. The MACRO packages, each consisting of an approximately 500-statement MACRO deck and a 400-statement secondary loader, are specialized to the characteristics of the respective minicomputers. Either package, or, in fact, almost any conceivable MACRO package for minicomputer software development, can be used on any Sigma 5 configuration that supports the METASYMBOL assembler; i.e., 32,000-word core memory with disk, cards, and printer input/output (I/O). Assembly is essentially I/O-limited both on the Sigma 5 and on a minicomputer, and, as a result, assembly on the Sigma 5 can often be performed in one-tenth or less of the time required for assembly on the minicomputer itself. A discussion of the differences between the source-code input to each of these MACRO packages and the source-code input directly to the respective minicomputer's assembler appears in the Klimasauskas and Erickson articles, giving both the additional capabilities provided and the restrictions which must be observed.

[1]See "The X930 Program Set for Sigma 5 Assembly" by C. C. Klimasauskas, and "The SAPDP Program Set for Sigma 5 Assembly" by D. E. Erickson in this issue.

References

1. Grauling, C. R., "Data Decoder Assembly," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. IV, pp. 170–176. Jet Propulsion Laboratory, Pasadena, Calif., Aug. 15, 1971.
2. Christensen, C., and House, A. D., "A Multiprogramming Virtual Memory System for a Small Computer," Spring Joint Computer Conference, AFIPS Conference Proceedings, Vol. 36, 1970.