



Software Product Description

PRODUCT NAME: KAP™ Fortran Version 3.2
for OpenVMS®

SPD 38.50.07

DESCRIPTION

KAP™ Fortran Version 3.2 for *OpenVMS®* from Compaq is developed by Kuck & Associates, Incorporated (KAI), and is distributed under the Standard Terms and Conditions from Compaq Computer Corporation.

The KAP Fortran optimizer is a FORTRAN-language, source-to-source preprocessor that restructures code for improved performance on serial and parallel processors. The KAP optimizer performs an *interprocedural dependence analysis* (IPA), allowing it to use advanced optimizations safely. When installed, the KAP optimizer integrates with the *Compaq Fortran* compiler for seamless operation. Major capabilities of the KAP Fortran optimizer include:

- Automatic and directed parallel decomposition for SMP
- Loop optimizations
- Memory management optimizations
- Scalar optimizations
- Function inlining
- BLAS recognition
- "Dusty Deck" transformations
- Informational program listings

Parallel Decomposition Support

The KAP Fortran product provides true shared memory multiprocessing capabilities for AlphaServer Symmetric Multiprocessing (SMP) systems from Compaq, providing the ability to do automatic, guided automatic and directed parallel decomposition of Fortran codes.

When performing *automatic parallel decomposition*, the KAP Fortran optimizer will:

1. Analyze the code;
2. Identify the compute intensive loops that are candidates for parallelization;
3. Determine if the selected loops can be safely executed in parallel;
4. Transform the code, creating and managing the parallel threads;
5. Insert all necessary synchronization points.

Because a primary objective of the automatic parallel decomposition is to produce a correct parallel program, the KAP optimizer will skip loops that cannot be properly analyzed, whether due to lack of information at compile time or to complex program structure. The advanced programmer can often improve parallel efficiency by guiding KAP in performing automatic parallel decomposition, supplying missing information through the use of directives, assertions, and command-line options.

When performing *directed decomposition*, the KAP optimizer accepts a subset of the ANSI X3H5 parallel directives. Directed decomposition requires the programmer to identify parallel regions and loops and manage all necessary synchronization. KAP scalar optimizations are disabled within parallel regions. It is possible to combine both directed and automatic decomposition within one program by defining specific parallel regions with directives, and then using the concurrent option when compiling to automatically parallelize the remaining regions.

Parallel Run-Time Environment

The KAP optimizers from Compaq for Fortran and C all share a common run-time environment based on DEC-threads. Programs may be composed of modules written in one or more of the three languages, and may be parallelized by use of the appropriate KAP optimizers.

A program processed with a KAP optimizer may be given one or more of the following options at run time by setting environment variables:

- Set number of threads to use (normally set to number of processors)
- Schedule for fastest turnaround or maximum throughput
- Allocate additional thread stack

Loop Optimizations

The KAP Fortran optimizers provide a variety of loop transformations intended to improve execution performance. These include:

- Inner loop unrolling
- Loop interchange
- Loop fusion
- Loop splitting
- Loop rerolling
- Loop distribution
- Loop peeling

Memory Management Optimizations

The KAP Fortran optimizers perform several optimizations that conserve memory resources and improve data locality. These include:

- Outer loop (two-dimensional) unrolling to block data for the cache
- COMMON block padding
- COMMON block alignment
- Storage order specification

Function and Subroutine Inlining

The KAP Fortran optimizers can selectively insert both function and subroutine code into the main code stream, a capability referred to as "inlining." Inlining a function allows the KAP optimizer to include the function code in its IPA, resulting in a more thorough analysis and optimization. Inlining also eliminates the call overhead and may enable better code scheduling by the compiler.

In addition to inlining, the KAP Fortran optimizers can perform only the IPA operation on a function or subroutine. When this option is selected, the function or subroutine is temporarily inlined while IPA is performed, and then is removed. The IPA analysis option provides the benefit of an improved interprocedural analysis without the code size expansion that results from inlining. The source of function and subroutine code for inlining or IPA can be a specific set of files, or a special inline library that is built and maintained by the KAP optimizer.

BLAS Recognition

The KAP Fortran optimizers can recognize common linear algebra algorithms and substitute function calls to the industry-standard Basic Linear Algebra Subroutines (BLAS). The program can then be linked against a library containing an optimized version of the BLAS, such as the *Digital Extended Math Library*. The KAP optimizers recognize most Level 1, 2, and 3 BLAS.

Scalar Optimizations

The KAP Fortran optimizers perform many standard scalar compiler optimizations, including:

- Dead code elimination
- Induction variable recognition
- Invariant IF restructuring
- Reciprocal substitution
- Global forward substitution
- Lifetime analysis

"Dusty Deck" Transformations

The KAP Fortran optimizers transform many obsolete and inefficient code structures into more modern structures. These older constructs often inhibit compiler optimizations and interfere with code scheduling. The KAP optimizers perform the following transformations:

- Convert logical IF-GOTO to block IF.
- Convert IF branches to DO loop.
- Convert adjacent IFs to IF-THEN-ELSE.
- Remove zero-trip IFs from around DO loops.

Informational Program Listings

The KAP Fortran optimizers optionally provide an informational listing file of the program, outlining the results of its processing. The content of the listing file may be controlled through an option switch. Content options include:

- Annotated original program listing
- Call tree of entire program
- KAP options used for each program unit

- Loop optimization table for each program unit
- Program unit names inserted in error output as they are processed
- Compilation performance statistics
- Loop summary table
- Transformed program listing

In each program listing produced, the following information is supplied, if relevant:

- Line numbers
- DO loop markings
- INCLUDE file markings
- Footnotes detailing important actions taken or conditions that may require attention, such as data dependences that inhibit parallel decomposition
- Syntax Error or Warning messages
- Questions generated by the KAP optimizer
- Summary of actions taken by the KAP optimizer

Control of KAP Options

The KAP Fortran products are provided with a set of default option settings. While the default settings make the KAP products easier to use, they may not provide optimal performance for every program. And because some transformations change the order of computation, some numerical differences in results may occur in sensitive programs. The KAP Fortran products provide a large set of command qualifiers and in-source directives and assertions that allow the advanced user to customize the applied transformations for a particular application program. For cases where the application is sensitive to accumulated rounding error, the optimization level may need to be reduced. Consult the product documentation for advice on using the many options provided.

