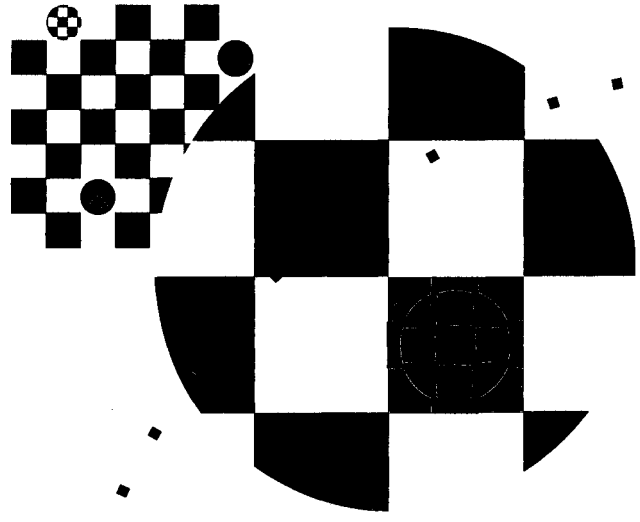

CONVEX

CXpa Reference

Second Edition

HEWLETT® PACKARD

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Contents

Using this book

Purpose and audience

The *CXpa Reference* is both a user's guide and a reference. This book introduces new users to CXpa and describes the metrics, graphs, reports, commands, and interfaces that are available in the CXpa software. This book is also available through the CXpa online help system.

Organization

This manual is organized as follows:

- **Part I, "Using CXpa"**—Contains three chapters that introduce new users to CXpa.
  - **Chapter 1, "Introduction"**—Introduces CXpa and profiling to new users.
  - **Chapter 2, "Preparing programs for profiling with CXpa"**—Contains instructions for compiling executables and instrumenting object files and archive libraries.
  - **Chapter 3, "Choosing performance data to collect"**—Introduces and describes the types of metrics that can be collected on each architecture and how to select source code regions and metrics for profiling.
- **Part II, "Reference pages"**—Contains four chapters.
  - **Chapter 4, "Reports"**—Contains detailed descriptions of the textual performance reports that CXpa creates.
  - **Chapter 5, "Windows"**—Contains descriptions and instructions for using each window and dialog used in CXpa's X window interface.
  - **Chapter 6, "Commands"**—Contains descriptions, syntax rules, and examples for all CXpa commands.
  - **Chapter 7, "Messages"**—Lists and explains CXpa messages.
- **Glossary**
- **Index**

Notational conventions

This document uses the following notational conventions.

Command syntax

Consider this example:

```
(CXpa) command <param1> [, ...] {a | b} [<param2>]
  ①      ②       ③        ④     ⑤       ⑥
```

① `(CXpa)` is the CXpa command prompt.

② **`command`** must be typed as it appears.

③ *<param1>* indicates a parameter that must be supplied by the user.

④ The horizontal ellipsis in brackets [, ...] indicates that more than one of the preceding parameter can be specified.

⑤ Either **`a`** or **`b`** must be specified.

⑥ [*<param2>*] indicates an optional parameter. All items in brackets are optional.

General conventions

- **`Bold constant-width font`** identifies user input in examples.
- *Italics*:
  - Designate user-supplied variables in a command-line example (when enclosed in <>)
  - Indicate document titles
- `Constant-width font` designates input and output, including:
  - Command names and options
  - System calls
  - Program statements, command output, and error messages returned
- Horizontal ellipsis (...) shows repetition of the preceding item(s).
- Vertical ellipsis shows that lines have been left out of an example.

- Words and abbreviations that indicate keyboard keys you press are identified in a distinctive bold type. For example, **RETURN** refers to the carriage return key. Words separated by a hyphen indicate two keys that you press simultaneously. For example, **CTRL-X** indicates that you must press and hold down the **CTRL** key and then press the **X** key.
- The shell prompt is shown as a percent sign (%).
- Unless otherwise indicated, source code examples are in Fortran.

Notes

NOTE: A NOTE highlights information that may be of particular interest regarding the software or your files.

Architecture dependencies

The architecture of the computer system can affect some aspects of CXpa and the program you are profiling. These architecture dependencies are indicated in several ways throughout this book.

If the entire reference topic applies to a particular architecture, it is marked by a symbol similar to the following:

The above symbol means that the reference topic applies to SPP 1200 machines only.

In other cases, architecture dependencies are indicated by the title of a section or by a notation in parentheses.

Associated documents

For more information, refer to the following books:

- *Exemplar Programming Guide* (Order No. DSW-067)—Describes efficient methods for programming in Convex C and Fortran on Exemplar SPP Series computers. Topics covered include the SPP Series programming model, automatic optimizations, basic and advanced manual optimizations, and the Convex Compiler Parallel Support Library (CPSlib).
- *Exemplar SPP 1000/1200/1600 Architecture* (Order No. DHW 014)—Describes the implementation of scalable parallel processing on Exemplar SPP1000, SPP1200, and SPP1600 Series machines.
- *PVM/GSM User's Guide for Exemplar Systems* (Order No. DSW-501)—Describes how to use the Convex Parallel Virtual Machine for Global Shared Memory (PVM/GSM), a programming model for Exemplar systems. PVM/GSM enables programmers to use an Exemplar system as a set of processing entities that communicate through message passing.
- *MPICH User's Guide for Exemplar Systems* (DSW-493)—Documents the implementation of the Message Passing Interface (MPI) standard on SPP Series systems.
- *C++ Programming Guide for Exemplar Systems* (Order No. DSW-621)—Describes how to use the C++ compiler for Exemplar systems.
- *Fortran Language Reference* (Order No. DSW-037), *Fortran User's Guide* (Order No. DSW-037)—Documents the Convex Fortran compiler.
- *C User's Guide* (Order No. DSW-086)—Documents the Convex C compiler.
- *PA-RISC 1.1 Architecture and Instruction Set Reference Manual,* available from Hewlett-Packard (HP Manual Part Number 09740-90039).

Ordering documentation

To order the current edition of this or any other Convex Technology Center document, send requests to:

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P.O. Box 833851
Richardson TX75083-3851 USA

Include the order number (DSW or DHW) or the exact title of the document.

Technical assistance

If you have questions that are not answered in this book, contact the Hewlett-Packard Convex Technical Assistance Center (TAC) at the following locations:

- Within the continental U.S., call 1 (800) 952-0379.
- From Canada, call 1 (800) 345-2384.
- All other locations, contact the local Convex Technology Center office.

The `contact` utility

The TAC recommends using the `contact` utility to report a hardware, software, or documentation problem. The `contact` utility is an interactive program that helps the TAC track reports and route them to the personnel most qualified to fix a problem.

After you invoke `contact`, it prompts you for information about the problem. When you finish your report, `contact` mails it to the TAC electronically. The TAC notifies you within 48 hours that your report has been received.

Using `contact` requires:

- UNIX-to-UNIX Communication Protocol (UUCP) connection to the TAC
- Full path name of the program or utility in question
- Version number of the program or utility in question

Refer to the contact(1) man page for complete details.

Acknowledgments

The author of this book would like to thank the following people for their contributions to this book:

- Brent Henderson and Chuck Summers, for their thorough, enlightening, and timely technical reviews and explanations.
- Richard Hargrove, Duane Eitzen, and Chuck Franke, whose technical reviews and comments improved the usability and technical accuracy of this book.
- Jerry Hill and Scott Cox, for editorial and peer reviews.
- Gary Brooks, Janet Greathouse, and Marilyn Lutz, for providing the support, vision, and resources necessary to make CXpa and this book possible.

—Clare Bernier

Part 1 Using CXpa

Part 1 of this book introduces new users to CXpa and contains the following chapters and subjects:

1. Introduction
   - What is a profiler?
   - Why use a profiler?
   - Steps for learning CXpa
   - Overview of CXpa
   - CXpa limitations
   - Learning CXpa quickly
   - Performance data files (PDFs)
   - Analyzing PDFs only
   - Profiling strategy
   - Using batch execution
   - Using pre-instrumented executables
   - Profiling message-passing applications with CXpa
   - CXpa and the `mpa` utility
   - Using online help
2. Preparing programs for profiling with CXpa
   - Compiling for CXpa
   - Profiling HP PA-RISC object files and archive libraries
3. Choosing performance data to collect
   - Introducing source code regions
   - Selecting regions in X window mode
   - Selecting and deselecting regions in line mode
   - Introducing metrics
   - Selecting metrics in X window mode
   - Selecting metrics in line mode

You can also access this information through the CXpa online help system.

Introduction

1

This chapter introduces general profiling concepts and the Convex performance analyzer, CXpa. If you are new to profiling, read this chapter before using CXpa.

The topics discussed in this chapter include:

- What is a profiler?
- Why use a profiler?
- Steps for learning CXpa
- Overview of CXpa
- CXpa limitations
- Learning CXpa quickly
- Performance data files (PDFs)
- Analyzing PDFs only
- Profiling strategy
- Using batch execution
- Using pre-instrumented executables
- Profiling message-passing applications with CXpa
- CXpa and the `mpa` utility
- Using online help

After reading this chapter, try using CXpa on one of your own programs while reading "Learning CXpa quickly."

What is a profiler?

A profiler is a software tool that measures the runtime performance of programs. Profilers typically measure the total CPU time it takes each portion of your program to execute. A profiler may also measure other things that can help you find performance bottlenecks, such as:

- Loop iteration or routine execution counts
- Wall clock time
- Cache miss counts and latency

By running your program under a profiler's control, you can collect performance data that the profiler can display in a report or graph. These reports and graphs enable you to determine the location of performance bottlenecks.

Different profilers collect performance data in different ways. Some profilers sample a program's performance at measured intervals to get an average of a routine's execution time. This is known as statistical sampling. The `prof` utility uses statistical sampling.

CXpa measures a program's entire execution time and reports the total time spent in individual routines, loops, and parallel regions (parallel loops). This produces profiling results that are more accurate than statistical sampling.

Most profilers, including CXpa, require you to compile your program with a special profiling option. This option tells the compiler to create a special executable file that contains information that the profiler uses to collect performance data. When you run this executable file under the profiler's control, the profiler collects performance data and reports the results.

Why use a profiler?

Using the information CXpa provides, you can discover which routines and loops slow down your program the most. In some cases, simple modifications to the source code (for example, inserting compiler directives) can result in significant performance improvements. Without profiling, you might not be able to find performance bottlenecks.

Profiling is an iterative process. By profiling, making changes to your program, and profiling again, you can improve the performance of your program and develop a better understanding of code performance.

Profiling versions of your program that have been compiled at different optimization levels can provide insight into the types of optimizations that work best for given situations.

Steps for learning CXpa

Profiling a program is an iterative process. You profile your program, make changes to the source code based on the results, and profile again. This profiling experience, along with an understanding of the Convex compiler's optimizations, is crucial to improving your program's performance.

The following steps suggest ways to gain practical experience using CXpa:

Step 1 Select a small program you have written (or are very familiar with) that takes several minutes to execute and contains some loops.

Step 2 Read "Learning CXpa quickly," which appears later in this chapter. As you read, perform the profiling steps on your program. Use the default options to profile routines only until you reach Step 5 below.

The first time you compile your program for CXpa, compile it without optimizations.

Step 3 Recompile your program at a higher optimization level and profile it again. Continue doing this until you have found the optimization level that produces the lowest wall clock time for your program.

Step 4 Identify the routine that takes the longest to execute.

Step 5 To get further insight into the performance of that routine, profile the loops in that routine and identify the loop that took the longest to execute.

Step 6 Try rewriting the loop (or routine) in another way. Refer to the *Exemplar Programming Guide* (DSW-067) for more information about optimizing your code.

Step 7 Recompile and profile the program again. Compare the execution time to the previous execution time.

You can repeat steps 4 through 6 to continue to identify areas of your program that are taking the most wall clock time and try to improve their performance.

Refer to the "Profiling strategy" section of this book for a step-by-step strategy for profiling.

Overview of CXpa

CXpa is an interactive runtime performance analyzer for programs compiled with Hewlett-Packard and Convex Fortran, C, and C++ compilers. Using CXpa, you can profile selected parts of your program, control your program's execution, and view performance information in reports or graphs.

CXpa supports:

- Profiling of routines, loops, and basic blocks for applications compiled with Convex Fortran and C compilers. This includes optimized loops and parallel loops created by the compiler.
- Routine-level profiling of object files and archive libraries created with Hewlett-Packard PA-RISC targeting compilers such as `f77`, `c89`, or C++.
- Display of profiling information for individual threads of execution or across the entire process.
- Pre-instrumented executables. This allows you to write profile selection settings (instrumentation) to the current executable file or to a copy of the current executable. The resulting executable file can be run outside the control of CXpa and profiling data collected in a performance data file (PDF) for later analysis.
- Profiling of message-passing applications.

Available metrics

By default, CXpa measures CPU time, wall clock time, and iteration/execution counts for selected regions of your program. The following additional metrics are provided on all architectures:

- Memory access event counts
- Latency time for memory access events (latency is the time it takes to satisfy a memory access request)
- Dynamic call graph

Available memory access event counts and latency metrics differ according to machine type, as described in the following sections.

SPP1000 and SPP1600 off-processor events and latency metrics

On SPP1000 and SPP1600 Series machines, performance counters located on the CPU agent chip (off-processor) can be configured to collect cache miss event counts and latency metrics for:

- Local cache misses—number of times that data not found in the processor cache was found in local memory (memory allocated to that processor's hypernode). This means that the memory reference request was sent across the hypernode memory crossbar.
- Remote cache misses—number of times that data not found in the processor cache was found in remote memory (memory allocated to another hypernode). This means that the memory reference request was sent across the Convex CTI (Coherent Toroidal Interconnect).
- Local and remote cache misses combined.
- Event latency time, event latency/CPU time, and event latency/counts metrics for the above events.

You can also specify whether the above off-processor events are collected during read accesses (loads) only or write accesses (stores) only. By default, events are collected during reads and writes.

SPP1200 and SPP1600 on-processor events and latency metrics

On SPP1200 and SPP1600 Series machines, event counters on the HP PA-RISC 7200 Series processors (on-processor event counters) can be configured to collect the following events:

- Data cache miss counts and latency, data cache access counts, average data cache miss latency, and data cache hit rates.
- Instruction cache miss counts and latency, and average instruction cache miss latency.
- Completed instruction counts, CPU clock cycles, average number of CPU cycles per instruction, and the MIPS rate.
- Data and instruction TLB (translation lookaside buffer) misses.

Refer to the "Introducing metrics" online help topic or section of this book for more information about metrics available on each architecture.

CXpa interfaces

CXpa has three interfaces: X window mode, line mode, and batch mode. You can run your application in line mode or batch mode to collect profiling data, then use CXpa's X window interface to view a graphical analysis of the data.

X window mode

Use CXpa's X window mode when you want to use a mouse-oriented interface or when you want graphs of performance data. CXpa's window mode has the following features:

- Mouse selection of program regions to profile and metrics to collect.
- 2D and 3D graphs of performance data that can display corresponding source code with the click of a mouse button.
- Dynamic call graph window with point-and-click navigation, clickbacks to source code, and caller/callee information and metrics for selected routines.
- Source Code window with source code region annotations.
- Analysis Report window for displaying textual performance reports.
- Analysis-only mode for visualizing multiple performance data files (PDFs) simultaneously, including PDFs that were created on different architectures.

Line mode

Line mode is a character-based interface to CXpa. Use line mode when you are using a CRT terminal or if you prefer a line-oriented interface in an xterm window. Line mode presents performance information in textual reports.

When you start CXpa in line mode with the name of a PDF file only, you can use the `set pdf` and `analyze` commands to access performance data for multiple performance data files (PDFs), including PDFs that were created on different architectures.

Batch mode

CXpa's batch mode enables you to run CXpa from a shell script. You can invoke CXpa in batch mode by:

- Using the `-x` option to supply a command file to CXpa.
- Redirecting input, output, and standard error to and from files.

Graphic analysis of performance data

The 2D and 3D Profile windows allow you to visualize the performance data collected when you run your program. You can open multiple 2D and 3D Profile windows to compare and contrast different aspects of your program's performance simultaneously.

You can obtain different views of your program's performance by selectively defining the source code regions and metrics that are graphed. The 2D Profile graphs the data per process, while the 3D Profile graphs the data per thread (for parallel codes).

Other features provided with the 2D and 3D profile graphs include:

- **Source code correlation**—Click on any bar in the graph to display the source code associated with the code region being graphed.
- **Sorting and zooming options**—The data for both graphs can be sorted alphabetically, by load order, from lowest to highest, or from highest to lowest.

  Zooming (scaling) options for the 2D and 3D profile graphs allow you to view or specify the range or number of data values displayed at one time in the 2D or 3D Profile window. This can be useful when there is a large number of data items to graph and you want to focus on a subset of the data.
- **Saving profiles for printing or export**—You can save profile graphs in PostScript or xwd formats for printing or to ASCII format for export to other graphic packages.
- **3D profile graph rotation**—The 3D profile graph can be rotated by clicking anywhere in the graph with the right mouse button and moving the mouse.

2D and 3D profile graphs are available in X window mode only. Refer to the "2D Profile window" and "3D Profile window" online help topics or sections in this book for more information.

Call Graph window

CXpa supports collection of dynamic call graph information, which can be displayed in an interactive Call Graph window that features:

- Point-and-click navigation.
- Clickbacks to source code for routines displayed in the graph.
- Display of values for all metrics collected for each routine.
- Listing of callers and callees and their call counts for each routine.
- Options for configuring the number of routines initially displayed in the graph and selecting the metric used to rank the routines.

Performance reports

CXpa displays textual performance reports for:

- Routines
- All loops (for modules compiled with Convex compilers at optimization levels at or above `-O1`).
- Parallel loops only (parallel loops created by Convex compilers at optimization level `-O3`).
- Basic blocks (for modules compiled with Convex compilers using the `-cxpab` option).

The metrics available in performance reports vary according to machine type, source code regions selected, and the options used when compiling your program. Textual performance reports are available in line mode and X window mode.

Performance analysis reports that can be displayed are as follows:

- **Counts**—Includes loop iteration/execution counts or routine call counts.
- **Dynamic Call Graph**—For each routine, the information displayed includes inclusive wall clock and CPU time (including time spent in child routines) and call counts for the routine, its parents, and its children. Routines are sorted from highest to lowest by inclusive wall clock time.
- **Computation**—Includes CPU time and % total CPU time metrics.
- **Time to Solution**—Includes wall clock time and CPU/wall clock time metrics.
- **Events**—Available event reports and metrics differ according to machine architecture:
  - Off-processor event reports (SPP1000 and SPP1600 only)—Locally resolved cache misses, remotely resolved cache misses, or locally and remotely resolved cache misses.
  - On-processor event reports (SPP1200 and SPP1600 only)—Data cache misses and latency; data cache accesses; instruction cache misses and latency; instructions completed and clock cycles; and data and instruction TLB (translation lookaside buffer) misses.

For a detailed discussion of each type of report, refer to the "Reports," "Routine reports," "Dynamic Call Graph report," "Loop reports," "Parallel Region reports," and "Basic Block report" online help topics or sections in this book.

Related Concepts

Analyzing PDFs only
Compiling
Introducing metrics
Learning CXpa quickly
Performance data files (PDFs)
Profiling HP PA-RISC object files and libraries
Profiling message-passing applications
Profiling strategy
Reports
Using pre-instrumented executables

Related Windows

2D Profile window
Analysis Control window
Call Graph window
3D Profile window
Analysis Report window
Executable Manager window

CXpa limitations

This section lists CXpa's limitations. CXpa can still be used effectively in situations where these limitations occur. However, code changes and/or compiling at a different optimization level may be required.

NOTE: To view current information on CXpa limitations in X window mode, select Release Notice from the Help menu in the Executable Manager or Analysis Control window. In line mode, enter the command `help release` to view an ASCII text version of the CXpa release notice.

