SP-217

RAYTHEON 520 COMPUTER

FORTRAN II

FORTRAN IV

REAL-TIME FORTRAN IV

FORTRAN

The most widely used compiler language is called FORTRAN, an abbreviation of FORmula TRANslation. FORTRAN processors have been made available for many types of digital computers, large and small. FORTRAN is an *algebraic compiler* since many of the statements allowable in the FORTRAN language closely resemble ordinary algebraic formulas. Other types of compiler language, COBOL, for example, are designed primarily for business and commercial applications rather than for scientific and engineering calculations.

One of the main advantages of FORTRAN is that it is easy to learn. With relatively brief training and practice, a scientist or engineer can acquire sufficient fluency in FORTRAN to do his own computer programming for simpler computing problems and to understand and assist with more complicated programs written in FORTRAN by programming specialists.

FORTRAN is not only a language in which a human speaks to a computer; one of its most important uses is to enable scientists, engineers, and programmers to talk to *each other* about computers and computations.

Raytheon makes three major FORTRAN packages available to users of the 520 Computer System. They are Extended FORTRAN II, FORTRAN IV and Real-Time FORTRAN IV. Each is a separate and distinct processor from the other two, eliminating the overhead processing penalties usually associated with multi-purpose FORTRAN processors. Raytheon FORTRAN IV and real Real-Time FORTRAN IV include all the features of the ASA standard.

Extended FORTRAN II

By use of the most recent discoveries in advanced programming techniques, Raytheon FORTRAN II has excluded many existing restrictions in the language, making it more versatile and easier to use. Removal of these restrictions was accomplished without any sacrifice of object program efficiency. Here are some of the compiler's features:

Names in FORTRAN II may have up to 40 characters rather than being restricted to six as in many FORTRAN processors. This applies not only to variable names but also to statement names, function names, etc. throughout the language.

Names as well as numbers are allowed as statement designation. They are subject to the same restrictions as other names in FORTRAN: e.g., the first character must be a letter and subsequent characters must be either letters or numbers and not special characters.

Arrays are no longer restricted to three dimensions but may have as many as 32. In Raytheon FORTRAN II any expression may be used as a subscript. Subscripted variables may appear in the expressions and subscripts.

Floating point expressions are accepted as subscripts; they are truncated in the standard manner before they are used as subscripts. Function values of any of the four function types may also appear as subscripts or in expressions used as subscripts.

An expression may have fixed-point and floating-point operands. Mixed-mode expressions will have floating point results. Entire arithmetic statements may be imbedded within larger statements.

The index of a DO-loop is always defined and is always available as a fixed-point variable no matter how the exit from the loop occurs. The first statement in the range of a DO-loop is no different from any other statement; it need not be executable. The index may be either incremented or decremented at the option of the programmer.

FORTRAN IV

Raytheon Computer's FORTRAN IV is language compatible with FORTRAN IV (version 13) used with IBM's 7094 and is a sub-set of the FORTRAN IV designed for System/360 machines. This compatibility in an efficient one-pass processor is available only with Raytheon Computer's 520.

Raytheon's FORTRAN IV allows exchange of programs between the 520 and the 7094 and debugging of many 7094/360 programs on a 520 when either of the other machines is not available. Debugging is done faster if the 520 is equipped with its optional 1 microsecond memory and at lower cost, since the 520 runs about 1/20 the cost of the 7094 on an hourly basis. Equipment requirements are minimized too, since Raytheon FORTRAN IV runs on a 520 with an 8K memory with paper tape and typewriter.

With Raytheon FORTRAN IV real-time and hybrid installations can use the 520 for data reduction and hybrid support programs which otherwise have to be run on a 7094.

The majority of FORTRAN programmers are familiar with this language; those who do require training will be learning a language that is the most widely used in the industry. Documentation effort and expense are also reduced.

Other features:

SYSTEM OPERATION

Raytheon 520 FORTRAN is a one-pass processor. The processor uses a maximum 6,000 words of memory including a symbol table capacity for up to 300 unique identifiers. The processor is relocatable, self-initializing, and interruptible. It is a 520 Monitor System routine and operates with three other co-resident system routines. These companion routines are supplied by Raytheon and their storage requirements are independent of those specified for the processor.