Supported Language Dialects

The KAP Fortran product supports the ANSI Fortran standard syntax. In addition, KAP accepts *Compaq Fortran* extensions to ANSI Fortran, with the following known exceptions:

- I/O statement UNLOCK
- Use of quotation mark character (") as delimiter for character constants
- Compilation control statements OPTIONS and DICTIONARY

Run-Time Library Distribution

The KAP Fortran product kits include one or more Run-Time Libraries that are needed to support the execution of certain KAP functions. You may copy and distribute royalty-free the Run-Time Libraries ("RTLs") with your application, provided that you:

- Distribute the RTLs only in conjunction with and as a part of your application.
- Include KAI's copyright notice on each copy of the application software media.
- Do not use the name, logo, or trademarks from Compaq or KAI to market your application.
- Agree to indemnify, hold harmless, and defend both Compaq and KAI from and against any claims or lawsuits, including attorney's fees, that arise or result from the use or distribution of your application.

For *OpenVMS Alpha* systems, the parallel library is designated as KMP.OLB.

HARDWARE REQUIREMENTS

The KAP Fortran Preprocessor from Compaq will operate on any AlphaStation or AlphaServer capable of running *OpenVMS*. Table 1 lists the disk space requirements.

Table 1

Disk Space Requirements (block Cluster size = 1)

TASK	SIZE
Installation:	24,000 blocks (12 MB)
Permanent:	24,000 blocks (12 MB)

These counts refer to the disk space required on the system disk. The sizes are approximate; actual sizes may vary depending on the user's system environment, configuration, and software options.

Parallel Processing Hardware Requirements:

Multiprocessor Alpha systems are required for proper operation of parallel loops. However, an application compiled using KAP's parallel decomposition option will run on single-processor systems for compatibility purposes, but may run slower than the serial version compiled without the option.

SOFTWARE REQUIREMENTS

For systems using terminals (no *DECwindows* interface):

- *OpenVMS Alpha Operating System V7.2*
- *Compaq Fortran for OpenVMS Alpha V7.2*

For workstations running *DECwindows*:

- *OpenVMS Alpha Operating System V7.2*
- *Compaq Fortran for OpenVMS Alpha V7.2*

For Workstations Running *DECwindows* using Motif®:

- *OpenVMS Alpha Operating System V7.2*
- *DECwindows Motif V1.2 for OpenVMS Alpha*
- *Compaq Fortran for OpenVMS Alpha V7.2*

Note that Versions 7.0-7.2 of *Compaq Fortran* contain both Fortran 77 and Fortran 90 compilers. KAP Fortran uses the Compaq Fortran 90 compiler. Fortran 77 code can still be processed; however, the KAP output may include Fortran 90 constructs that the Fortran 77 compiler cannot handle.

Note that KAP Fortran does not perform transformations on program units that contain DICTONARY statements accessing data structures declared using the CDD/Repository product.

OpenVMS Tailoring

The following OpenVMS classes are required for full functionality of this layered product:

- OpenVMS Required Saveset
- Programming support
- Utilities

OPTIONAL SOFTWARE

- *Digital Extended Math Library V2.9 for OpenVMS Alpha*

SOFTWARE LICENSING

This software is furnished only under a license. Traditional licenses are available. For more information about licensing terms and policies from Compaq, contact your local Compaq office or Compaq partner.

License Management Facility Support

This layered product supports the *OpenVMS License Management Facility*.

License units for this product are allocated on an Unlimited System Use basis.

For more information on the *OpenVMS License Management Facility*, refer to the *OpenVMS Operating System Software Product Description* or documentation.

GROWTH CONSIDERATIONS

The minimum hardware and software requirements for any future version of this product may be different from the requirements for the current version.

DISTRIBUTION MEDIA

These products are distributed on the Compaq CD-ROM Software Library for *OpenVMS*, and are also available as an individual product CD-ROM.

The software documentation for this product is available as part of the *Compaq OpenVMS Online Documentation Library* on CD-ROM (QA-0HAAA-H8). A separate printed documentation set may also be ordered.

YEAR 2000 READY

This product is Year 2000 Ready.

Year 2000 Ready is defined: "Year 2000 Ready" products are defined by Compaq as products capable of accurately processing, providing, and/or receiving date data from, into and between the twentieth and the twenty-first centuries, and the years 1999 and 2000, including leap year calculations, when used in accordance with the associated product documentation and provided that all hardware, firmware, and software used in combination with such products properly exchange accurate date data with the products.

For additional information visit the DIGITAL Brand area on Compaq's Year 2000 Ready web site located at <http://www.compaq.com/year2000/warranties3.html>.

SOFTWARE WARRANTY

This software is provided by Compaq with a 90 day conformance warranty in accordance with the Compaq warranty terms applicable to the license purchase.

ORDERING INFORMATION

KAP Fortran:

Unlimited Use Software Licenses: QL-0HAA*-**

Software Media/Documentation: QA-0HAAA-H8

Software Documentation: QA-0HAAA-GZ

Software Product Services: QT-0HAA*-**

* Denotes variant fields. For additional information on available licenses, services, and media, refer to the appropriate price book.

SOFTWARE PRODUCT SERVICES

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