The limitations include:

- If a process forks, but does not perform an `exec()`. CXpa will only profile the parent process.
- Object files and archive libraries instrumented for profiling with `cxoi` do not contain source file line number information. This means that source code correlation and clickbacks for routines within these modules always refers to line 1 of the source file that contains the routine.

  CXpa source code annotations are not displayed in the Source Code window or in source file listings for object files and libraries instrumented with `cxoi`.
- The following constructs cannot be profiled:
  - Loops with no exit point that the compiler can detect. For example:

```
foo() { exit(1); }
.
.
.
while (1) { if (...) foo(); }
```

  - Loops whose exits are implemented by the compiler's code generator via branch tables. For example, the UL abbreviation ("uninstrumentable") in the optimization column in the following report fragment indicates that CXpa could not profile a loop region:

```
================================================================================
                          Loop Performance Analysis
================================================================================

Optimized Loops:
                            Times      Iteration Count          CPU Time
 Line     NL Optimization   Exec     Min      Max    Avg (less inner)(plus inner)PS
-------  -- -----------  -------- ------ ------ ------ ---------  ---------  --
   804    0 UL              N/A    N/A    N/A    N/A       N/A        N/A    u

(u) contains 1 or more uninstrumentable points
```

- Applications compiled with one or more source file(s) with greater than 32,767 lines each will not work correctly under CXpa. To work around the problem, split the large source file(s) using one of the following UNIX utilities: `fsplit`, `csplit`, or `split`. Recompile the source files and relink the application.

Learning CXpa quickly

This section takes you step-by-step through a profiling session and briefly explains how to use CXpa's standard features in X window and line modes.

Using CXpa in X window mode

To use CXpa in X window mode, follow these steps:

1. If you are using a Convex compiler, compile and link your program using one of the following options:

   `-cxpa` to instrument routines, loops, and parallel loops.
   `-cxpar` to instrument routines only.
   `-cxpab` to instrument basic blocks only.

   For example:

   ```
   % /usr/convex/bin/fc -cxpa prog.f
   ```

   To profile applications compiled with other PA-RISC targeting compilers (such as the Hewlett-Packard `f77` or `c89` compilers) use the `cxoi` utility to instrument the object files and archive libraries for routine-level profiling. `cxoi` is a separate utility supplied with CXpa.

   Refer to the `cxoi` man page or to the "Profiling HP PA-RISC object files and libraries" online help topic or section of this book for instructions.

2. Set your `DISPLAY` environment variable. For example, using C shell syntax:

   ```
   % setenv DISPLAY display_name:0.0
   ```

   Using Bourne shell (sh) syntax:

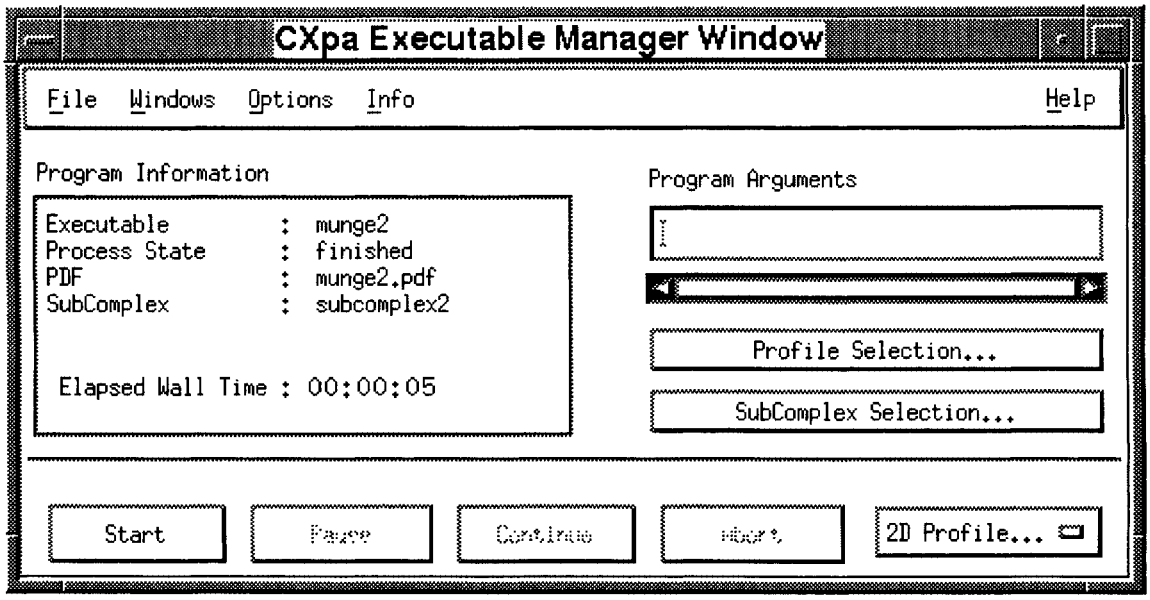
   ```
   $ DISPLAY=display_name:0.0; export DISPLAY
   ```

3. Invoke CXpa with the name of an executable file. For example:

   ```
   % cxpa a.out &
   ```

NOTE: CXpa is a licensed product. If you do not acquire a license after starting CXpa, contact the system administrator at your site for more information.

   CXpa opens an Executable Manager window. The `&` runs CXpa in the background.

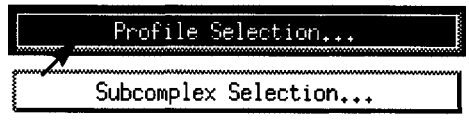


By default, CXpa collects CPU time, wall clock time, and iteration/execution counts for all routines in your program. Use these defaults the first time you profile a program using CXpa. To accept the defaults, skip to step 5.

NOTE: You will obtain the most accurate profiling results if you run the program in a standalone environment (that is, on a "quiet" system or on a dedicated system or subcomplex).

To select different source code regions (such as loops or parallel loops) for profiling and/or collect different metrics (such as events), continue with step 4.

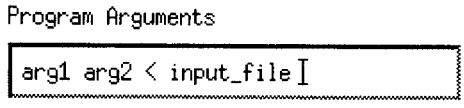
4. Press the Profile Selection button to open a Profile Selection dialog. Select the regions you want to profile and/or the metrics you want to collect.



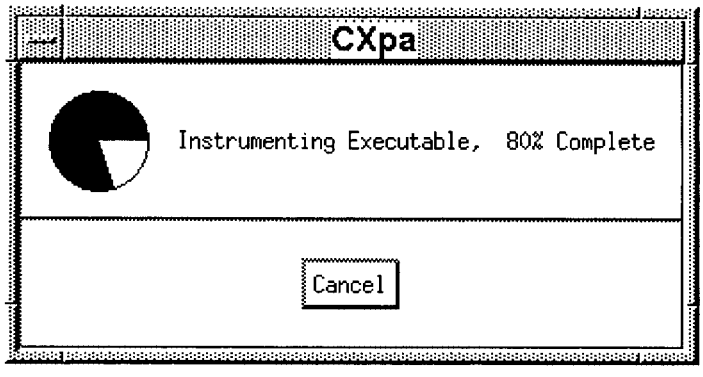
Refer to the "Selecting metrics in X window mode" and "Selecting regions in X window mode" online help topics or sections in this book for more information.

NOTE: Profiling time and intrusion increase as you select more regions and metrics.

5. Enter arguments to the program you are profiling in the Program Arguments field.



6. Press the Start button. An xterm window appears to display your program's input and output. A dialog also appears while CXpa is instrumenting your executable.



Large programs may take a while to instrument. Once your program is instrumented, it starts executing, and the dialog disappears.

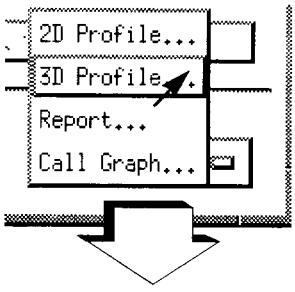
- To stop instrumentation and cancel the run, press the Cancel button.
- To suspend program execution during profiling, press the Pause button at the bottom of the Executable Manager window.

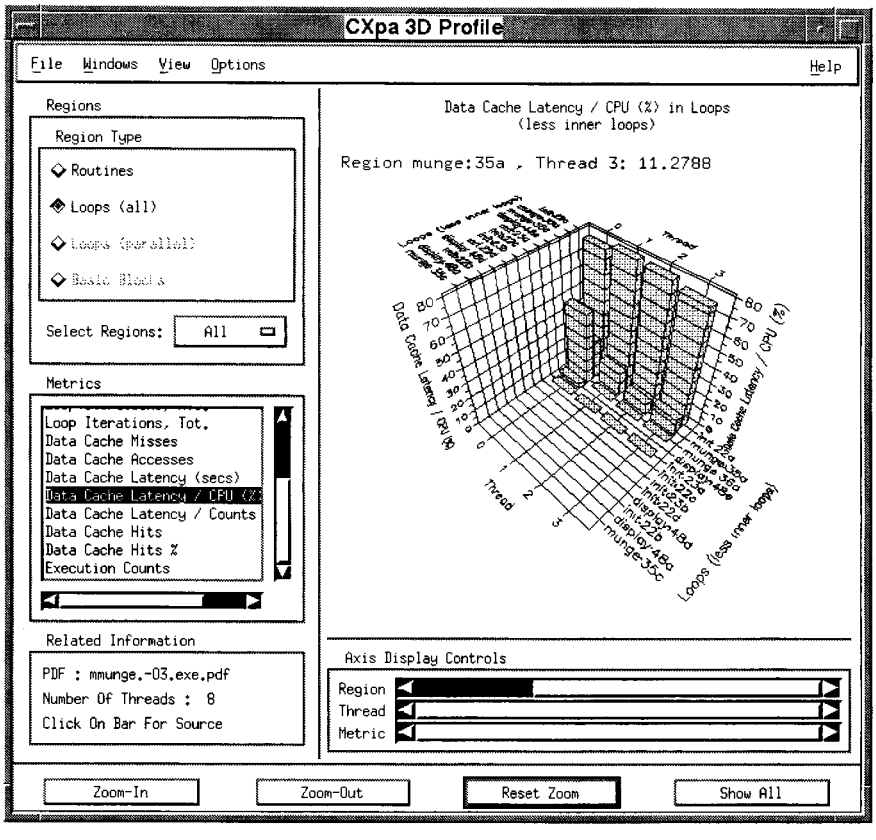
NOTE: To obtain the most accurate profiling data, do not pause your program during profiling. For best results, run the program to completion and then analyze the results.

Once your program is paused, you can:

- View a 2D or 3D profile graph or text report composed of intermediate data, as shown in step 7.
- Abort your program.
- Continue your program's execution.

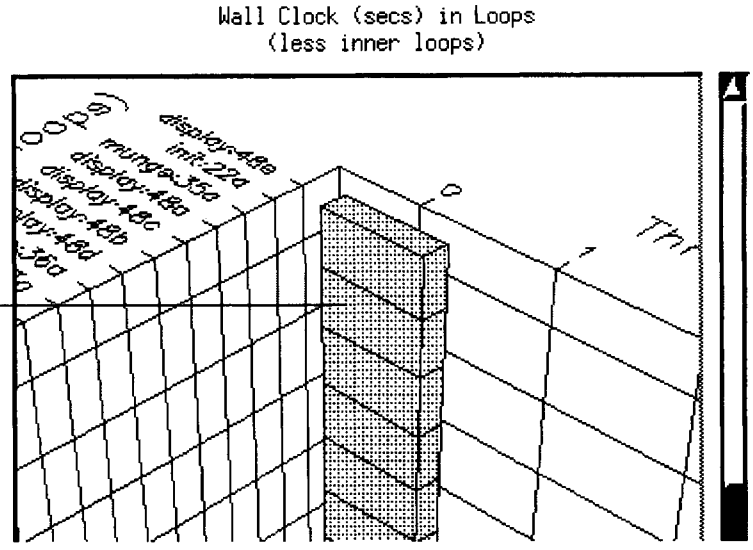
7. Display profile results by selecting one of the options from the button at the bottom-right corner or from the Windows menu:
   - **2D Profile**—Displays a 2D graph of profiling data accumulated across all threads of the process. You can dynamically select regions and metrics to graph and display source code associated with bars in the graph.
   - **3D Profile**—Displays a 3D graph of profiling data for individual threads. You can dynamically select regions and metrics to graph and display source code associated with bars in the graph.
   - **Report**—Displays an Analysis Report window that contains textual performance reports.
   - **Call Graph** —Displays a dynamic call graph window that initially shows the top 10 routines in your program ranked by inclusive wall clock time (that is, including time spent in called routines). The Call Graph window features point-and-click navigation, clickbacks to source code, and access to detailed caller/callee and metric information for each routine.



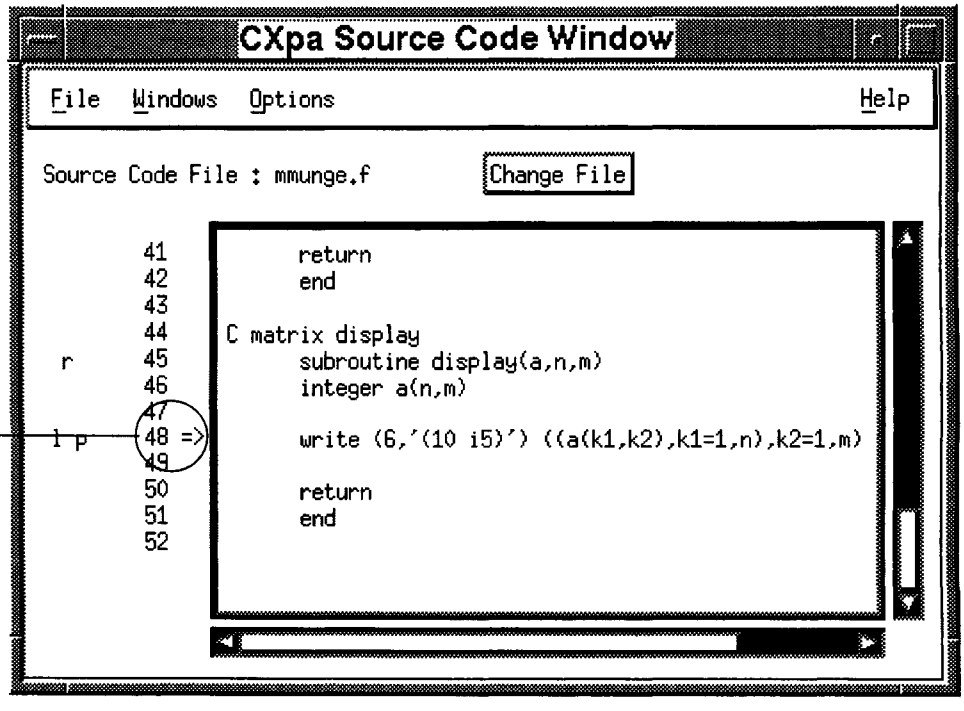


The above example shows a 3D graph of the ratio of data cache miss latency to CPU time (expressed as a percentage) for all profiled loop regions in a program running on an SPP1200 system.

8. From the 2D or 3D Profile window, you can display the source code represented by a bar in the graph by clicking on the bar with the left mouse button. The Source Code window appears with an arrow (=>) pointing to the start of the section of code represented by the bar you clicked.

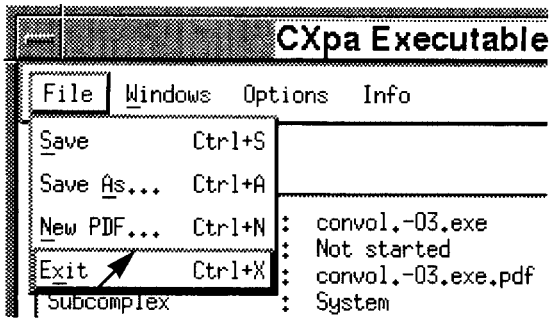


Left click on any bar on the graph to display source code associated with that region.



=> annotation indicates associated source code.

9. Quit CXpa by selecting Exit from the File menu in the Executable Manager window.



Refer to the "Profiling strategy" section of this book for more information about profiling intrusion and a step-by-step strategy for profiling.

Using CXpa in line mode

If you are working from a CRT or if you prefer a line-oriented interface in an xterm window, you can use line mode. To invoke CXpa in line mode, you must use the `-nw` option at the command line. If your `DISPLAY` variable is not set, CXdb displays a message and starts in line mode.

To use CXpa in line mode:

1. If you are using a Convex compiler, compile and link your program using one of the following options:

   `-cxpa` to instrument routines, loops, and parallel loops.
   `-cxpar` to instrument routines only.
   `-cxpab` to instrument basic blocks only.

   For example:

   ```
   % /usr/convex/bin/fc -cxpa prog.f
   ```

   To profile applications compiled with other PA-RISC targeting compilers (such as the Hewlett-Packard `f77` or `c89` compilers) use the `cxoi` utility to instrument the object files and libraries for routine-level profiling. `cxoi` is a separate utility supplied with CXpa.

   Refer to the `cxoi` man page or to the "Profiling HP PA-RISC object files and libraries" online help topic or section of this book for instructions.

2. Invoke CXpa with the name of an executable file in line mode:

   ```
   % /usr/convex/bin/cxpa -nw a.out
   ```

Your shell prompt changes to the CXpa line-mode prompt:

```
                CONVEX Performance Analyzer

Type 'help' for help.
Reading executable a.out...
Selecting profile a.out.pdf...

(CXpa)
```

As shown in the output above, CXpa displays the name of the executable file to be profiled and the name of the performance data file (PDF file) that profiling data will be written to (by default, this file is named <*executable*>.pdf).

CXpa is a licensed product. If you do not acquire a license after starting CXpa, contact the system administrator at your site for more information.

3. Select the source code regions of your program you want to profile with a form of the `select` command.

   In line mode, if you do not select one or more source code regions in your program for profiling with the `select` command, CXpa will not collect any metrics.

   For example:

   ```
   (CXpa) select routine all
   ```

   The previous command selects all routines in your program for profiling. This is the recommended selection for the first time you profile your program under CXpa.

NOTE: You will obtain the most accurate profiling results if you run the program in a standalone environment (that is, on a "quiet" or dedicated system or subcomplex).

4. Choose the type of metrics that you want to collect with the `collect` command. By default, CXpa collects CPU time and wall clock time. The first time you profile your program, use the default selection.

   The following metrics can be specified with the `collect` command:

   - `cpu`—Collects CPU time.
   - `wall_clock`—Collects wall clock time.
   - `call_graph`—Collects dynamic call graph information.
   - `events`—Collects memory access events and latency time. If you enable event collection with this parameter, you must then use the `set events` command to specify the type of events collected.
   - `counts`—By default, iteration/execution counts are always

collected. You do not need to specify this parameter unless you want CXpa to collect only iteration/execution counts. To do this, specify the `counts` parameter only (for example, `collect counts`).

For example:

```
(CXpa) collect cpu wall_clock
```

5. If you enabled event collection with the `events` parameter of the `collect` command, choose the type of event you want to collect with the `set events` command:

NOTE: Each use of the `set events` command overwrites its previous setting.

The number and type of events you can collect are architecture-specific. Refer to the online help topic or reference page for the `set events` command for more information.

```
(CXpa) set events local_misses
```

The above command tells CXpa to collect the number of times your program had to access hypernode-local memory to find a value due to a processor data cache miss. The `local_misses` parameter is specific to SPP1000 and SPP1600 Series machines.

6. Run your program with the `run` command:

```
(CXpa) run
```

Output from your program appears in the process interface xterm window as it runs.

While your program is running, you can type **CTRL-c** to pause your program.

NOTE: To obtain the most accurate profiling data, do not pause your program during profiling. For best results, run the program to completion and then analyze the results.

Once a program is paused, the CXpa prompt will reappear. While the program is paused you can:

- View intermediate performance reports by using the `analyze` command.
- Resume the execution of your program by using the `continue` command.
- Terminate execution of your program with the `stop` command.

7. When your program finishes, use a form of the `analyze` command to view final performance reports. For example:

```
(CXpa) analyze
```

When you enter the `analyze` command without specifying any parameters, CXpa generates and displays all available performance reports. To display reports for a specific region type, use the `analyze routine`, `analyze loop`, `analyze block`, or `analyze pregion` command.