The BOSS Monitor System controls processing sequences (such as Load and Go, batch processing, etc.) and supplies the processor with job parameters (such as diagnostic and output options, etc.). Job parameters are available to the processor from fixed memory locations in BOSS. The processor receives control from and returns control to BOSS for each compilation.

DIAGNOSTIC CAPABILITIES

Source language diagnostics are comprehensive and designed to provide maximum assistance to the programmer. Diagnostic processing proceeds where errors are found so that the maximum amount of error information may be obtained from each run. More than 30 error types are explicitly identified.

LOGICAL OPERATORS

The logical operators NOT, AND, and OR are permitted in FORTRAN IV.

SEVEN DIMENSIONAL ARRAYS

Up to seven dimensions may be specified in an array-declarator subscript. Therefore, an array is an ordered set of data of one, two, three, four, five, six or seven dimensions in 520 FORTRAN.

MIXED-MODE ARITHMETIC

The Raytheon 520 FORTRAN permits mixing of integer and real data as well as the mode mixing allowed in ASA FORTRAN in arithmetic expressions.

PROGRAM SEGMENTING

Program units too large to fit in available memory may be subdivided into segments for compilation and execution by calling the Link routine.

Other features:

Restrictions on naming functions, identifiers, and variables are substantially relaxed. Statement numbers can be arguments to subprograms. Subscripts in these compilers are standard IBM formats and sub-program calls allow for a variable number of arguments.

OPTIMIZATION

Optimization features that help provide more efficient object code include the following:

Common sub-expressions including subscripts within each sub-expression are only computed once over each statement.

Constant subscripts or portions thereof are combined with the array base address by the processor.

Integer exponentiation is replaced by successive multiplications when it is advantageous to do so.

Logical expressions (in FORTRAN only) are evaluated so that redundant terms are eliminated and individual terms are not unnecessarily interrogated.

Unnecessary load and store operations are minimized.

REAL-TIME FORTRAN IV

The real-time version of FORTRAN IV contains these additional features:

RECURSIVE Statement

Subprogram and function subprogram statements can be preceded by the word RECURSIVE. This causes the subprogram to be compiled so that it is recursive. During program execution this subprogram may call itself or be interrupted and called by the interrupt service routine without destroying any information. The recursive feature is implemented by use of a run-time dynamic storage allocation routine which can be called directly by a programmer if he wishes to make use of it.

PROTECT Statement

A PROTECT Statement may be placed at the beginning of any subprogram. This will inhibit all interrupts until that subprogram has completed execution and returned control to the calling program.

CONNECT Statement

The CONNECT statement when executed connects an interrupt to a subprogram. Therefore, in a main program a user may execute the statement CONNECT (2,ABC) which means connect the second interrupt to the subprogram named ABC. Execution of the main program continues, and when the second level interrupt occurs, control is automatically transferred to the subprogram ABC. When ABC completes execution control is automatically returned to the point in the main program where it was interrupted.

In-Line Assembly Language

FLEXTRAN assembly language commands

may be intermixed with FORTRAN statements. This allows a user to optimize loops, handle special real-time peripheral devices, or do special data manipulation operations that cannot be performed conveniently in FORTRAN language.

COUNT TIME Statement

A COUNT TIME statement can be used to accumulate execution times for any specified segment of a FORTRAN program. It accumulates the times in microseconds of all instructions between the COUNT TIME statement and a specified statement number.

DEBUGGING FEATURES

TRACE

The dynamic TRACE mode permits tracing of sections of programs or entire programs during debugging.

Memory Map

At the end of each main program and subprogram a Memory Map is printed. This consists of a list of all variables and statement numbers and the relocatable addresses which they have been assigned. The Memory Map also includes all variables that are in COMMON and the addresses they have been assigned.

DUMP

DUMP and PDUMP are library subroutines which allow the user to take snapshot dumps of core memory. In the call to these dump routines the user can specify whether the dump should be in floating point, integer, octal, or octal with mnemonics.

RAYTHEON COMPUTER
2700 S. Fairview St., Santa Ana, Calif. 92704
Phone: 714-546-7160 • TWX 714-546-0444

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