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CROSS SOFTWARE FOR MICROPROCESSOR PROGRAM DEVELOPMENT AT CERN

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Programs for a variety of microprocessors (including Intel 8080; Motorola 6800, 6809 and 68000; and Texas Instruments 9900) can be prepared on different host computers (such as IBM 370, CDC 6000, and Nord 10) using portable programs developed at CERN.

The range of cross software consists of: an assembler for each target microprocessor, a single linkage editor, a single object module librarian, and a variety of pre-loaders which convert object modules from CERN's format (CUFOM) into manufacturers' formats. The programs are written in BCPL and PASCAL, programming languages which are available on a wide range of computers.

Introduction

Many users of microprocessors at CERN prepare their programs on the central IBM 370 and CDC 6000 computers, or on local host computers (Nord 10). The programs are edited, assembled, linked, and prepared for loading on the host computer. They are then loaded into the microprocessor either through a low speed communications line (4800 bits/second asynchronous) to which a terminal is also connected or, in the case of microprocessors within CAMAC equipment attached to a local host, through the local host's CAMAC interface.

The necessary cross software (assemblers, linkage editor, object module librarian, and pre-loaders) has been written at CERN during the last four years, initially in the programming language BCPL and more recently in PASCAL. The following microprocessors are supported in this way: Intel 8080; Motorola 6800, 6801, 6809 and 68000; Texas Instruments 9900.

Assemblers

The first microprocessor assemblers, for the Intel 8080 and the Motorola 6800, were based on an assembler for the ModComp II, written in BCPL. They include macro facilities, but are not manufacturer compatible: there are a number of small differences between the assembly language accepted by each manufacturer's assembler and the corresponding CERN one.

The assembler for the TMS 9900 is manufacturer compatible, but does not have macro facilities. It is written in BCPL as a collection of modules, many of which are also used in the CUFOM processors described in the two following sections.

The most recent assemblers, for the Motorola 68000 and for the 6800, 6801 and 6809, are written in PASCAL. They are upward compatible with Motorola's cross macro assemblers.

Linkage editor and object module librarian

All the assemblers produce object modules in CUFOM (CERN universal format for object modules). The linkage editor links together a set of CUFOM modules to form a single CUFOM module, suitable for input to one of the pre-loaders. The object module librarian creates or updates a library of CUFOM modules, which may be used as additional input to the linkage editor.

The link editor and librarian are written in BCPL as a collection of modules.

Pre-loaders

The pre-loaders convert a single module from CUFOM into manufacturers' load module formats. There is one pre-loader for each target microprocessor and load module format. The range of load module formats includes Intel, Motorola, Texas Instruments, Tektronix, Data I/O and Prolog formats.

The pre-loaders are written in BCPL as a collection of modules.

Portability

The cross software described above can in principle be run on any computer and operating system for which BCPL and PASCAL have been implemented. There are however a number of practical difficulties which restrict the range of potential host computers.

1. A 16-bit host (for example Nord 10) cannot support the Motorola 68000 which has 24-bit addressing.

2. Computers which can directly address only 32 Kwords of memory (for example PDP-11) will have difficulty accommodating assemblies of reasonable size.

3. The main routine of each program usually has to be modified to suit the file naming and parameter passing conventions of a new host computer and operating system.

At CERN, the cross software is run on IBM 370 under OS-VS2 (MVS), on CDC 6000 under NOS/BE 1.3, and on Nord 10 under SINTRAN III. The assemblers in PASCAL run on IBM and CDC, but not on Nord. The most probable new host at CERN is the VAX 11.

Current developments

We are now trying to provide cross compilers for higher level languages for selected microprocessors. A PASCAL compiler for the TMS 9900 is being developed, using as a basis the P4 compiler from ETH Zurich. Compilers for BCPL (from Warwick University and from Siemens), for MODULA-2 (from ETH Zurich), and for M6800 MPL (from Motorola) have been or are being imported, and are in various stages of installation at CERN. It is unclear which, if any, of these languages will become popular for microprocessor applications at CERN.

History and acknowledgements

The cross assemblers for the I8080 and M6800 were developed by Chris Adams and Ian Willers, from Willers' assembler for the ModComp II. The assembler for the TMS 9900 and the CUFOM processors (linkage editor, librarian, and pre-loaders) were written by Jean Montuelle. The assembler for the M68000, and the Motorola compatible assembler for the 6800, 6801 and 6809, were written by Horst von Eicken. Several people participated in the discussions from which the first version of CUFOM emerged; they are acknowledged in [8].

The BCPL implementation for the IBM 370 was obtained from Martin Richards of Cambridge University. The CDC 6000 implementation of BCPL started in Berkeley, California. The Nord 10 implementation was written at CERN by Steve Mellor and Ian Willers. PASCAL implementations for CDC 6000 and IBM 370 have been obtained from ETH Zurich, the Australian Atomic Energy Commission, and the University of Minnesota.

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GENERAL INFORMATION ON THE PROGRAM LIBRARY OF THE CERN COMPUTER CENTRE

Contents

The CERN library of computer programs contains over 350 program packages, consisting of about 1500 subroutines, of which 90% are written in FORTRAN and the remainder in CDC and IBM assembly code, some programs also being available in special versions for other machines. Most of these programs were developed by CERN physicists and mathematicians and are therefore oriented towards the needs of a high-energy physics laboratory. However, the majority of the programs are of a general data-handling or mathematical nature, applicable to a wide range of problems. For a complete list of contents, see the paragraph below on documentation.

Reliability

Although each program package is thoroughly tested before introduction into the library, the best evidence of the validity of the programs and documentation is their extensive use both at CERN and elsewhere, and their constant maintenance by the authors and by the CERN computer users' support group. Statistics on programs usage at CERN have been maintained since 1974 and little-used programs are constantly being eliminated or replaced. On CERN's principal central computer, the CDC 7600, the average job uses about 20 library subroutines, and the average subroutine is used by 20 jobs per day.

Availability

The programs and documentation may be used freely inside CERN and are also available to other institutions under the conditions stated below under "Policy on Outside Distribution of Programs in the CERN Program Library". Programs are distributed in source form (FORTRAN or Assembler), the entire library consisting of over 100,000 card images. This source is available in any of the following formats:

(1) 80-column card images on cards or magnetic tape. Requests for this format must specify version (IBM or CDC, FORTRAN or Assembler).

(2) For CDC machines, an UPDATE OLDPL on magnetic tape.

(3) For PATCHY users, a binary PAM file on magnetic tape.

All requests for library material should be addressed to the Program Library, Data Handling Division, CERN, CH-1211 Geneva 23. Please be as specific as possible in specifying desired program version, magnetic tape format, label, density, character code etc.

Documentation

Each program package is assigned a four-character CERN code which identifies the package and indicates in which category the program has been classified. Prospective users may consult the list of program titles arranged according to the CERN code, and a keyword index is also available to help in finding a routine to solve a particular problem. More detailed information may be found in the "short write-up" consisting of one or two pages for each program package, and designed to describe it sufficiently to determine its suitability for the problem. A full set of short write-ups, along with the list of library contents, keyword list, and other general information about the library, make up the Program Library Manuals which fill two loose-leaf binders. For programs requiring additional documentation, "long write-ups" are available, which vary in length from a few pages to over a hundred pages according to the complexity of the package.

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