CXpa displays reports in line mode using the pager specified with your `PAGER` environment variable. If the `PAGER` environment variable is not set, CXpa uses the `more` command to page the output. You can also redirect output of the `analyze` command to a file using redirection operators.

8. To exit CXpa, use the `quit` command.

Refer to the "Profiling strategy" section of this book for more information about profiling intrusion and a step-by-step strategy for profiling.

Editing the command line

CXpa's line mode provides command-line editing functions similar to UNIX command-line editing. You can display the available editing functions by entering **ESC-?** on the CXpa command line. The editing functions are as follows:

Function	Key sequence
Backward character	**CTRL-b**
Backward word	**ESC-b**
Beginning of line	**CTRL-a**
Capitalize forward word	**ESC-c**
Delete backward character	**CTRL-h**
Delete backward character	**DEL**
Delete backward word	**ESC-h**
Delete forward character	**CTRL-d**
Delete forward word	**ESC-d**
Display key bindings	**ESC-?**
End of line	**CTRL-e**
Erase line	**CTRL-g**
Erase screen	**ESC-g**
Execute current command	**RETURN**
Execute a shell command	!<*command*>
Forward character	**CTRL-f**
Forward word	**ESC-f**
Kill to end of line	**CTRL-k**
Lower case word	**ESC-l**
Next command	**CTRL-n**

Previous command	**CTRL-p**
Transpose characters	**CTRL-t**
Transpose words	**ESC-t**
Upper case word	**ESC-u**

Related Topics

Compiling
Introducing metrics
Introducing source code regions
Profiling strategy
Profiling HP PA-RISC object files and libraries
Profiling message-passing applications
Reports
Selecting and deselecting regions in line mode
Selecting metrics in line mode
Selecting metrics in X window mode
Selecting regions in X window mode
Using batch mode
Using online help

Related Windows

2D Profile window
3D Profile window
Analysis Control window
Analysis Report window
Call Graph window
Executable Manager window
Help window
Profile Selection dialog

Related Commands

`analyze`
`collect`
`help`
`rerun`
`run`
`select`
`set events`
`set visibility`

Learning CXpa quickly

Performance data files (PDFs)

When you use CXpa to profile a program, it creates a performance data file (PDF) to store profiling data. The PDF is a binary file that contains the performance data for a single run of your program.

The data in a PDF is used to create 2D and 3D profile graphs and analysis reports. If you do not set the PDF name, CXpa uses the default PDF name of *<executable>*.pdf.

NOTE: PDFs are platform independent. For example, the data stored in a PDF created on an SPP1000 Series system can be viewed (in reports or graphs) on an SPP1200 Series system, or vice versa.

Changing the PDF name

You can change (set) the name of the PDF to be written to or read from during a CXpa session. You may want to do this for two reasons:

- **To prevent CXpa from overwriting an existing PDF**—If you have invoked CXpa with the name of an executable, when you run your program CXpa overwrites all of the data in the PDF. If you do not want this to occur, you must change the name of the PDF between runs of your program, as described in the following sections.
- **To analyze a different PDF**—If you have invoked CXpa with the name of a PDF file only, you can analyze PDFs created in previous CXpa sessions, including PDFs created on different architectures or from different executables. In this "analysis-only" mode, you can analyze and compare data for several PDFs during a CXpa session.

NOTE: If you invoke CXpa with an executable, you can only analyze a PDF created during the current CXpa session. To analyze a PDF created with a different executable or multiple PDF files, invoke CXpa with the name of a PDF file (without specifying an executable).

In X window mode

To specify a new PDF file in X window mode, perform the following steps from the Executable Manager or Analysis Control window:

1. Select New PDF from the File menu in the Executable Manager window or Open PDF from the File menu in the Analysis Control window. CXpa opens a New PDF or Open PDF dialog.

2. Choose a new PDF name by clicking in the Files list or by typing a new name in the PDF Selection field.
3. Press OK.

CXpa will now write to and/or read from the selected PDF during this profiling session.

- If you invoked CXpa with the name of an executable file, profiling data will be written to the specified PDF when you run your program, and performance analysis reports and graphs will be generated from the data in that PDF.
- If you invoked CXpa with the name of a PDF file or files only (without specifying an executable file), performance analysis reports and graphs will be generated from the data in the PDFs that you specified.

In line mode or batch mode

To choose a new PDF name in line mode, use the `set pdf` command:

`(CXpa)` **`set pdf`** *<new_pdf_name>*

CXpa will now write to and/or read from the specified PDF during this profiling session.

Related Topics

Analyzing PDFs only

Related Windows

Analysis Control window
Executable Manager window
Merge PDFs dialog
New PDF dialog
Open PDF dialog

Related Commands

`analyze`
`cxpa`
`merge`
`set pdf`

Analyzing PDFs only

In X window and line mode, you can view performance data in PDFs that were created in previous CXpa sessions by invoking CXpa with the name of a PDF file or files (without specifying an executable). In this "analysis-only" mode of CXpa, you can analyze profiling data, but you cannot instrument or run your program.

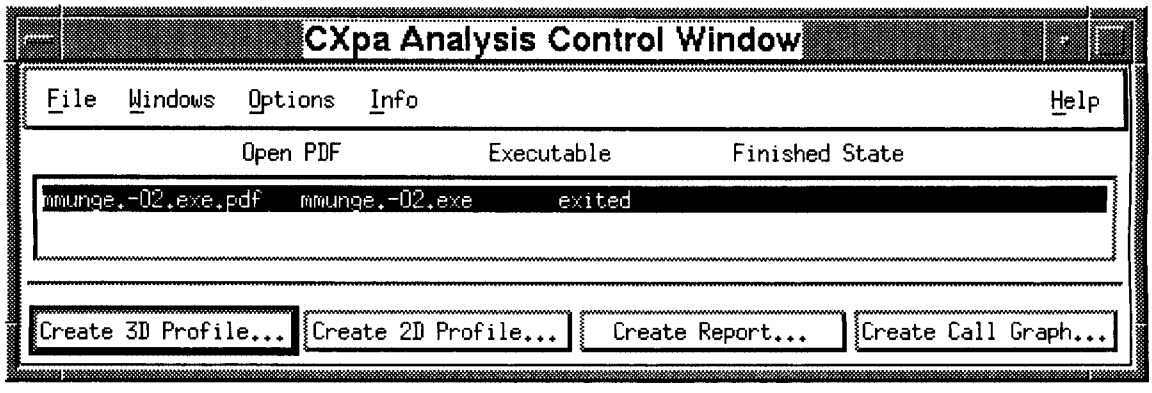
You can also merge PDF files created from multiple runs of the same executable into a single PDF file for comparison and analysis. This feature is useful when profiling message-passing applications or in comparing performance of an application when run with different data sets. Refer to the "merge" or "Merge PDFs dialog" online help topic or section of this book for more information.

Analyzing PDFs in X window mode

Start CXpa with the name of an existing PDF file or files, without specifying an executable file name. For example:

% **cxpa** <*pdf-name*(s)> **&**

CXpa opens an Analysis Control window.



NOTE: You can use a CXpa X application resource to specify automatic creation of profile or report windows when you invoke CXpa with the name of a PDF file (without specifying an executable). The resource is `Cxpa*defaultWindow`, and it can accept the following values: `All`, `None`, `Callgraph`, `2DProfile`, `3DProfile`, `Report`, or `Source`. The default is `None`.

Analyzing PDFs only

From the Analysis Control window, you can analyze PDFs that were created in previous CXpa sessions, including PDFs that were created on different architectures or from different executables. This enables you to analyze and compare data in multiple PDFs.

Invoking CXpa with multiple PDF files for analysis

You can invoke CXpa from the shell in X window mode with the names of multiple PDF files. You can use shell wildcard characters to specify the PDF files to load. For example:

```
% cxpa  *.pdf &
```

When you do so, each of the specified PDF files are automatically listed in the Open PDF column in the Analysis Control window, and the last PDF file specified is highlighted (selected for analysis).

To select or deselect a PDF file, click on its name in the list.

Opening other PDFs

To open another PDF, select the Open PDF option from the File menu. A new entry appears in the PDF list.

Choosing an active PDF

You can choose the active PDF by clicking on a PDF in the Open PDF column. The buttons at the bottom of the Analysis Control window create windows that contain 2D or 3D profile graphs or textual reports from information in the active PDF.

Analyzing PDFs in line mode

To analyze PDFs only in line mode, start CXpa with the name of an existing PDF file or PDF files (without specifying an executable):

```
% cxpa <pdf_name(s)> -nw
```

You will see a CXpa prompt. In analysis mode, you can analyze PDFs created in previous CXpa sessions, including PDFs created on other architectures, but you cannot instrument or run applications.

Use the `analyze` command to generate reports from the data in that PDF.

Opening other PDFs

If you invoked CXpa with a PDF only (without specifying an executable), you can view another PDF without quitting CXpa. To change PDFs, use the `set pdf` command:

```
(CXpa) set pdf <pdf_name>
```

Analyzing PDFs only

Related Topics

Performance data files (PDFs)

Related Windows

Analysis Control window
Executable Manager window
Merge PDFs dialog
New PDF dialog
Open PDF dialog

Related Commands

`analyze`
`cxpa`
`merge`
`set pdf`

Profiling strategy

When running your application under CXpa with regions and metrics selected for profiling, you may notice that your code executes more slowly than expected. This can be due to profiling intrusion introduced by CXpa.

This section describes the causes and effects of profiling intrusion and provides a profiling strategy that will help you quickly locate regions of source code that cause performance bottlenecks and minimize profiling intrusion.

Profiling intrusion—what is it, and what causes it?

All methods of profiling are intrusive—that is, the overhead associated with profiling can affect the validity of the results. When using CXpa, keep in mind that *the greater the number of regions and metrics selected for profiling during a program run, the greater the amount of profiling intrusion introduced—that is, time delays.*

These time delays occur when hardware counters that provide CPU time, wall clock time, cache performance, and instruction counts are accessed at data sampling points. Each source code region enabled for profiling has a minimum of two data sampling points—a region entry point and a region exit point. The more data sampling points enabled, the greater the amount of profiling intrusion. Additional time delays can also occur when profiling data is stored during a program run. The greater the amount of profiling data that must be stored, the greater the time delay.

When only routines are selected for profiling, the profiling intrusion is minimal. Profiling loops is much more intrusive, because the number of data points that must be sampled is far greater, especially in loop nests or in loops with large iteration counts.

Profiling intrusion—an example

This example uses the following simplified source code region structure (after optimization):

```
ROUTINE (CALLED n TIMES)
   100 ITERATIONS OF LOOP AT NESTING LEVEL 0
      100 ITERATIONS OF LOOP AT NESTING LEVEL 1
         100 ITERATIONS OF LOOP AT NESTING LEVEL 2
```

The number of data sampling points enabled when different types of source code regions in the above fragment of pseudocode are selected for profiling is shown in the following table.

Source code regions selected for profiling	Number of sampled data points
Routines only	$2 * n$
All loops at nesting level 0 only	$(100 * 2) * n = 200 * n$
All loops at nesting level 1 only	$(100 * 2) * n = 200 * n$
All loops at nesting level 2 only	$(100 * 2) * n = 200 * n$
All loops at all nesting levels	$(100 * 2) * (100 * 2) * (100 * 2) * n = 8{,}000{,}000 * n$
All routines, All loops at all nesting levels	$(2 * n) + (8{,}000{,}000 * n)$

As illustrated above, profiling all loops at all nesting levels or profiling all available source code regions during a single program run results in a level of profiling intrusion that can produce misleading results. This is because the number of sampled data points in a loop nest grows by a factor of 2 * the number of iterations of the loop nest with each level of nesting.

Recommended profiling strategy

By using a top-down profiling strategy, you will minimize the number of regions and metrics selected for profiling during each run of your program. This will significantly reduce the amount of profiling intrusion and increase the validity of the results. Region selection should proceed from coarse-grained (routines) to fine-grained (loops or parallel loops in specific routines) as code regions that exhibit performance problems are identified. There are two key principles to remember:

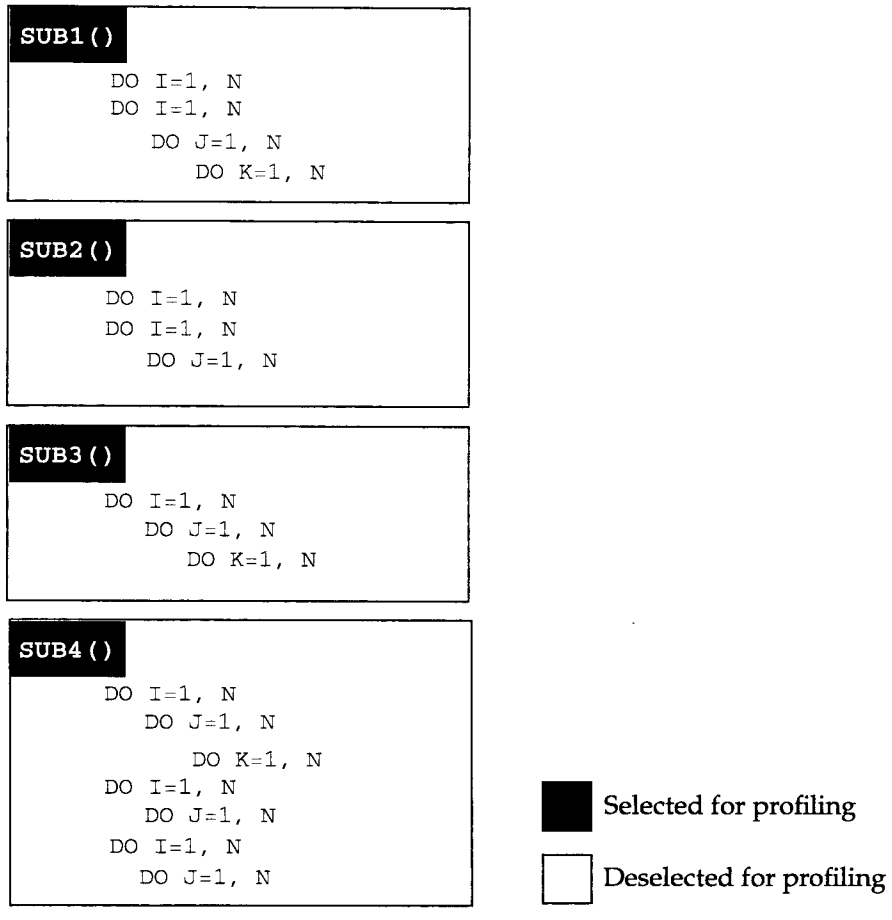
- Minimize the number of sampled data points per program run by selecting only the regions that are significant during each run and following the profiling strategy outlined below.
- Collect only the metrics you are interested in per program run (for example, do not enable event collection for a run unless you really need to examine cache performance or instruction metrics).

The procedure below outlines the recommended profiling strategy:

1. The first time you profile your program under CXpa:
   - Select all routines (or fewer, if you already identified the critical routines) for profiling at the routine region level.
   - Collect wall clock and CPU time metrics.

   This provides a complete picture of your program's performance. Using this information, you can then identify the routines that take the longest to execute.

Example—First profiling run region selections

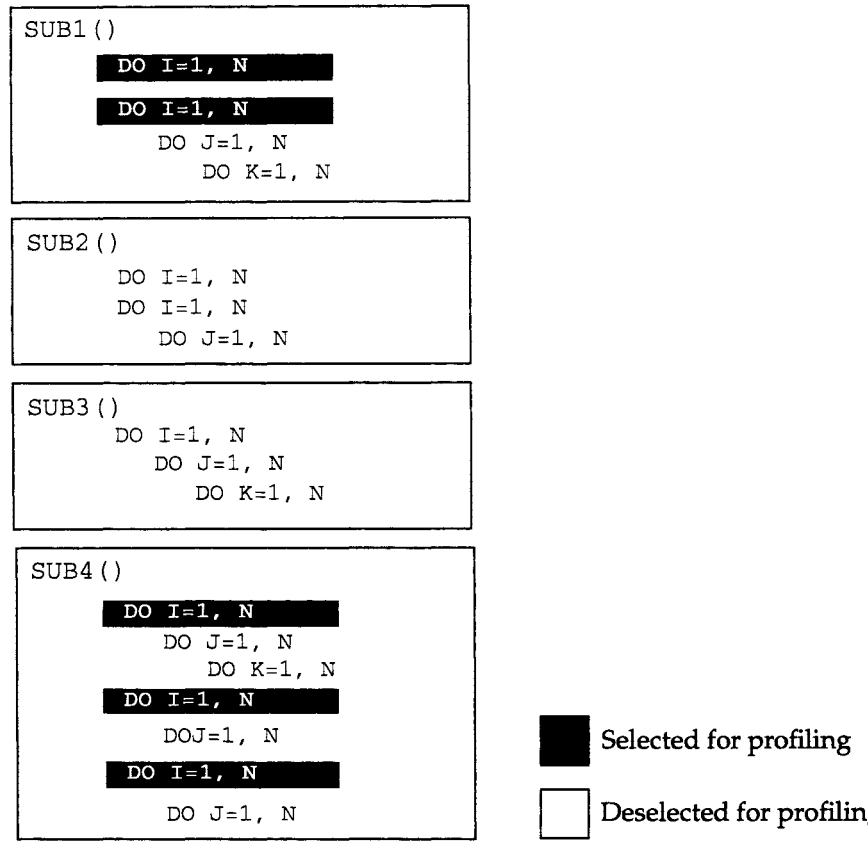


2. After you have identified the routines that consume the most wall clock time or CPU time, select only those routines for profiling, and select all loops at loop nesting level 0 within those routines for profiling (as shown in the following example).

   This gives you a loop-level view of these routines without incurring the profiling intrusion associated with selecting all loops at all nesting levels. Continue to collect CPU time and wall clock time.

   Using this method, you are profiling a section (or "slice") of the loops in these routines that contains only the outermost loops (loop nesting level 0).

Example—Second profiling run region selections



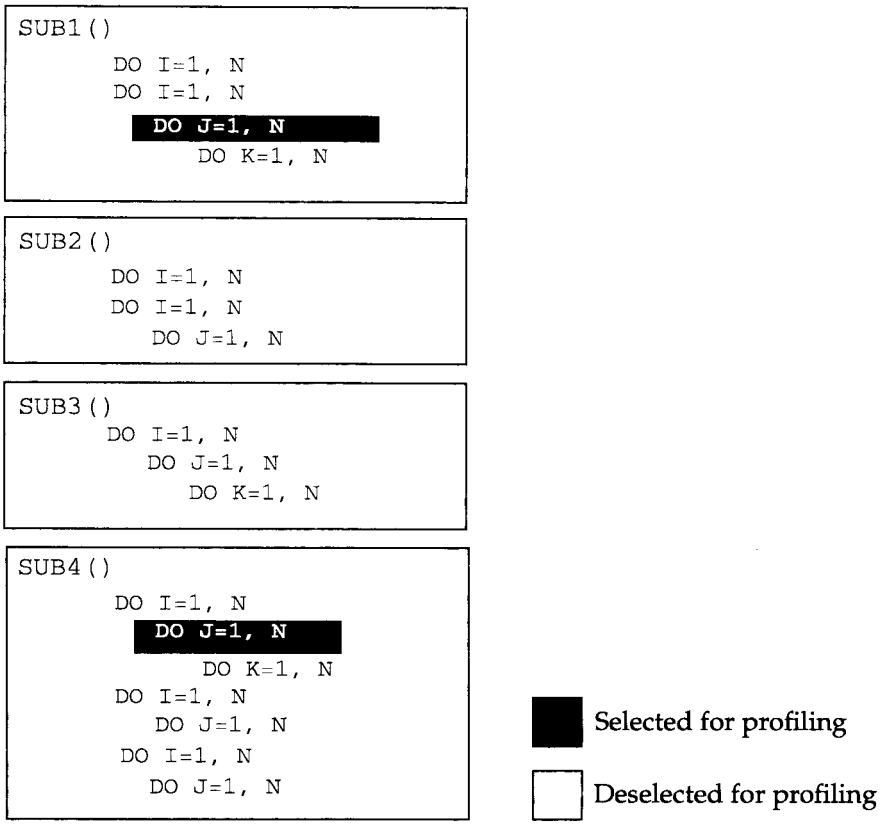
Refer to the following sections of this book for instructions on how to accomplish this using CXpa's X window interface or command-line interface:

- Profile Selection dialog
- `select` and `set visibility` commands

Rerun your program under CXpa to identify the loops or loop nests within the selected routines that consume the most wall clock time and/or CPU time.

