



# Software Product Description

PRODUCT NAME: Compaq KAP™ C/OpenMP Version 4.2 for Tru64 UNIX®

SPD 45.73.11

## DESCRIPTION

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

The Compaq KAP™ for C/OpenMP for Tru64 UNIX product is developed by KAI Software, a Division of Intel Americas, Inc. (KAI), and is distributed under Compaq Computer Corporation's Standard Terms and Conditions. This product is the successor to DIGITAL KAP for C for DIGITAL UNIX.

### *Major Optimization Capabilities*

- Automatic parallel decomposition for SMP
- Loop optimizations
- Memory management optimizations
- Scalar optimizations
- Function inlining
- Informational program listings

### *Parallel Decomposition Support*

The Compaq KAP C/OpenMP product provides true shared memory multiprocessing capabilities for Compaq AlphaServer Symmetric Multiprocessing (SMP) systems, providing the ability to do automatic and guided automatic decomposition of C codes. The Compaq KAP C/OpenMP V4.2 product supports the OpenMP C directives, as defined in the specification published by the OpenMP Architecture Review

Board (<http://www.openmp.org>). The Compaq KAP C/OpenMP V4.2 product now automatically inserts OpenMP parallel directives for processing by the Compaq C compiler, rather than calls to a parallel run time library. There is no support for OpenMP C++ directives.

When performing *automatic parallel decomposition*, the Compaq KAP C/OpenMP 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, inserting OpenMP directives;
5. insert all necessary synchronization points.

Because a primary objective of the automatic parallel decomposition facility is to produce a correct parallel program, the Compaq KAP C/OpenMP optimizer must often pass up opportunities to parallelize loops that cannot be properly analyzed due to lack of information or complex program structure. The advanced programmer can often improve parallel efficiency by guiding the Compaq KAP C/OpenMP optimizer in performing automatic parallel decomposition, supplying missing information through the use of directives, assertions, and command line options.

### *Parallel Run Time Environment*

For programs parallelized using OpenMP directives, consult the Compaq C documentation for run time options.

NOTE: Modules using OpenMP directives and processed by the compiler may not be mixed with modules using the Compaq KAP parallel RTL produced by previous versions of the Compaq KAP optimizer.

#### *Loop Optimizations*

The Compaq KAP C/OpenMP optimizer provides 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 Compaq KAP C/OpenMP optimizer provides several optimizations to conserve memory resources and improve data locality. These include:

- Outer loop (two-dimensional) unrolling to block data for the cache
- Natural data alignment

#### *Function Inlining*

The Compaq KAP C/OpenMP optimizer can selectively insert both function and subroutine code into the main code stream, a capability referred to as "inlining". Inlining a function allows the Compaq KAP C/OpenMP 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 Compaq KAP C/OpenMP optimizer 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 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 file that is built and maintained by the Compaq KAP C/OpenMP optimizer.

#### *Scalar Optimizations*

The Compaq KAP C/OpenMP optimizer can perform many standard scalar compiler optimizations, including:

- Dead code elimination

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

#### *Informational Program Listings*

The Compaq KAP C/OpenMP optimizer optionally provides an informational listing file, outlining the results of its processing. The content of the listing file may be controlled through an option switch. Content options include:

- 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, summarizing number of loops transformed
- Transformed program listing

#### *Control of KAP Options*

The Compaq KAP C/OpenMP optimizer is provided with a set of default option settings. While the default settings make the optimizer easier to use, they may not provide optimal performance for every program. And, since some of the transformations change the order of computation, some numerical differences in results may occur in sensitive programs. The Compaq KAP C/OpenMP optimizer provides a large set of command qualifiers and in-source directives and assertions that allow the advanced user to customize KAP 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 user documentation for advice on using the many options provided.

#### *Run-Time Library Distribution*

The Compaq KAP C/OpenMP kit includes one or more Run-Time Libraries that are needed to support the execution of certain Compaq KAP functions. You may copy and distribute royalty-free the Run-Time Libraries (the "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;

- do not use the Compaq or KAI name, logo, or trademarks 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 Compaq KAP C/OpenMP V4.2, the RTL images are designated as:

- libkio.a

## HARDWARE REQUIREMENTS

Compaq KAP C/OpenMP V4.2 for Tru64 UNIX will operate on any AlphaStation or AlphaServer capable of running Tru64 UNIX.

### Disk Space Requirements

Disk space required for installation:

Root file system:	/ 0 KB
Other file systems:	/usr 10,000 KB
	/tmp 3 KB
	/var 0 KB

Disk space required for use (permanent):

Root file system:	/ 0 KB
Other file systems:	/usr 10,000 KB
	/var 0 KB

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.

## SOFTWARE REQUIREMENTS

*For Compaq Tru64 UNIX Systems:*

- Compaq Tru64 UNIX Operating System, V4.0D-V4.0G or V5.0-V5.1
- Developer's Toolkit for Tru64 UNIX V4.0D-V4.0G or V5.0-V5.1 (SPD 44.36)
- For V4.0F only, Developer's Toolkit Supplement V4.0F

## GROWTH CONSIDERATIONS

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

## DISTRIBUTION MEDIA

This product is distributed on the Compaq CD-ROM Software Library for Tru64 UNIX and is also available as an individual product CD-ROM.

The software documentation for this product is available as part of the Tru64 UNIX Online Documentation Library on CD-ROM (QA-054AA-H8), and is also available as a printed documentation set.

## ORDERING INFORMATION

Unlimited Use Software Licenses:	QL-0HHA*-AA
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