3. On subsequent runs of your program, you can select different sections or "slices" of the loops within the routines selected for profiling, as shown in the following example. When specifying a fixed range of loop nesting levels, set the minimum loop nesting loop level equal to the maximum loop nesting level.

Example—Third profiling run region selections



4. Once you have identified the loops that are causing the performance problem, you can also choose to collect different metrics, such as cache misses and latency. With fewer source code regions selected, less time is spent in the timing routines CXpa uses to collect performance data. As a result, the profiling information obtained is more accurate.

Related Topics

Introducing metrics
Introducing source code regions
Selecting and deselecting regions in line mode
Selecting metrics in line mode
Selecting metrics in X window mode
Selecting regions in X window mode

Related Windows

Profile Selection dialog

Related Commands

`collect`
`select`
`set events`
`set visibility`

Using batch mode

This section describes how to use CXpa in batch mode from the command line or from a shell script.

Using batch mode from the command line

To use CXpa in batch mode from the command line, specify a command file for input when you start CXpa by using the `-x` option and redirect input and output. For example:

```
% cxpa -x <cmdfile> a.out < <input_file> >& <output_file>
```

The above command tells CXpa to execute a command file at startup, read input to your program from a file, and redirect all output and messages to a file.

Command file input using the `-x` option

You can tell CXpa to execute a command file from the command line by using the `-x` option. When you use the `-x` option, CXpa executes in batch mode. The following example shows how to use the `-x` option to specify a command file:

```
% cxpa -x cmdfile a.out
```

CXpa executes the command file and quits when it encounters the `quit` command or the end of the file. The following file listing shows a sample CXpa command file:

```
#This line is a comment.
select routine all
collect cpu wall_clock
run
analyze > cxpa.report
quit
```

A CXpa command file is a text file with that contains a list of CXpa commands. Each command must appear on a separate line. The # symbol denotes comments.

Argument input using the `-e` option

You can specify arguments to pass to the program you are profiling on the CXpa command line with the `-e` option. These arguments are used when you execute your program in CXpa with the `run` command. This option is helpful for integrating CXpa with existing program execution shell scripts and is available in CXpa's line mode, batch mode, and X window interface.

The following example shows how to use the `-e` option to specify program arguments:

```
% cxpa -x cmdfile -e a.out 12 35 14
```

Following the `-e` option, CXpa expects the name of the executable (optional) followed by program arguments. No other CXpa options may follow the `-e` option.

The following section explains how to use CXpa with a shell script that compiles and runs a program.

Using batch mode from a script

The following example shows a way to integrate CXpa into a script that compiles and runs a program. This example assumes the use of the Convex compilers.

```
#!/bin/csh -f
#
#Name: batch_script
#Run this script with cxpa if command line switch -cxpa is found
#

set PROFILER = ''
set PROFILER_COMP_FLAG = ''
foreach arg ($argv)
  if ($arg == '-cxpa') then
    set PROFILER = '/usr/convex/bin/cxpa -x cmd_file -e'
    set PROFILER_COMP_FLAG = '-cxpa'
    cat << EOF >! cmd_file
      select routine all
      run
      analyze
      quit
EOF
  endif
end

# compile a.out
#
/usr/convex/bin/cc $PROFILER_COMP_FLAG -O0 foo.c -o a.out

# Now run the executable
#

$PROFILER a.out arg1 arg2
```

If you include the `-cxpa` option when you invoke this script, it will compile the program with a CXpa option (`-cxpa`), invoke CXpa with the resulting executable file, and execute a CXpa command file that performs a batch profiling session.

To profile with CXpa in batch mode using this script, use the following command line:

```
% batch_script -cxpa
```

Related Commands

- `add path`
- `analyze`
- `collect`
- `continue`
- `cxpa`
- `deselect`
- `path`
- `rerun`
- `run`
- `select`
- `set events`
- `set pdf`
- `set subcomplex`
- `set visibility`
- `source`
- `stop`
- `quit`

Using pre-instrumented executables

You can write profile selection settings (instrumentation) to the current executable file or to a copy of the current executable. This is referred to as *pre-instrumenting* an executable. Use pre-instrumented executables to:

- Profile with CXpa in environments that do not support CXpa controlling a child process.
- Profile applications in conjunction with tools such as PVM that replicate processes or with applications where a driver program or script starts the process.

  Refer to the "Profiling message-passing applications with CXpa" online help topic or section of this book for information about using pre-instrumented executables when profiling PVM applications with CXpa.
- Maintain separate copies of an executable with different regions and metrics selected for profiling. This makes it easier to generate multiple PDF files for comparison and analysis.
- Profile applications run with the `mpa` utility. Refer to the "CXpa and the `mpa` utility" online help topic or section of this book for more information.

The resulting executable file can be run outside the control of CXpa, and profiling data is collected in a performance data file (PDF) for later analysis. The resulting PDF file will be named *<executable>*`.`*<pid>*`.pdf`. The *pid* is the program's UNIX process ID. You can also profile the new executable in the usual way (that is, by invoking CXpa with the name of the executable and running it under CXpa).

NOTE: When pre-instrumenting an executable on an architecture that is different from the architecture the executable will be run on to generate profiling data, you must specify the `-tm` *<architecture>* option when you start CXpa. This ensures that the correct timing routines are called to collect appropriate hardware metrics for the target system. Valid values for *<architecture>* are as follows:

`spp1000`—Exemplar SPP1000 Series
`spp1200`—Exemplar SPP1200 Series
`spp1600`—Exemplar SPP1600 Series

When you write instrumentation to a copy of the executable file, the resulting executable is an exact copy of the executable being profiled, except that it contains the current source code region and metric selections. All source code correlation is maintained. The size and permissions of the executable do not change, but the time stamp on the executable does.

The directory where the PDF files are created by a pre-instrumented program is controlled by the environment variable `PROFDIR`. If `PROFDIR` does not exist, *<executable>.<pid>*.pdf is created in the directory the application completes execution in (usually the directory from which the application is invoked).

If the `PROFDIR` environment variable is set to

`PROFDIR=`*string*

string/*<executable>*.*<pid>*`.pdf` is used as the name for each PDF file, where *pid* is the program's UNIX process ID.

If the `PROFDIR` environment variable is an empty string, no PDF file is created (although data is collected).

The next two sections describe procedures for using pre-instrumented executables in CXpa's X window interface or command-line interface.

Using pre-instrumented executables in line mode

The following procedure demonstrates how to use CXpa's command-line interface to:

- Pre-instrument an executable.
- Run the executable from the shell to generate a performance data file (PDF).
- View performance graphs and reports generated from the data in the PDF file.

1. At the shell prompt, invoke CXpa with the name of the executable (the `-nw` option invokes CXpa in line mode). The executable must be prepared for profiling with CXpa.

```
% /usr/convex/bin/cxpa -nw a.out

            CONVEX Performance Analyzer

Type 'help' for help.
Reading executable mmunge.-O3.exe...
Selecting profile mmunge.-O3.exe.pdf...
```

2. At the (CXpa) prompt, select regions and metrics for profiling.

```
(CXpa) select routine all
(CXpa) collect cpu wall_clock
```

The `select routine all` command selects all routine regions in the program for profiling. The `collect cpu wall_clock` command tells CXpa to collect wall clock time and CPU time metrics.

Refer to the "Selecting and deselecting regions and metrics in line mode" and the "Introducing metrics" online help topics or sections of this book for more information about selecting regions and metrics for profiling.

3. Use the `save executable` command to write the instrumentation to the executable or to a copy of the executable:
   - When you execute the `save executable` command without specifying a file name, CXpa writes the instrumentation to the current executable without changing its name.
   - When you specify a file name with the `save executable` command, CXpa writes the instrumentation to a copy of the executable, using the specified file name.

   In the following example, the instrumentation is written to the file `a.out.inst`, which is a copy of the `a.out` executable.

```
(CXpa) save executable a.out.inst
```

4. Quit CXpa.

```
(CXpa) quit
```

5. From the shell prompt, run the executable to generate a PDF file. CXpa automatically names the PDF file *<executable>.<pid>*.pdf.

   For example, if you saved the instrumentation to a copy of the `a.out` executable named `a.out.inst`:

```
% a.out.inst
(The program runs to completion.)

% ls *.pdf
% a.out.inst.1324.pdf
```

6. From the shell prompt, invoke CXpa with the name of the resulting PDF file.

```
% cxpa  -nw  a.out.inst.1324.pdf
```

7. From the (CXpa) prompt, use the `analyze` command to generate and view text reports of the performance data in the PDF file.

```
(CXpa) analyze
```

Using pre-instrumented executables in X window mode

The following procedure demonstrates how to use CXpa's X window interface to:

- Use CXpa to pre-instrument an executable.
- Run the executable from the shell to generate a performance data file (PDF).
- View performance graphs and reports generated form the data in the PDF file.

1. Set your DISPLAY environment variable. For example, using C shell syntax:

   ```
   % setenv DISPLAY display_name:0.0
   ```

   Using Bourne shell (sh) syntax:

   ```
   $ DISPLAY=display_name:0.0; export DISPLAY
   ```

2. At the shell prompt, invoke CXpa with the name of the executable The executable must be compiled for profiling with CXpa.

   ```
   % /usr/convex/bin/cxpa a.out
   ```

   The Executable Manager window is created.

   Continue with step 4 if you wish to accept the default region and metric selections. The default selections collect CPU time and wall clock time metrics for all routine regions and should be used the first time you profile your program with CXpa.

3. Click on the Profile Selection button in the Executable Manager window to open a Profile Selection dialog where you can select regions and metrics for profiling. When you have finished making selections, press OK to apply the selections and close the Profile Selection dialog.

   Refer to the "Profile Selection dialog" and the "Introducing metrics" sections of this book for more information about selecting regions and metrics for profiling.

4. Write the instrumentation to the executable or to a copy of the executable:
   - Select Save from the File menu in the Executable Manager window to write the instrumentation to the current executable without changing its name.
   - Select Save As from the File menu in the Executable Manager window. CXpa opens a Save Executable As dialog where you can specify the name of the new executable file.

5. Select Exit from the File menu in the Executable Manager window to quit CXpa.
6. From the shell prompt, run the executable to generate a PDF file CXpa automatically names the PDF file *<executable>.<pid>*.pdf.

   For example, if you saved the instrumentation to a copy of the `a.out` executable named `a.out.inst`:

   ```
   % a.out.inst
   ```
   (The program runs to completion.)

   ```
   % ls *.pdf
   % a.out.inst.1324.pdf
   ```
7. From the shell prompt, invoke CXpa with the name of the resulting PDF file.

   ```
   % cxpa  a.out.inst.1324.pdf
   ```

   The Analysis Control window is created.
8. Press one of the buttons at the bottom of the Analysis Control window to generate and view 2D and 3D graphs or text reports of the performance data in the PDF file.

Related Topics

CXpa and the `mpa` utility
Introducing metrics
Introducing source code regions
Performance data files (PDFs)
Profiling message-passing applications with CXpa
Reports
Selecting and deselecting regions in line mode
Selecting metrics in line mode
Selecting metrics in X window mode
Selecting regions in X window mode
Using batch mode

Related Windows

Analysis Control window
Executable Manager window
Profile Selection dialog
Save Executable As dialog

Related Commands

`analyze`
`collect`
`run`
`save executable`
`select`
`set events`

Profiling message-passing applications with CXpa

You can profile a PVM (parallel virtual machine) or MPI (message-passing interface) application using CXpa by generating a separate PDF file for each of the application processes. This allows you to simultaneously profile all processes in a program. During analysis, you can combine the data from these PDF files into a single PDF file.

Generating PDF files

To generate profiling data from a PVM or MPI program using CXpa, perform the following steps:

1. Build the application with a Convex compiler and add the `-cxpa` option to the compilation and/or link line.

   For more information on building applications using Convex PVM, refer to the *Convex PVM/GSM User's Guide for Exemplar Systems*, Order No. DSW-501. For information on building applications using MPI on SPP Series systems, refer to the *MPICH User's Guide for Exemplar Systems*, Order No. DSW-493.

2. Once the application is built, you must use CXpa to instrument the application. At the shell prompt, invoke CXpa with the name of the executable. For example:

   ```
   % /usr/convex/bin/cxpa my_app.exe
   ```

3. From within CXpa, select regions and metrics for profiling:

   – In line mode, use the `select`, `collect`, and `set events` commands to select regions and metrics for profiling. For example:

   ```
   (CXpa) select routine all
   (CXpa) collect cpu wall_clock events
   (CXpa) set events data_cache
   ```

   The above series of commands selects all routine regions for profiling and enables collection of CPU time, wall clock time, and data cache event metrics at these regions. The `data_cache` parameter of the `set events` command is specific to SPP1200 and SPP1600 Series machines.

- In X window mode, use the Profile Selection dialog to select regions and metrics for profiling.

4. From within CXpa, write the CXpa instrumentation selections to the executable file (pre-instrument the executable):
   - In line mode, use the `save executable` command. Executing the `save executable` command without specifying a filename writes the instrumentation to the executable, modifying it in place. To write the instrumentation to a copy of the executable, specify a filename with the `save executable` command.
   - In X window mode, select Save from the File menu in the Executable Manager window to modify the executable in place, or select Save As from the File menu to open a dialog where you can specify the name of a copy of the executable file to write the instrumentation to.
5. Exit CXpa.

   `(CXpa)` **`quit`**
6. From the shell, run the PVM or MPI application as you normally would.

When you run the executable, a separate PDF file is generated for each application process. The process ID (PID) of each process is inserted into the name of the PDF file generated, uniquely naming each of the resulting PDF files using the format *<executable>.<pid>*.pdf.

This is necessary because all the processes are likely to have the same name (*<executable>*.pdf, by default), which would result in CXpa successively overwriting the PDF file associated with each process.

The PDF file for the parent process usually (but not always) has the lowest-numbered PID.

NOTE: If a process forks, but does not perform an exec(), CXpa will only profile the parent process.

The directory where the PDF files are created by a pre-instrumented executable is controlled by the environment variable `PROFDIR`. If `PROFDIR` does not exist, *<executable>.<pid>*.pdf is created in the directory the application completes execution in (usually the directory from which the application is invoked).

If the `PROFDIR` environment variable is set to

`PROFDIR=`*string*

string / *<executable>* . *<pid>* . `pdf` is used as the name for each PDF file, where *pid* is the program's UNIX process ID.

If the PROFDIR environment variable is an empty string, no PDF file is created (although data is collected).

Analyzing profiling data from multiple PDF files

Once the PDF files are generated, use the following procedure to analyze the profiling data using CXpa's X window interface.

For a line mode (tty interface) example, refer to the "merge" command online help topic or section of this book.

1. Set your DISPLAY environment variable. For example, using C shell syntax:

   % **setenv DISPLAY** *display_name*:**0.0**

   Using Bourne shell (sh) syntax:

   $ **DISPLAY=***display_name*:**0.0; export DISPLAY**

2. Start CXpa in X window mode, specifying the names of the PDF files generated by the PVM or MPI application. For example:

   % **/usr/convex/bin/cxpa my_app.exe.*.pdf**

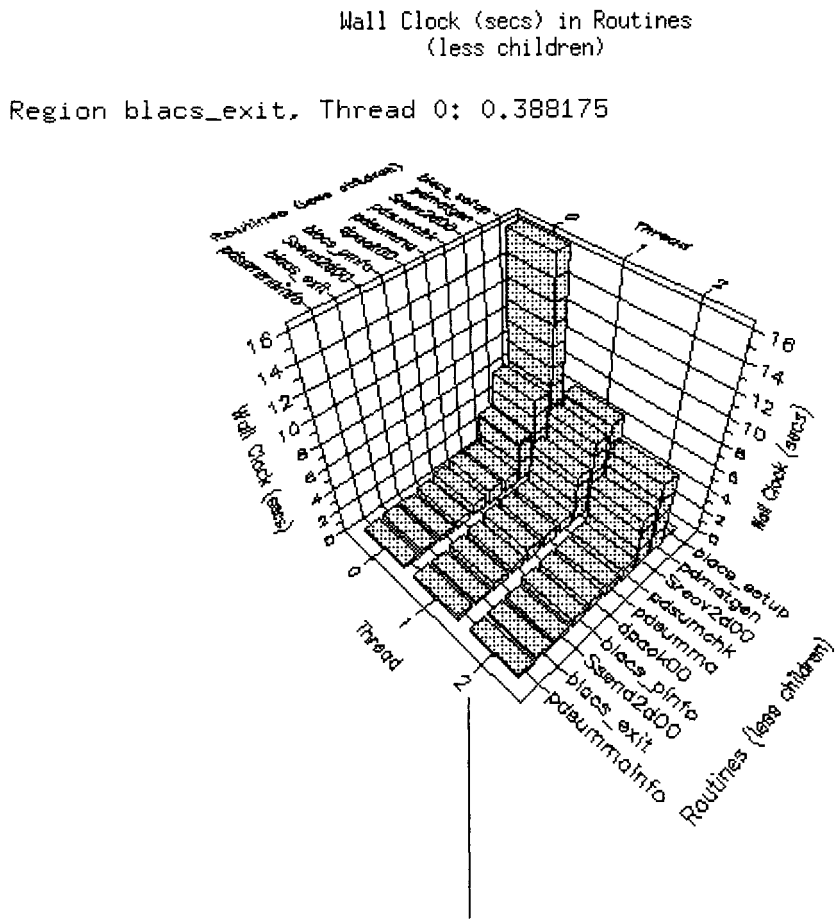
   The above command invokes CXpa with multiple PDF files in "analysis-only" mode using its X window interface.

   The Analysis Control window is displayed, and the name of each PDF file specified is displayed in the PDF list. The name of the last PDF file specified is highlighted in the list, and it is the current PDF.

   Once the PDF files have been loaded into CXpa, use the Merge feature to combine the data from the specified PDFs into a single PDF for analysis.

3. Select Merge from the File menu. CXpa opens a Merge PDFs dialog.
4. Specify the name of the PDF file that will contain the merged data, then close the dialog.
5. Select Open PDF from the File menu. CXpa opens an Open PDF dialog.
6. Specify the name of the PDF file that contains the merged data, then close the dialog. The new PDF name becomes the current PDF and is highlighted in the PDF list.
7. Press one of the buttons at the bottom of the Analysis Control window (Create 3D Profile, Create 2D Profile, Create Report, or Create Call Graph) to display profiling data for the processes that created the PDF file.

In the 3D Profile window, the profiling data for each process is mapped to the thread axis in the 3D Profile graph, as shown in the following example.

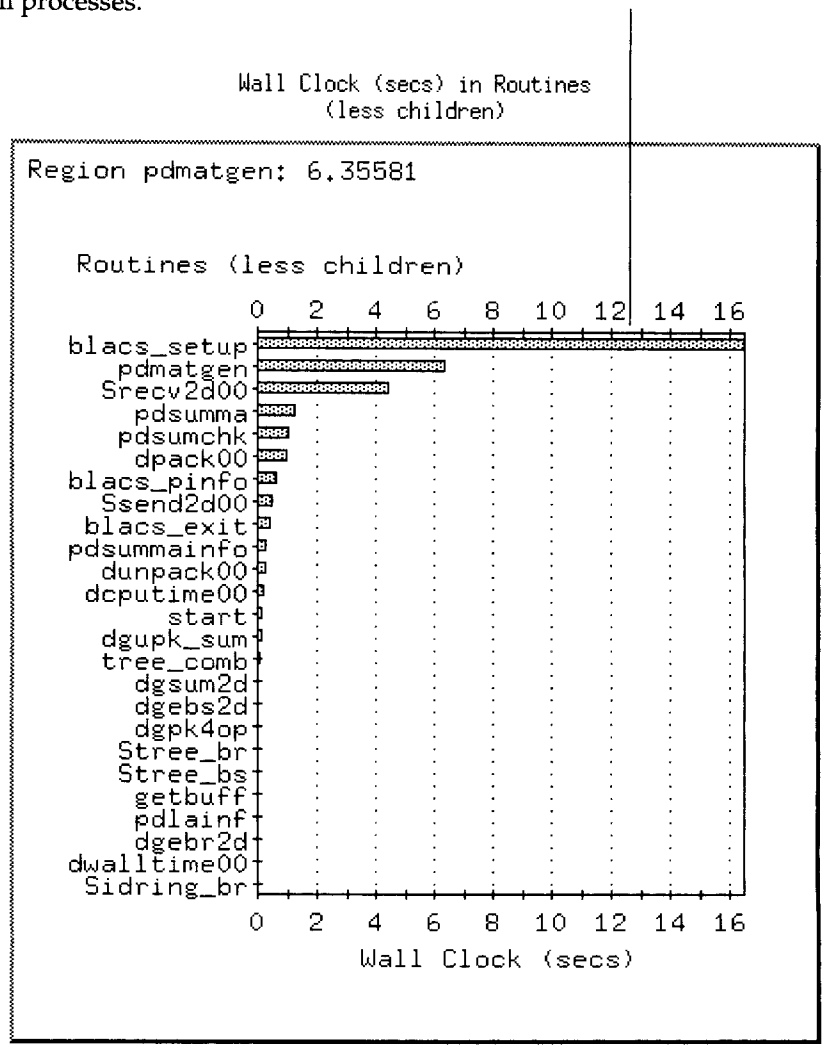


In this 3D Profile graph of a PVM application, the numbers on the thread axis represent individual processes.

Each bar in the graph represents the total wall clock time spent in a routine region for a single process.

In the 2D Profile window, the profiling data in the 2D Profile graph represents the sum of the data for each region across all processes, except for wall clock time. For wall clock time, the bars in the graph represent the maximum amount of wall clock spent in each routine across all processes, as shown in the following example:

In this 2D Profile graph of a PVM application, each bar in the 2D profile graph represents the maximum amount of wall clock time spent in the associated routine for all processes.



Related Windows

2D Profile window
3D Profile window
Analysis Control window
Analysis Report window
Call Graph window
Executable Manager window
Profile Selection dialog

Related Commands

`add path`
`analyze`
`collect`
`continue`
`cxpa`
`deselect`
`merge`
`path`
`rerun`
`run`
`select`
`set events`
`set pdf`
`set subcomplex`
`set visibility`
`source`
`stop`
`quit`

Related Concepts

Compiling
Introducing metrics
Learning CXpa quickly
Profiling HP PA-RISC object files and libraries
Reports
Selecting and deselecting regions in line mode
Selecting regions in X window mode
Selecting metrics in line mode
Selecting regions in X window mode
Using pre-instrumented executables

CXpa and the mpa utility

If you are using the mpa utility on an SPP Series system to modify process attributes (for example, data size or parallel process attributes such as maximum and minimum number of threads) and want to profile it with CXpa, the preferred method is to pre-instrument the executable for profiling with CXpa, then run the executable with mpa. For example:

```
% /usr/convex/bin/cxpa -nw a.out

        CONVEX Performance Analyzer

Type 'help' for help.
Reading executable a.out...
Selecting profile a.out.pdf...
(CXpa) select routine all
(CXpa) collect wall_clock cpu
(CXpa) save executable as a.out.inst
(CXpa) instrumenting, enter <CTRL+C> to abort.
...10%...20%...30%...40%...50%...60%...70%...80%...90%...100%
(CXpa) instrumentation finished.
(CXpa) quit
% /bin/mpa <mpa_options> a.out.inst
% /usr/convex/bin/cxpa a.out.inst.15237.pdf
```

The commands in the above example demonstrate how to profile executables run with the mpa utility:

- The command /usr/convex/bin/cxpa -nw a.out, runs CXpa from the shell in line mode (-nw) and specifies the executable file a.out for profiling.
- The command select routine all selects all routines in the program for profiling.
- The command collect cpu wall_clock enables collection of CPU and wall clock time.
- The command save executable a.out.inst writes the instrumentation specified by the collect and select commands to a copy of the executable file name which is named a.out.inst.
- The quit command exits CXpa.

- The command `/bin/mpa` *<mpa_options>* `a.out.inst` runs the instrumented executable file `a.out.inst` from the shell using `mpa` to modify the program's process attributes with the specified options. As the program runs, profiling data is collected in the file a.out.inst.*<pid>*.pdf (the program's UNIX process ID, *pid*, is inserted into the name of the PDF file).
- The last command runs CXpa in X window mode from the shell and specifies the PDF file a.out.inst.15237.pdf for analysis.

Refer to the man page for the `mpa` utility for information about using the `mpa` utility and its options; refer to the "Using pre-instrumented executables" online help topic or section of this book for detailed information about pre-instrumenting executables.

Using online help

In X window mode, you can access the Help window by pressing any Help button or by choosing an option from any Help menu in the upper-right corner of any CXpa window. Refer to the reference page for the `help` command for information about accessing online help for commands in line mode.

NOTE: To view the online release notice for the version of CXpa you are using, select Release Notice from the Help menu of the Executable Manager window or Analysis Control window.

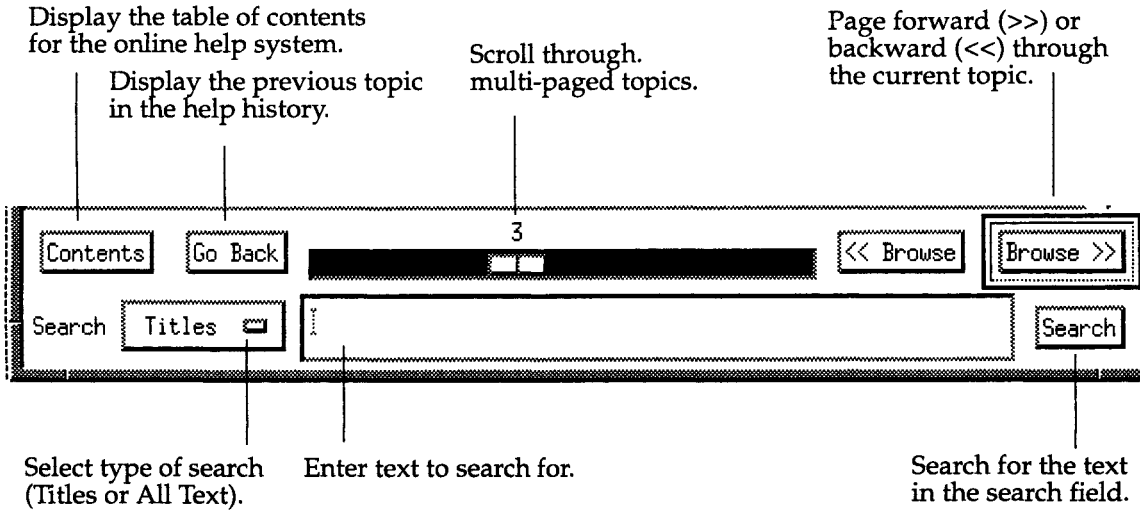
This section explains how to use the following features of the Help window:

- Using the buttons and scroll bars
- Using the menus
- Selecting a topic
- Searching for a topic
- Exiting from help

You can access this help page online by selecting the Using Help option of the Help menu in the upper-right corner of any CXpa window.

Using the buttons and scroll bars

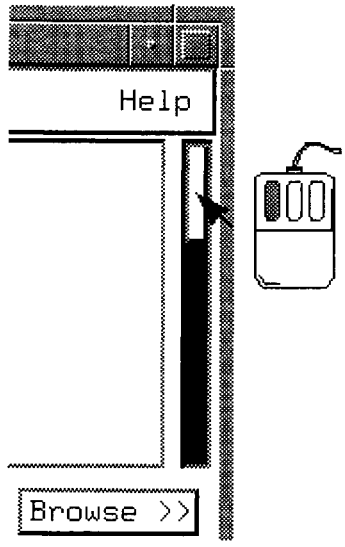
The buttons in this window are for navigating the online help system, as shown in the following figure.



The following list describes each button in detail:

- **Contents**—Displays the table of contents for the online help system. The table of contents provides an overview of and access to the rest of the help system.
- **Go Back**—Displays the previous topic stored in the help history. The help history contains all the topics viewed during the current CXpa session.
- **Slider**—Scrolls through the pages of the current topic. If the current topic does not consist of multiple pages, the slider is not displayed.
- **Browse**—Pages forward (>>) or backward (<<) through the current topic, one window length at a time. These buttons are deactivated if there is no next or previous page.
- **Search Field**—Provides a place to enter the text you wish to search for.
- **Titles/All Text**—Specifies a search of reference page titles or of the complete text of all pages.
- **Search**—Searches for the text entered in the Search Field.

To scroll through the current page, point to the scroll bar with the mouse, and hold down the left mouse button while sliding the bar up and down to scroll the text. (The scroll bar does not appear if the entire page is displayed in the Help window.)



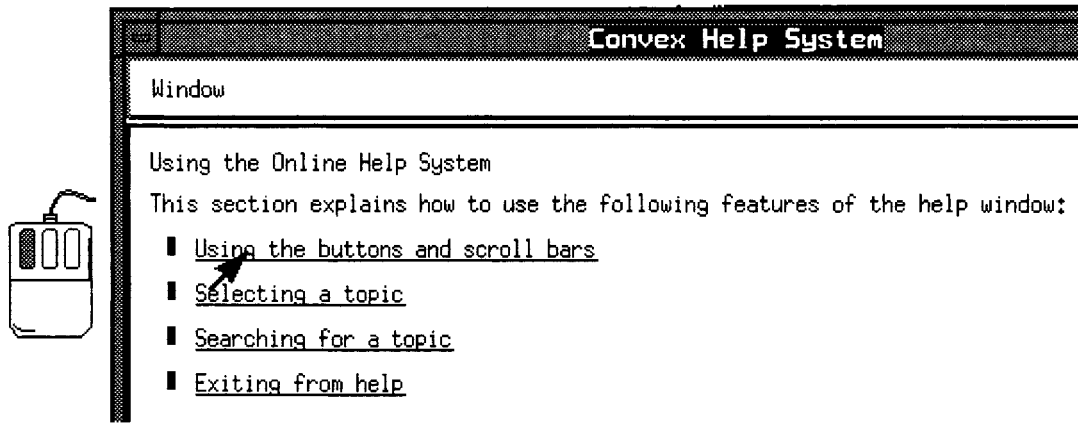
Using the menus

The two menus at the top of the window are described below:

- Window menu
  - **Print Text**—Prints an ASCII version of the current topic to your default printer using the `lpr` command. Your default printer is determined using the `PRINTER` environment variable.
  - **Close**—Closes the Help Window. This exits you from the Help System.
- Help menu
  - **On Help**—Displays the "Using the Online Help System" topic.
  - **On Version**—Displays version information for the online help system.

Selecting a topic

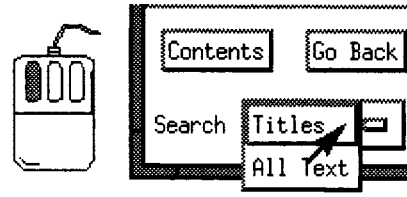
In this Help window, any underlined text is a Help topic name. Click on the underlined text with the left mouse button to view the help page for that topic.



Searching for a topic

You can search for a topic name by performing the following steps:

1. Select the type of search you want to perform. Searching the titles of the topics is generally quicker, while searching All Text is more thorough. Typically, you will want to search the titles first, and then search All Text if a titles search proves unsuccessful.



2. Activate the Search Field by moving the cursor into the field area.
3. Type the character string that you want to search for. You can include spaces in the string, but you cannot use a regular expression.

   The topics you can search for include:
   - Report names
   - Window or dialog names
   - Topic names (for example, PDF, event, metric, line mode, and so on)
   - Message ID numbers (for example, A18)
   - CXpa commands

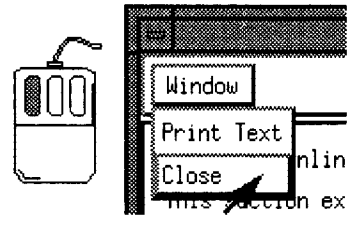
4. Click on the Search button, or press **RETURN**.

The Help window displays a list of topic names that match the search string. To view one of the topics from the search list, click on it with the mouse.

If only one topic name matches the search string, the Help window displays that topic directly.

Exiting from help

To exit from this help system, activate the Window menu with the left mouse button, and select the Close option.



Using online help

Preparing programs for profiling with CXpa

2

This chapter explains how to prepare programs for profiling with CXpa.

If your program is compiled with a Convex compiler, you must compile your program with a CXpa compiler option before you can profile it using CXpa. You need only use CXpa compiler options on the source files of your program that you wish to profile. You can also choose what kinds of regions in your program you want to profile, whether routines, loops, parallel regions, or basic blocks.

This chapter contains two reference pages: "Compiling for CXpa" and "Profiling HP PA-RISC object files and archive libraries." The following topics are covered:

- Compiling for CXpa (using Convex compilers):
  - Compiler syntax and options
  - Compiling and linking in one step
  - Compiling and linking separately
  - Profiling instrumented routines that call uninstrumented routines
  - Using the `-cxpalib` and `-cxpamon` compiler options
  - Problems compiling routines with both `-cxpa` and `-cxpab` options
  - Problems including CXpa compiler options (`-cxpamon`, `-cxpalib`, `-cxpa`, `cxpar`, and `-cxpab`) within Fortran `OPTIONS` statements.
- Profiling HP PA-RISC object files and archive libraries
  - Using the Convex object file instrumentor (`/usr/convex/bin/cxoi`, a separate utility shipped with CXpa) to instrument object and archive library files produced by any PA-RISC targeting compiler for routine-level profiling with CXpa.

Compiling for CXpa

This section describes how to compile programs for use with CXpa using Convex compilers.

NOTE: Refer to the `cxoi` man page or to the "Profiling HP PA-RISC object files and Libraries" online help topic or section of this book for instructions on how to prepare programs compiled with other PA-RISC targeting compilers, such as `f77` and `c89`, for routine-level profiling with CXpa.

Syntax

<compiler> [*cxpa_option*] [*optimization_ option*] *<source_files>*

Parameter	Meaning
compiler	Specifies one of the Convex compilers: `/usr/convex/bin/cc`—The Convex C compiler. `/usr/convex/bin/fc`—The Convex Fortran compiler. `/usr/convex/bin/CC`—The Convex C++ compiler. Refer to the "Compiling C++ programs for CXpa" section of this reference topic for more information. You can also include other Convex compiler options.
cxpa_option	Specifies CXpa options to the compiler: `-cxpa`—Compiles for routine, loop, and parallel region profiling. `-cxpar`—Compiles for routine profiling only. `-cxpab`—Compiles for basic block profiling only. `-cxpalib`—Links your program with system libraries that are instrumented for CXpa, if they are present on your system.

optimization_option	Specifies an optimization level. These relate to profiling in the following ways:
Optimization level(s)	Types of regions available for profiling
`-no, -O0`	Routines (if compiled `-cxpa` or `-cxpar`); basic blocks (if compiled `-cxpab`).
`-O1, -O2`	Routines (if compiled `-cxpa` or `-cxpar`); loops (if compiled `-cxpa`); basic blocks (if compiled `-cxpab`).
`-O3`	Routines (if compiled `-cxpa` or `-cxpar`); parallel regions and loops (if compiled `-cxpa`); basic blocks (if compiled `-cxpab`).
source_files	Specifies the name of one or more source files to instrument for profiling.

Description

Before you can profile your program with CXpa, it must be prepared by the compiler (that is, *instrumented*) for profiling. The compiler adds instructions to the executable file that enable CXpa to gather performance data during execution of your program.

When you compile your program, you specify the types of regions in your program that you are interested in profiling. You can profile four different types of regions:

- **Routine**—A main routine, functions, or procedures.
- **Loops**—A loop construct (such as the Fortran `DO` statement or C `for` statement). To profile loops you must compile at optimization level `-O1` or higher. At lower optimization levels, the compiler does not instrument loops.
- **Parallel regions (parallel loops)**—A loop that has been parallelized by the compiler. To profile parallel loops you must compile at optimization level `-O3`. At lower optimization levels, the compiler does not create parallel loops.
- **Basic blocks**—A basic block construct (such as the statements within a loop). A basic block is determined by the compiler, but is always a single-entry, single-exit section of code.

The compiler adds instructions around these regions in the executable depending upon the compiler option you choose.

There are three compiler options that instrument an executable for profiling. Each compiler option instruments a different type of program region:

- `-cxpa`—Routines, serial loops, and parallel loop regions (recommended for most profiling tasks).
- `-cxpar`—Routines only.
- `-cxpab`—Blocks only.

You can use these with any other compiler options except `-p`, `-pb`, and `-pg`; these options are designed for use with other profilers and cannot be used with CXpa options.

Only one CXpa instrumentation option (`-cxpa`, `-cxpar`, or `-cxpab`) should be used on a single source file when compiling your source code. You can, however, compile different source files for a single program with different options. If you do, you must use a CXpa compiler option when linking them together.

With CXpa, you can select specific regions to profile. For example, you can profile some or all of the loops that were instrumented by the compiler. Instrumented regions that are not profiled are ignored by CXpa and incur virtually no overhead.

An executable that has been instrumented for use with CXpa can still be executed outside of CXpa. CXpa instrumentation is designed to have a minimal effect on the size and performance of the executable.

Compiling and linking in one step

If you are compiling your source files into an executable with a single call to the compiler, you are compiling and linking in the same step. In this case, object files are not saved, and the executable file is ready to be used by CXpa.

An example of compiling a single source file is:

```
% /usr/convex/bin/cc -cxpa -O1 main.c
```

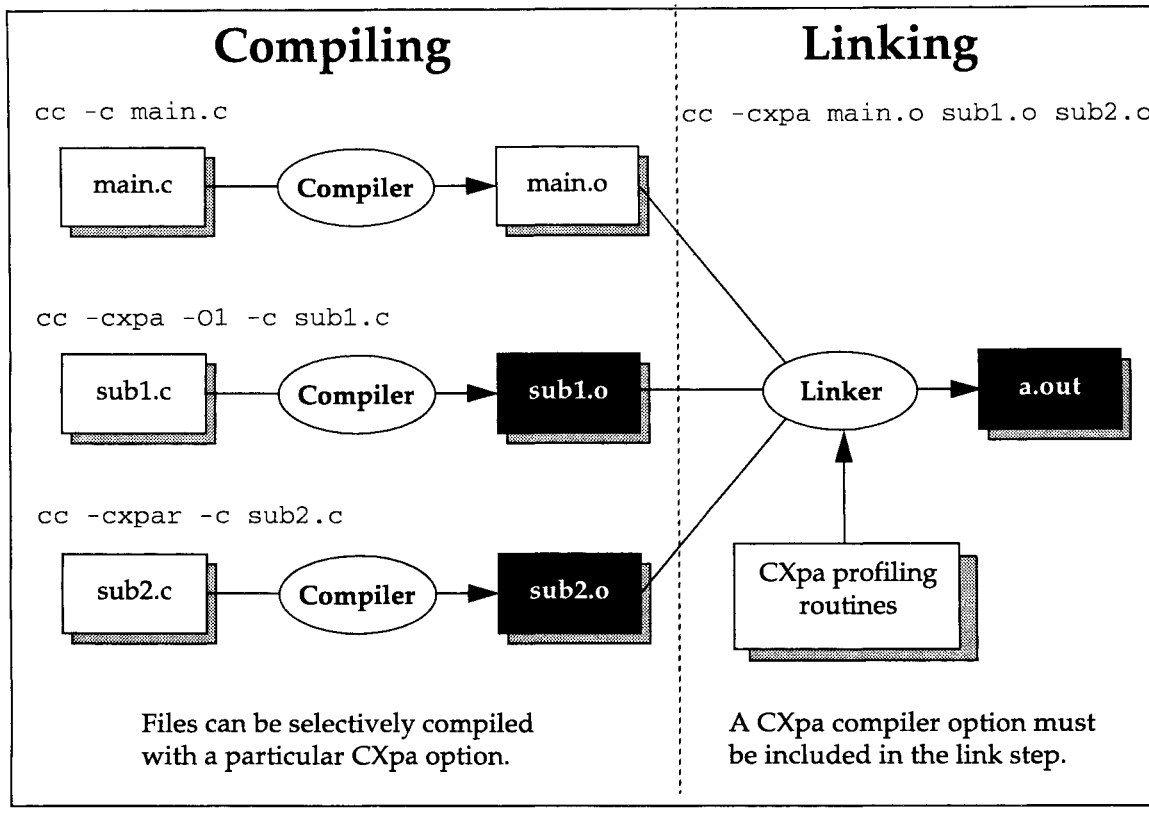
The source file `main.c` is compiled at optimization level `-O1` with the compiler option `-cxpa` to produce the executable `a.out`. Because the `-cxpa` and `-O1` options were used, the executable has been instrumented for routine and loop profiling.

Compiling and linking separately

Typically, the numerous source files of large programs are compiled separately. Each source file is compiled into an object file using the `-c` compiler option and then linked together into an executable.

Compiling for CXpa

When compiling for CXpa, you can compile each source file with the same or different profiling option. You must, however, use the `-cxpa` option when linking, as shown in the following figure.



In the above figure, the program being compiled is made up of three source files. The source file main.c is compiled into an object file (because of the `-c` option) without adding any instrumentation for CXpa.

The source file sub1.c is compiled for routine and loop profiling with the `-cxpa` and `-O1` options, while sub2.c is compiled with the `-cxpar` option for routine-level profiling only.

```
% /usr/convex/bin/cc -cxpa main.o sub1.o sub2.o
```

Another call to the compiler invokes the linker, which combines the object files into an executable. The linker also links CXpa's timing routines into the executable. You cannot profile using CXpa unless these routines are linked into your executable.

Compiling C++ applications for CXpa

To profile a C++ application with CXpa, compile your program using the Convex C++ compiler with a CXpa compiler option (`-cxpa`, `-cxpar`, or `-cxpab`). The exact usage and implementation of the CXpa compiler options with the C++ compiler depend on whether you are using the compiler in compiler mode or in translator mode (with the `+T` compiler option), and are as follows:

Compiler mode

When the Convex C++ compiler is used in compiler mode (the default) and you specify any CXpa compiler option (`-cxpa`, `-cxpab`, `-cxpar`), the `cxoi` utility is used to instrument the object files, and the Convex linker is used. Only routine-level profiling is available.

For example, when compiling and linking in one step:

```
% /usr/convex/bin/CC -cxpa -o myprog.exe myprog.C
```

The executable file generated from the above compilation line is instrumented for routine-level profiling with CXpa. The `cxoi` utility was used to instrument the executable.

If you specify the `-c` option to suppress the link phase and generate object files only, you must supply the `-cxpa` option at the final link phase so that the CXpa runtime profiling routines are linked into the executable.

For example, when compiling and linking separately:

```
% /usr/convex/bin/CC -cxpa -c main.C sub1.C
% /usr/convex/bin/CC -cxpa main.o sub1.o
```

The first line in the above example generates object files that are instrumented for profiling with CXpa. The `cxoi` utility is used to instrument the files for routine-level profiling. The second line links these object files into an executable using the Convex linker. The `-cxpa` option in the second line is required to link the CXpa runtime profiling routines into the executable.

Translator mode

If the `+T` option is specified, the C++ compiler is invoked in translator mode. In translator mode, the compiler translates C++ program source into a C program, which is then compiled by the Convex C compiler (`/usr/convex/bin/cc`), and any of the CXpa compiler options can be used as documented in the "Syntax" section at the beginning of this reference topic. Routines, loops, parallel loops, and blocks are available for profiling, and the Convex linker is used. For example:

```
% /usr/convex/bin/CC +T -cxpa main.C sub1.C
```

The executable file produced by the above compilation line is compiled in translator mode (`+T`) which invokes the Convex C compiler (`/usr/convex/bin/cc`). Routine, loop, and/or parallel regions are instrumented for profiling with CXpa (`-cxpa`).

Restrictions

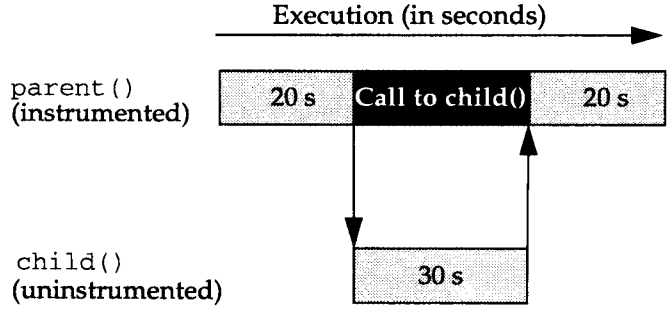
Note the following restrictions when compiling with a CXpa compiler option:

- The `-cxpa` option is incompatible with the `-hpcc` option, which selects the Hewlett-Packard compiler modes. These options cannot be used together.
- The `+a0` and `-cxpa` options should not be used together because the `-cxpa` option enables the `+a1` option by default. The `+a1` option tells the compiler to generate ANSI C-style declarations in the C source file it generates.
- You cannot use CXpa to profile an executable that has been compiled with the `-s` option (this option causes the output of the linker to be stripped of symbol table information).

Refer to the release notice and the CC(1) man page for the Convex C++ compiler for more information.

Profiling routines that call uninstrumented routines

If an instrumented routine calls an uninstrumented routine, CXpa will not be able to separate the time spent in the uninstrumented child routine from the time spent in the instrumented parent. This condition is illustrated in the following figure:



In this figure, routine `parent()` has been instrumented for CXpa while routine `child()` has not. The time spent in `parent()` not including children is reported as 70 seconds because CXpa cannot separate time spent in `child()`. If routine `child()` had been instrumented for profiling with CXpa, CXpa would have correctly reported `parent()` as having executed for 40 seconds not including children.

Using instrumented libraries with `-cxpalib`

Use the `-cxpalib` CXpa compiler option to link your program with installed system libraries that are instrumented for CXpa.

If you use the `-cxpalib` option, note the following:

- The program you are profiling may execute more slowly.
- Errors in the instrumented libraries may cause your program to terminate abnormally.
- The amount of profiling data will be significantly increased.

Problems with compiling routines with both `-cxpa` and `-cxpab`

Compiling a source file with both the `-cxpa` and `-cxpab` options can result in inaccurate timing information because the instrumentation for basic blocks interferes with the timing of routines if basic blocks are enabled.

Problems using the Fortran `OPTIONS` statement with CXpa

Do not use CXpa compiler options (`-cxpamon`, `-cxpalib`, `-cxpa`, `cxpar`, and `-cxpab`) within Fortran `OPTIONS` statements.

Related Topics

Profiling HP PA-RISC object files and libraries

Related Commands

`cxpa`

Compiling for CXpa

Profiling HP PA-RISC object files and archive libraries

Description

The Convex object file instrumentor (`/usr/convex/bin/cxoi`, a separate utility shipped with CXpa) enables you to instrument object and archive library files produced by any PA-RISC targeting compiler. This includes executables compiled with Hewlett-Packard Fortran, C, and C++ compilers. Only routines are exposed for profiling with this utility.

The `cxoi` utility only *enables* selection of routine regions for profiling in object and archive library files; it does not automatically select these regions for profiling. Region selection is done using CXpa.

Refer to the "Learning CXpa quickly" online help topic or section of this book for more information on selecting regions and metrics for profiling.

Syntax

`cxoi {`*lib.a* `|` *file.o*`} [-o` *output_file*`] [-t`*x*`,`*name*`]`

Parameter	Meaning
lib.a	Archive library file.
file.o	Object file.
`-o` *output_file*	Write the instrumented *file.o* or *lib.a* to *output_file*. If you do not specify the `-o` option, `cxoi` names the instrumented file *file*`.cxoi.o` or *lib*`.cxoi.a`.
`-t`*x*`,`*name*	Substitute subprocess *x* with *name* where *x* is one or more of a set of identifiers indicating the subprocess(es). This option works in two modes: If *x* is a single identifier, *name* represents the full path name of the new subprocess. If *x* is a set of identifiers, *name* represents a prefix to which the standard suffixes are concatenated to construct the full path names of the new subprocesses. The *x* can take one or more of the values: `a` Assembler (standard suffix is `as`). `l` Linker (standard suffix is `ld`).

Examples

To prepare HP PA-RISC object files and archive libraries for routine-level profiling with CXpa:

1. Use the `cxoi` utility to insert instrumentation slots for collecting routine-level performance information into the object file or archive library.

   – To instrument all routine entry points in an object file for profiling with CXpa, use a command line similar to the following:

   ```
   % /usr/convex/bin/cxoi file.o
   ```

   – To instrument all routine entry points in an archive library for profiling with CXpa, use a command line similar to the following:

   ```
   % /usr/convex/bin/cxoi libx.a
   ```

   By default, `cxoi` names the instrumented object or library file *file*`.cxoi.o` or *lib*`.cxoi.a`. To specify a different name for the instrumented file, use the `-o` option. For example, the command line

   ```
   % /usr/convex/bin/cxoi libc.a -o mylibc.a
   ```

   creates a new archive library file, `mylibc.a`, that contains CXpa instrumentation slots for routine entry points. The original file, `libc.a`, is not modified.

   To modify the original object or library file in place, use the `-o` option and specify the original file name. For example, the command line

   ```
   % /usr/convex/bin/cxoi libc.a -o libc.a
   ```

   overwrites the original library file with an instrumented version.

2. Once the object or archive library file has been preprocessed with `cxoi`, link it into an executable file for profiling under CXpa using the `-cxpa` option of a Convex compiler.

   When you create the executable, use a command line similar to the following:

   ```
   % /usr/convex/bin/fc -cxpa file.cxoi.o
   ```

   or

   ```
   % /usr/convex/bin/fc -cxpa file.o libx.cxoi.a
   ```

You can now invoke CXpa with the name of the new executable and select regions and metrics for profiling.

Refer to the `cxoi` man page for more information.

Makefile example

The following example Makefile for a Fortran program illustrates how to write standard Makefile rules to compile, instrument, and link sources into an executable file for CXpa profiling.

```
F77     = /usr/bin/f77
C89     = /bin/c89
FC      = /usr/convex/bin/fc
CC      = /usr/convex/bin/cc
CXOI    = /usr/convex/bin/cxoi

OBJECTS       = main.o      bar.o
CXOI_OBJECTS = main.cxoi.o bar.cxoi.o

%.o: %.c
        $(C89) -c $*.c

%.cxoi.o: %.o
        $(CXOI) $*.o

all: foo foo.for.cxpa

foo: $(OBJECTS)
        $(CC) -cxpa $(OBJECTS) -o foo

foo.for.cxpa: $(CXOI_OBJECTS)
        $(CC) -cxpa $(CXOI_OBJECTS) -o foo.for.cxpa
```

Limitations

Note the following limitations:

- The `cxoi` utility cannot be used to instrument shared libraries.
- The `cxoi` preprocessor only exposes routines for CXpa profiling. It does not support profiling of loops or basic blocks.
- Using `cxoi` requires space in /usr/tmp (or in the directory specified by the environment variable `TMPDIR`) totaling at most 3 times the size of the file being instrumented. If /usr/tmp does not have the required amount of space, you can set the `TMPDIR` environment variable to point to a different directory with sufficient space.
- Routines whose names begin with one or more leading underscores (_), millicode, and routines declared static (C or C++) are never exposed for profiling.
- CXpa may not support source code correlation for any routines exposed for profiling using the `cxoi` utility.

- Object files and archive libraries instrumented for profiling with `cxoi` do not contain source file line number information. This means that source code correlation and clickbacks for routines within these modules always refers to line 1 of the source file that contains the routine.

  CXpa source code annotations are not displayed in the Source Code window or in source file listings for object files and libraries instrumented with `cxoi`.

Known problems

Known problems for this release of `cxoi` are listed below:

- Do not use the `cxoi` utility on libraries or object files that are already instrumented for CXpa unless they have been recompiled (that is, on files already compiled with the `-cxpa`, `-cxpar`, or `-cxpab` options or on files instrumented with `cxoi`). This can result in linker errors or duplicate profiling results.
- CXpa may display the following message:

  ```
  ERROR D5: Cannot find symbolic support in current executable.
  ```

  This message can be ignored; performance analysis is not affected.
- If a process forks, but does not perform an `exec()`, CXpa will only profile the parent process.

Related Windows

Executable Manager window Profile Selection dialog

Related Concepts

Glossary
Introducing metrics
Learning CXpa quickly
Profiling strategy
Selecting and deselecting regions in line mode
Selecting metrics in line mode
Selecting metrics in X window mode
Selecting regions in X window mode

Related Commands

`analyze`
`cxpa`
`select`
`collect`
`run`
`set events`

Choosing performance data to collect

3

This chapter explains how to configure CXpa to collect specific types of performance data (metrics) at specified regions of your program.

The information in this chapter includes:

- Introducing source code regions
- Selecting regions in X window mode
- Selecting and deselecting regions in line mode
- Introducing metrics
- Selecting metrics in X window mode
- Selecting metrics in line mode

Introducing source code regions

Before you run your program under CXpa, you must specify the types of regions of your program for which you want to collect profiling data (metrics). CXpa collects metrics only at the regions selected for profiling.

Depending on the option(s) with which you compiled your source code, four types of source code regions can be selected for profiling:

- **Routines**—Routine regions are only available for profiling if your source code is compiled with Convex compilers using the `-cxpa` or `-cxpar` option. If you used `cxoi` to instrument object files and archive libraries, only routine regions are available for profiling in those object files and archive libraries.
- **Loops (all)**—Loop regions are only available for profiling if your source code contains loops and is compiled with Convex compilers using the `-cxpa` option at optimization level `-O1` or higher.
- **Parallel loops**—Parallel loops are a subset of all loops that you can select for profiling. They are only available for profiling if your source code contains loops and is compiled with Convex Compilers using the `-cxpa` option at optimization level `-O3` (at optimization levels below `-O3`, the compiler does not parallelize loops).
- **Basic blocks**—Basic block regions are only available for profiling if your source code is compiled with Convex compilers using the `-cxpab` option.

Regions are initially selected or deselected for profiling depending on which CXpa interface you are using:

- In X window mode, all routine source code regions in your program are initially selected.
- In line mode, all available source code regions in your program are initially deselected. You must use the `select` command to select regions for profiling.

When you run your program, CXpa collects performance data at every selected source code region that is executed. You can control which regions of your program are selected for profiling using the Profile Selection dialog (in X window mode) or the `select` and `deselect` commands (in line mode).

Selecting source code regions

You can select/deselect different types of source code regions in all routines or limit region and metric selection and collection to specific routines. You do not have to recompile your program to select or deselect regions for profiling.

Region selection should proceed from coarse-grained (all routines) to fine-grained (loops or parallel loops in specific routines) as code regions that exhibit performance problems are identified. This approach minimizes profiling intrusion (time delays that can be introduced due to the overhead of sampling hardware timers and storing profiling data while your program is running).

There are two key principles to remember:

- Minimize the number of data sampling points per program run.
- Collect only the metrics you are interested in per program run.

Use the following guidelines for selecting regions to profile:

- The first time you profile your program under CXpa, select all routines in your program for profiling at the routine region level (this is the default). This provides a complete picture of your program's performance. Using this information, you can then identify the routines that take the longest to execute.
- After you have identified the routines that consume the most wall clock time or CPU time, then select only those routines for profiling at the loop level and rerun your program under CXpa. With fewer source code regions selected, less time is spent in the timing routines CXpa uses to collect performance data.
- Profiling time increases with the number of regions selected for profiling. In general selecting loop regions for profiling increases execution time more than selecting routine regions.
- If you want to profile only parallel loops, select parallel loops only for profiling. This provides a more accurate representation of the performance of parallel loops.

Refer to the "Profiling strategy" section of this book for more information about profiling intrusion, and a step-by-step strategy for profiling.

NOTE: Selecting all source code regions in all routines for profiling will result in increased profiling time, and significant profiling intrusion may be incurred.

CXpa provides functionality to select only specific regions for profiling. You can select or deselect:

- All routine regions
- Source code regions in specific routines
- Source code regions at specific lines (in line mode only)

NOTE: Only routine-level profiling data is collected for selected routine regions. To profile loops, parallel regions, or basic blocks inside of a routine, you must select the corresponding loop, parallel region, or basic block region.

You can also choose to select or deselect all types of regions (routines, all loops, parallel loops, and blocks) or only specific types (for example, only parallel loops).

For instructions on how to select regions in X window mode, refer to the reference topic "Selecting regions in X window mode."

For instructions on how to select regions in line mode, refer to the reference topic "Selecting and deselecting regions in line mode."

Source code annotations for regions

CXpa displays special source code annotations that indicate the location of source code regions that can be selected for profiling and whether or not they are currently selected or deselected (as shown in the following table).

Source code region type	Selected	Deselected
Routine	`R`	`r`
Loop	`L`	`l`
Parallel loops	`P`	`p`
Basic block	`B`	`b`

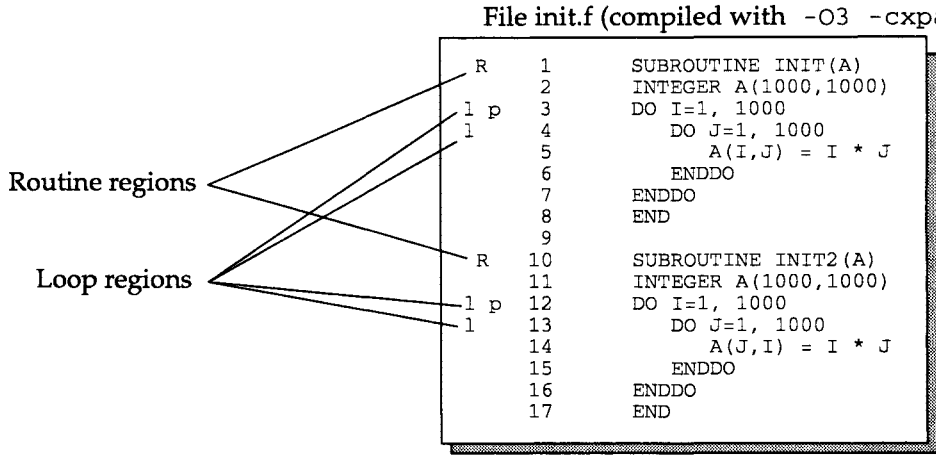
In X window mode, you can display annotated source code by:

- Selecting the Source Code option from the Windows menu in any CXpa window
- Clicking on a bar in the graph displayed in the 2D or 3D Profile windows

In line mode, you can display annotated source code using the `list` or `list selectable` commands.

Introducing source code regions

The following figure shows annotated source code for sample routines with several types of selectable source code regions.



Each of the routine regions in the above example is currently selected for profiling. The loop regions beginning at lines 3, 4, 12, and 13 can be selected for profiling, but are currently deselected. The parallel regions beginning at lines 3 and 12 can also be selected for profiling, but are currently deselected. No basic block regions can be selected for profiling because these routines were not compiled with the `-cxpab` option.

Related Topics

Compiling
Profiling strategy
Selecting regions in X window mode
Selecting and deselecting regions in line mode

Related Windows

Executable Manager window
Profile Selection dialog

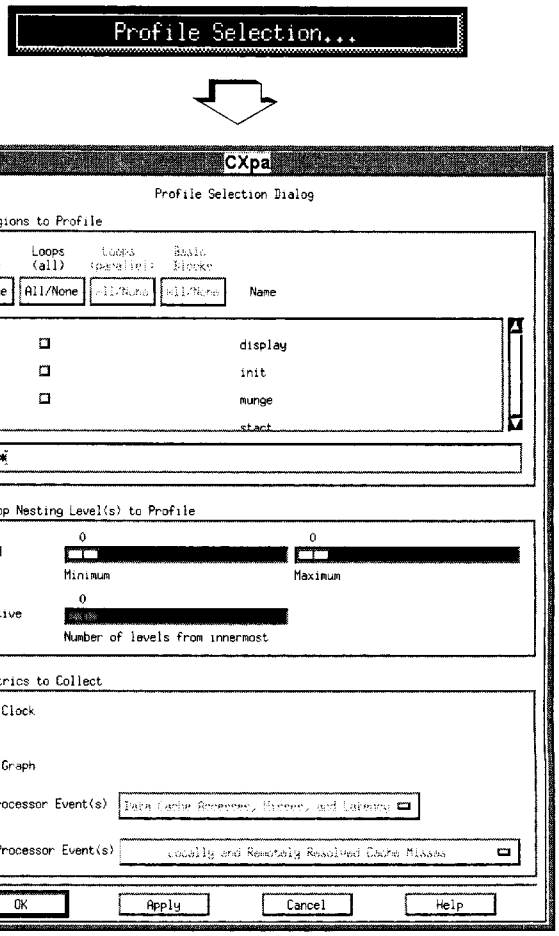
Related Commands

`deselect`
`list selectable`
`select`

Selecting regions in X window mode

By default, all routine regions in your program that were instrumented for profiling with CXpa are initially selected for profiling in X window mode.

To select a different set of regions for profiling, press the Profile Selection button in the Executable Manager window. The Profile Selection dialog appears.



Selecting regions in X window mode

Using the Select Regions to Profile portion of the Profile Selection dialog, you can select or deselect the types of regions you want to profile for all routines in your program or for specific routines.

Guidelines for selecting regions to profile

When running your application under CXpa with regions and metrics selected for profiling, you may notice that your code executes more slowly than expected. This can be due to profiling intrusion introduced by CXpa. Profiling intrusion refers to time delays that can be introduced due to the overhead of sampling hardware timers and storing profiling data while your program is running.

By using a top-down profiling strategy that minimizes the number of regions and metrics selected for profiling during each run of your program, you can significantly reduce the amount of profiling intrusion and increase the accuracy of the results. Region selection should proceed from coarse-grained (all routines) to fine-grained (loops or parallel loops in specific routines) as code regions that exhibit performance problems are identified. There are two key principles to remember:

- Minimize the number of data sampling points per program run.
- Collect only the metrics you are interested in per program run (for example, don't enable event collection for a run unless you really need to examine cache performance or instruction metrics).

Refer to the "Profiling stragety" section of this book for more information about profiling intrusion, and a step-by-step strategy for profiling.

NOTE: Selecting all source code regions in all routines for profiling is not recommended, due to increased profiling time and the amount of profiling intrusion that may be incurred.

NOTE: Profiling time increases with the number of regions and metrics selected for profiling. In general, selecting loop regions for profiling increases execution time more than selecting routine regions.

The following sections describe how to select source code regions using the Profile Selection dialog.

Selecting source code regions to profile

The upper panel of the Profile Selection dialog (Select Regions to Profile) is where you select the types of source code regions you want to profile and specify a set of routines that contain these regions to profile during a specific run of your program. You can specify either all routines or a subset of routines. The metrics you select will only be collected at these regions in the specified set of routines.

Selecting regions in X window mode

Depending on how you compiled your program, four different types of source code regions can be selected for profiling:

- Routines
- All loops (including parallel loops)
- Parallel loops only—parallel loops created by Convex compilers at optimization level `-O3`
- Basic blocks

Only types of regions that actually appear in your program can be selected (for example, if none of the routines in your program contain loops that were parallelized by the compiler, parallel loop regions will not be selectable).

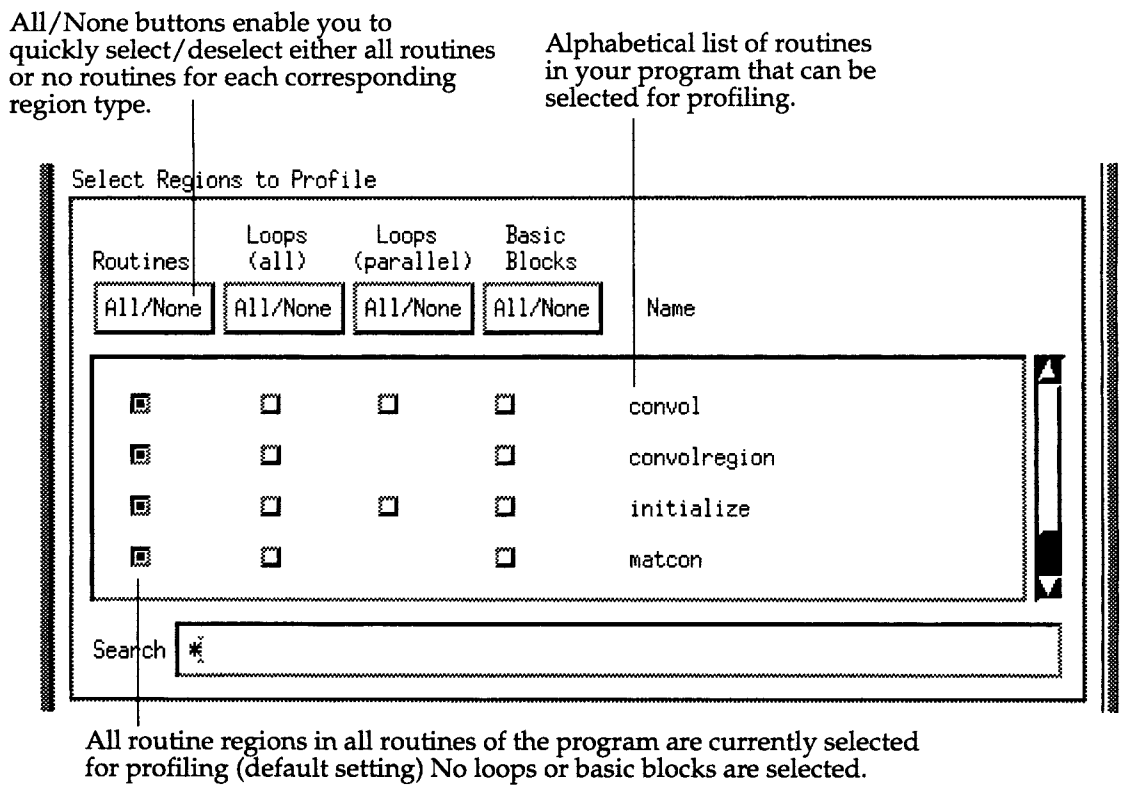
The routines in your program that can be selected for profiling are displayed in alphabetical order, and toggle buttons are displayed opposite each routine name. If a toggle button is not displayed for a particular region type for a routine, it means that no regions of that type can be profiled for that routine. For example, loop regions are not available for profiling unless the routine is compiled at optimization level `-O1` or greater with the `-cxpa` option.

If your program contains a large number of routines, you can:

- Use the scrollbar to move through the routine list.
- Type the name of a routine in the Search field, then press **RETURN** to scroll the routine list so that the desired routine is displayed at the top of the list.

Default setting—Selecting routine regions in all routines

The default region selection setting, which selects all available routine regions for profiling at the routine level, is shown in the following figure. This is the recommended setting for the first time you run your program under CXpa. This will enable you to dentify the routines that take the longest to execute. Because no loop regions are selected for profiling, loop nesting level settings are ignored.

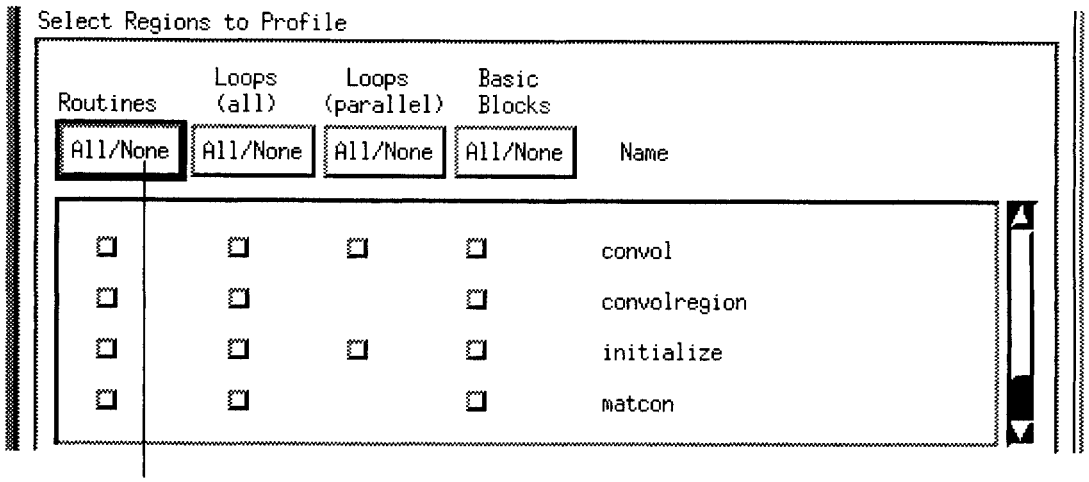


If you have changed the settings, but want to return the settings to this default, use the All/None buttons at the top of the region columns to select/deselect other types of source code regions so that routine regions are again selected for all routines.

Selecting source code regions in specific routines

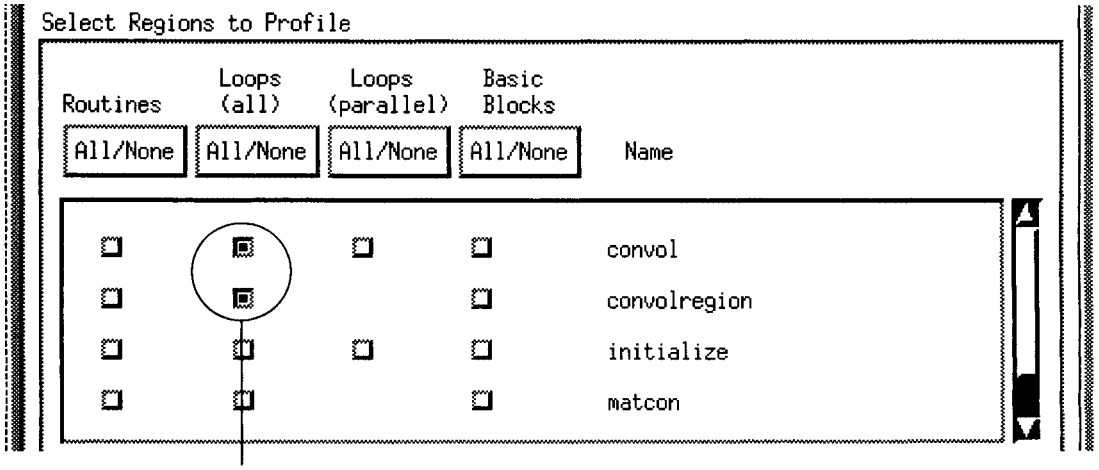
Once you have determined which routines take the longest time to execute, you will want to profile other source code regions (loops) within those routines to further isolate performance problems. To select regions in specific routines:

1. Click on the All/None buttons at the top of each region column to ensure that all regions and routines are deselected.



All source code regions in all routines are deselected for profiling.

2. Click the toggle button corresponding to the desired region type opposite the routine you want to profile. The following example figure shows all loops are selected for profiling in routines `convol` and `convolregion` only.



All loops in routines `convol` and `convolregion` only are selected for profiling.

Although you can profile multiple types of source code regions for each routine, this is not recommended, because of the amount of profiling intrusion that may be introduced.

If you selected loop regions for profiling (as in the above example), the current loop nesting level setting applies to all loops. If no loops in a routine fall within the specified loop nesting level range, then no loops in that routine are selected for profiling.

The loop nesting level setting is displayed in the Select Loop Nesting Level(s) to Profile section of the Profile Selection dialog. Refer to the next section for information about selecting loop nesting levels.

Selecting loop nesting levels

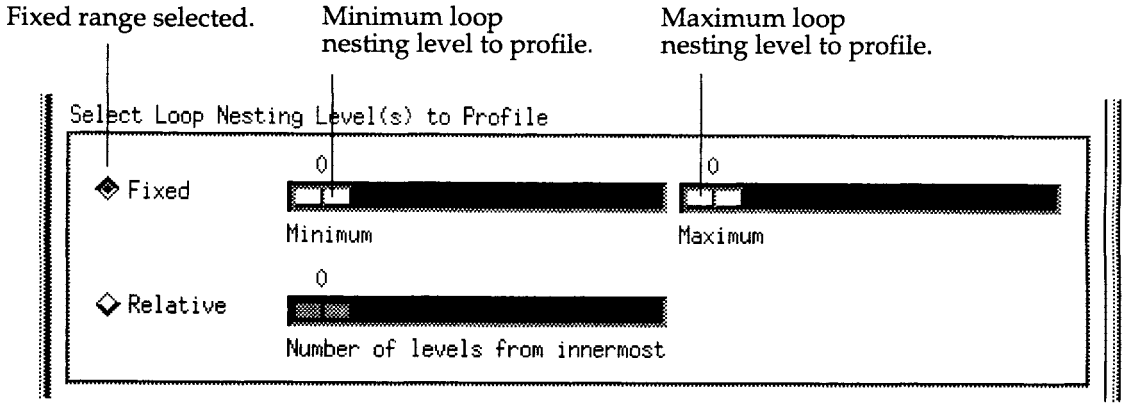
If you have chosen to profile loop regions, you can optionally specify either a fixed range of loop nesting levels to profile or the number of loop nesting levels to profile relative to each loop nest's innermost level.

The loop nesting level setting applies to all loops selected for profiling and is only active when loop regions are selected for profiling.

CXpa automatically determines the number of loop nesting levels in your program and sets the maximum loop nesting levels and the maximum number of levels from the innermost loop appropriately. These nesting levels correspond to the loops that are created by the compiler, and may not correspond directly to your original source code due to optimizations performed.

Default loop nesting level range settings

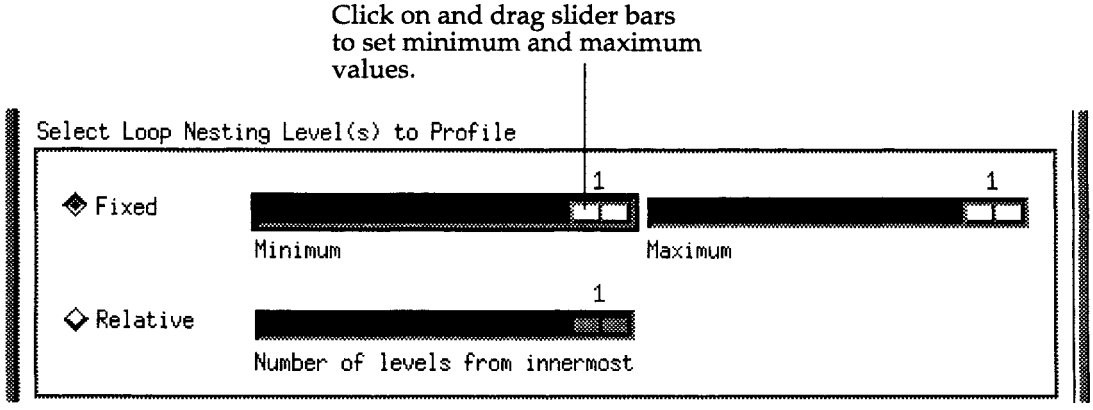
The first time you profile loop regions in your program, use the default setting for loop nesting levels (shown in the following figure). The default setting specifies a fixed loop nesting level range with a minimum of 0 and a maximum of 0 (after optimization). This means that all loops with a nesting level of 0 after optimization (outermost loops) are selected for profiling. This will minimize profiling intrusion.



Loop nesting level range default settings—Selects all loops at nesting level 0 only (outermost loops) for profiling.

Specifying a fixed loop nesting level range

On subsequent runs of your program, you can select different sections or "slices" of the loops within your program for profiling. When specifying a fixed range of loop nesting levels, you will generally want to set the minimum loop nesting level equal to the maximum loop nesting level, as shown in the following example:



Sample loop nesting level range with minimum and maximum nesting levels set to 1 selects only loops at nesting level 1 (after optimization) for profiling.

Specifying the number of relative loop nesting levels

Instead of choosing a fixed range of loop nesting levels for profiling, you can specify the number of loop nesting levels to profile relative to the innermost loop of each loop nest in your program.

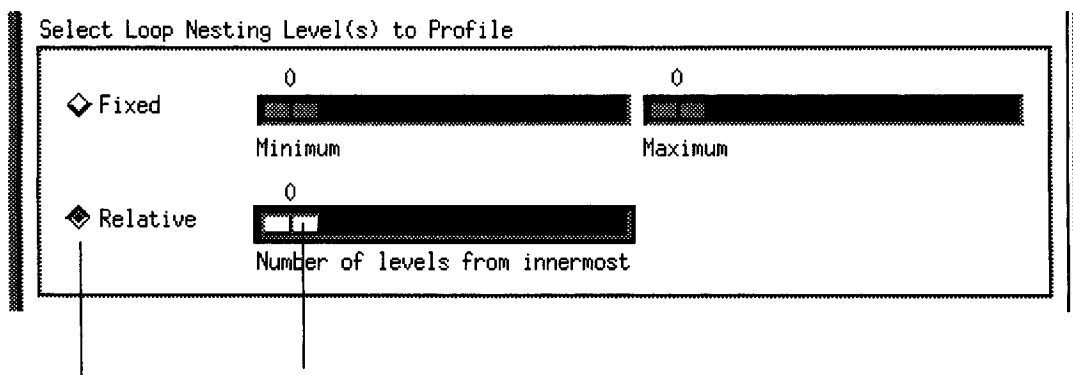
- A relative setting of 0 means that only the loops at the innermost (deepest) level of each loop nest are selected for profiling.
- A relative setting of 1 means that only the loops at the two innermost nesting levels of each loop nest are selected for profiling.

  For example, if the innermost nesting level of a loop nest is 4, the loops at nesting levels 3 and 4 of that loop nest will be selected for profiling.
- A maximum setting (setting the slider bar as far to the right as it will go) is equivalent to selecting all loops at all loop nesting levels.

When a relative loop nesting level is specified, loops that are not part of a loop nest are also selected for profiling.

To specify a relative setting for loop nesting levels:

1. Click the Relative toggle button in the Select Loop Nesting Level(s) to Profile panel.
2. Click and drag the slider bars to select the number of loop nesting levels to profile relative to the innermost loops in your program, as shown in the following figure:



Relative loop nesting level selected.

A relative loop nesting level setting of 0 selects all loops at the innermost nesting level of each loop nest for profiling, along with any loops that are not part of a loop nest.

Related Topics

Compiling
Introducing metrics
Introducing source code regions
Profiling strategy
Selecting metrics in X window mode

Related Windows

Executable Manager window
Profile Selection dialog

Selecting regions in X window mode

Selecting and deselecting regions in line mode

In line mode, you can select or deselect any set of source code regions in your program with a variant of the `select` and `deselect` commands. You can:

- Select or deselect one type of source code region:
  - In all routines
  - In specific routines
  - At specific lines
- Select or deselect all source code regions:
  - In specific routines
  - At specific lines
  - In all routines

Each of these methods is described in detail in the sections that follow. The same source code is used in all figures to contrast different command options.

In the examples, uppercase annotations indicate selected source code regions, while lowercase annotations indicate deselected source code regions. In line mode, annotated source code is displayed using the `list` or `list selectable` commands.

In line mode, all available source code regions in your program are initially deselected, so if you run your program without using the `select` command (that is, without selecting any source code regions to profile), no metrics are collected.

NOTE: The loop nesting level setting affects the number of loops selected for profiling. The default loop nesting level setting only selects loops at nesting level 0 (outermost loops) for profiling. Refer to the "Profile Selection dialog" or "`set visibility`" command online help topics or sections of this book for more information about loop nesting levels.

Selecting specific regions to profile provides greater control over profiling and can shorten profiling time. Refer to the "Profiling strategy" section of this book for more information about selecting regions and metrics and a step-by-step profiling strategy.

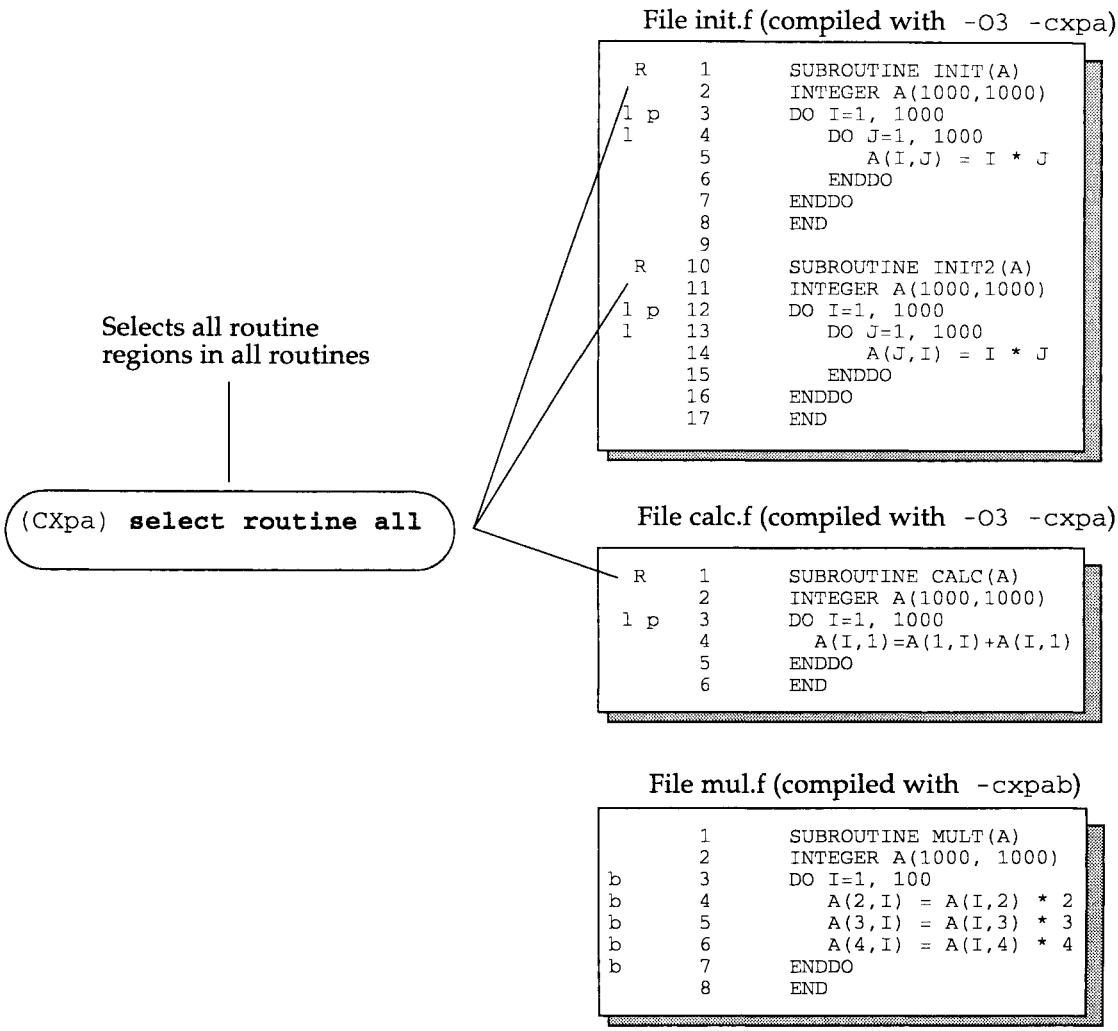
Selecting and deselecting regions in line mode

Selecting or deselecting one type of region in all routines

To select or deselect one type of source code region in all routines, use one or more of the following variants of the `select` or `deselect` commands:

- `select routine all` or `deselect routine all`—Selects or deselects all routine regions in all routines compiled with `-cxpa` or `-cxpar` or instrumented for profiling with the cxoi utility. Using the command `select routine all` is the best way to begin a profiling session because it identifies the routines that contain performance bottlenecks.
- `select loop all` or `deselect loop all`—Selects or deselects all loop regions (including parallel loops created by the Convex compiler at optimization level `-O3`) in all routines compiled with `-cxpa` at optimization level `-O1` or higher.
- `select pregion all` or `deselect pregion all`—Selects or deselects all parallel loops that were created by the Convex compiler at optimization level `-O3` for all instrumented routines in your program.
- `select block all` or `deselect block all`—Selects or deselects all basic block regions in your program for all routines compiled with `-cxpab`.

For example, the following figure shows that the `select routine all` command selects all routine regions in the routines compiled with `-cxpa` or `-cxpar`. No other regions are affected.



Selecting or deselecting one type of region in specific routines

You can select or deselect one type of source code region in specific routines using one or more of the following commands:

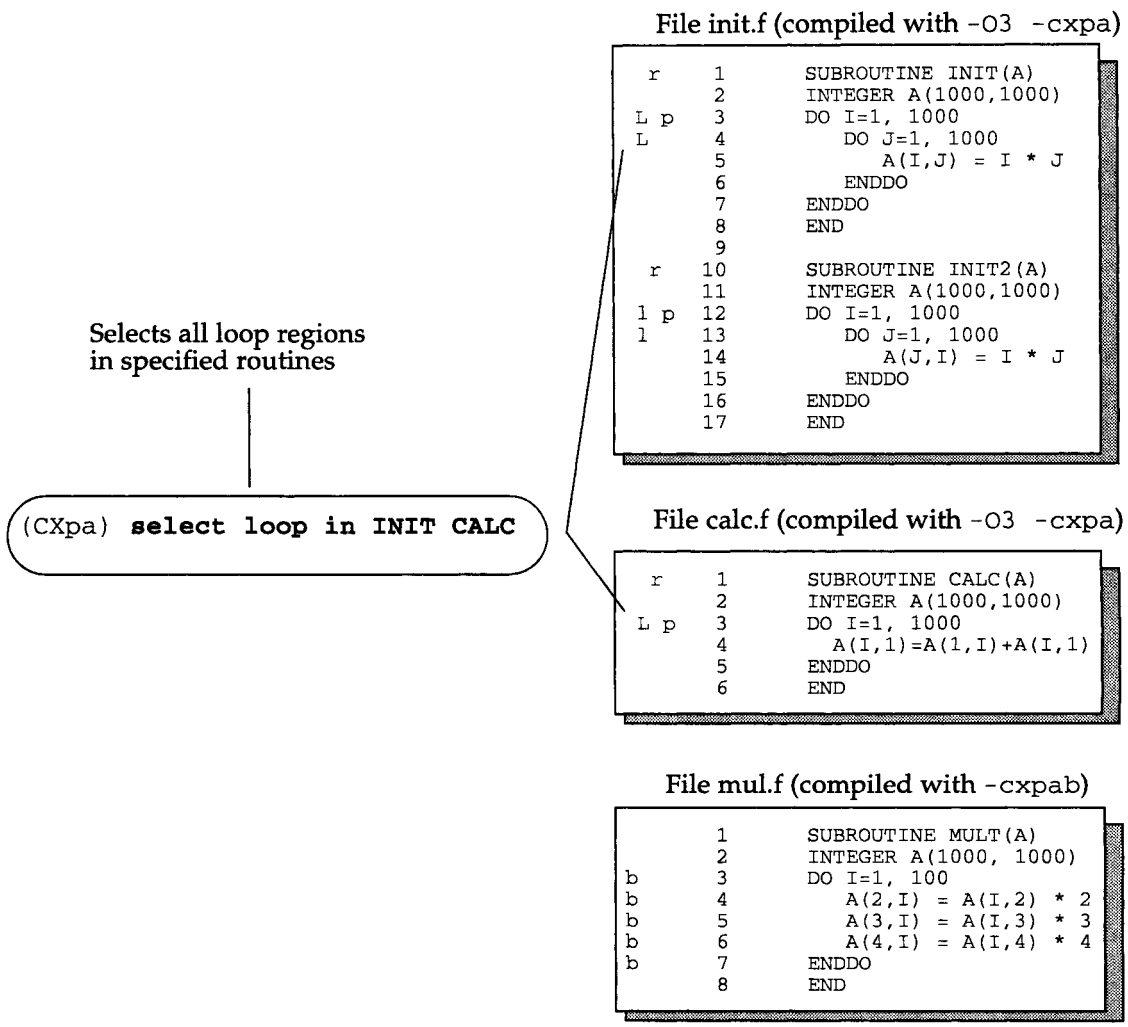
- `select loop in` or `deselect loop in`—Selects or deselects all loop regions in the specified routine (or routines) compiled with `-cxpa` at optimization level `-O1` or higher.

Selecting and deselecting regions in line mode

- `select pregion in` or `deselect pregion in`—Selects or deselects all parallel loops created by the compiler in the specified routine (or routines) compiled with `-cxpa` at optimization level `-O3` or higher.
- `select block in` or `deselect block in`—Selects or deselects all basic block regions in the specified routine (or routines) compiled with `-cxpab`.

Each of these commands selects all regions of the indicated type in the specified routine (or routines). Multiple routines are separated by spaces on the command line.

In the following figure, the `select loop in` command selects all loop regions in the `INIT` and `CALC` routines. No other regions are affected.



Selecting and deselecting regions in line mode

Selecting or deselecting one type of region at specific lines

If you do not want to select or deselect all regions at a specific line, you can select or deselect a single region type at a line.

To select or deselect one type of region at a specific source line (or source lines), use one or more of the following commands:

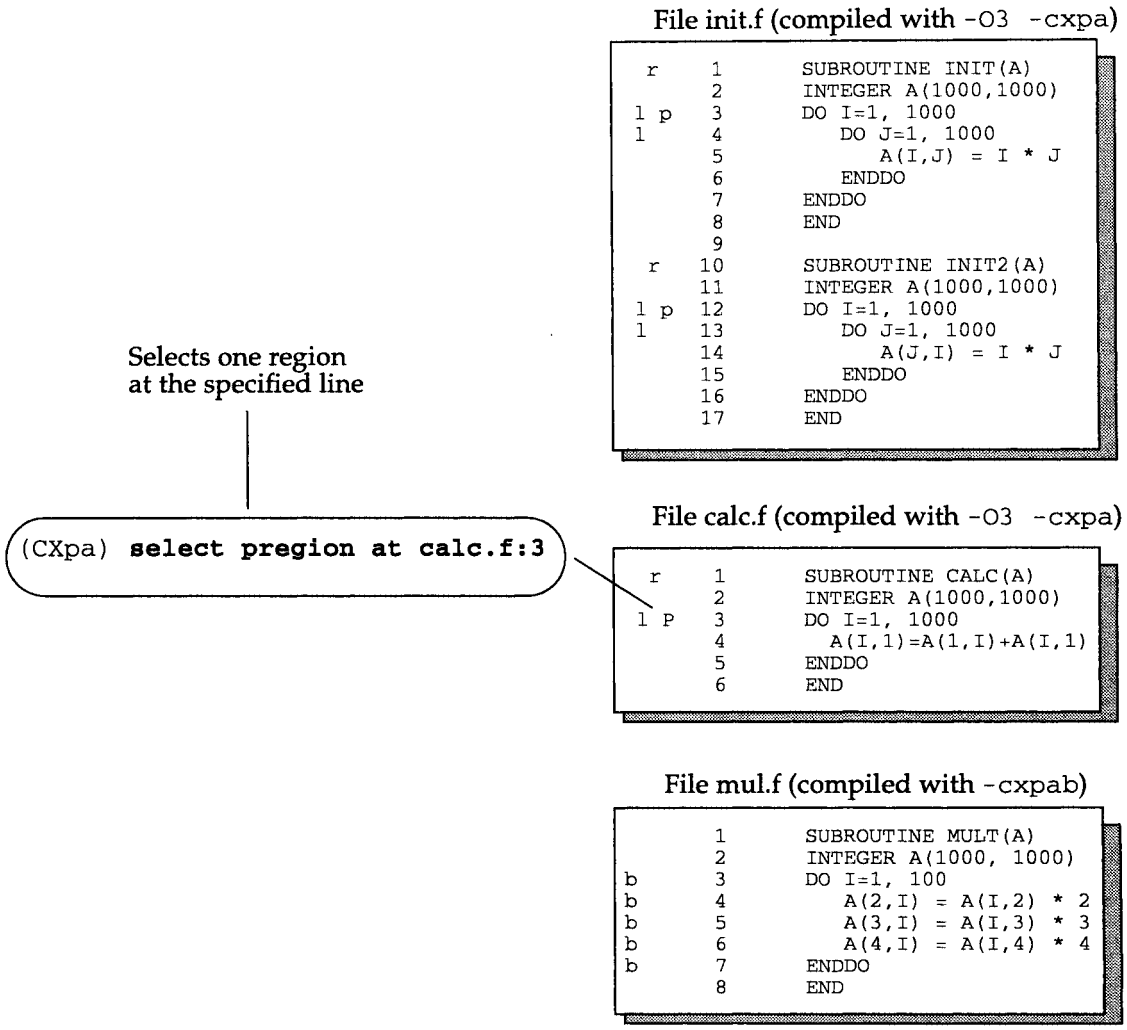
- `select loop at` or `deselect loop at`—Selects or deselects the loop region at the specified line number (or line numbers) in routines compiled with `-cxpa` at optimization level `-O1` or higher.
- `select pregion at` or `deselect pregion at`—Selects or deselects the parallel loop created by the compiler at the specified line number (or line numbers) in a routine compiled with `-cxpa` at optimization level `-O3` or higher.
- `select block at` or `deselect block at`—Selects or deselects the basic block region at the specified line number (or line numbers) in routines compiled with `-cxpab`.

Using one of these commands selects the region of the indicated type at the specified line in the specified file. Multiple line numbers can be specified and are separated by spaces on the command line.

Use the `list selectable` command to display line numbers and program source code that contain selectable source code regions.

Selecting and deselecting regions in line mode

The `select pregion at` command in the following figure selects the parallel loop at line 3 in the calc.f source file. The loop region on the same line remains deselected.

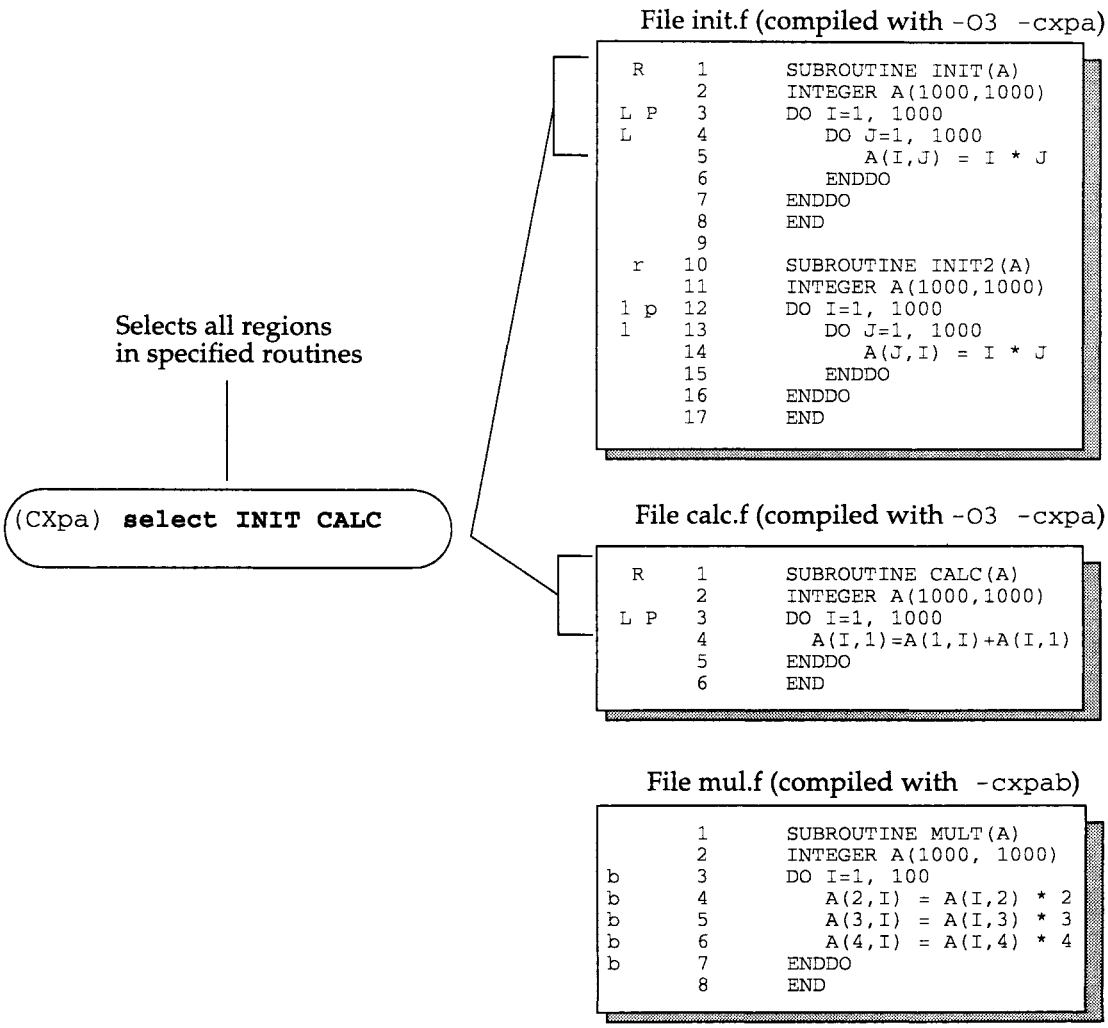


Selecting or deselecting all regions in specific routines

After profiling all routines in your program, you may want to profile only specific routines whose performance you want to improve. Use the commands `select` *<routine-name>* or `deselect` *<routine-name>* to select or deselect all regions in a routine. You can enter multiple routine names by separating them with a space.

Selecting and deselecting regions in line mode

The following figure illustrates how to select all regions in specific routines.



Selecting and deselecting regions in line mode

Selecting or deselecting all regions at specific lines

You can select or deselect all regions at a specific source line. This makes it possible to profile a single loop in a routine without having to profile all of the loops within that routine.

To select or deselect all regions at a line in a specific routine, use the `select at` or `deselect at` commands, followed by the file name and line number you want to enable. The file name and line number are separated by a colon. The example below shows how to select all regions at a specific line.

File init.f (compiled with `-O3 -cxpa`)

```
  r     1       SUBROUTINE INIT(A)
        2       INTEGER A(1000,1000)
l p     3       DO I=1, 1000
l       4          DO J=1, 1000
        5             A(I,J) = I * J
        6          ENDDO
        7       ENDDO
        8       END
        9
  r    10       SUBROUTINE INIT2(A)
       11       INTEGER A(1000,1000)
l p    12       DO I=1, 1000
l      13          DO J=1, 1000
       14             A(J,I) = I * J
       15          ENDDO
       16       ENDDO
       17       END
```

Selects all regions at specified line

```
(CXpa) select at calc.f:3
```

File calc.f (compiled with `-O3 -cxpa`)

```
  r     1       SUBROUTINE CALC(A)
        2       INTEGER A(1000,1000)
L P     3       DO I=1, 1000
        4         A(I,1)=A(1,I)+A(I,1)
        5       ENDDO
        6       END
```

File mul.f (compiled with `-cxpab`)

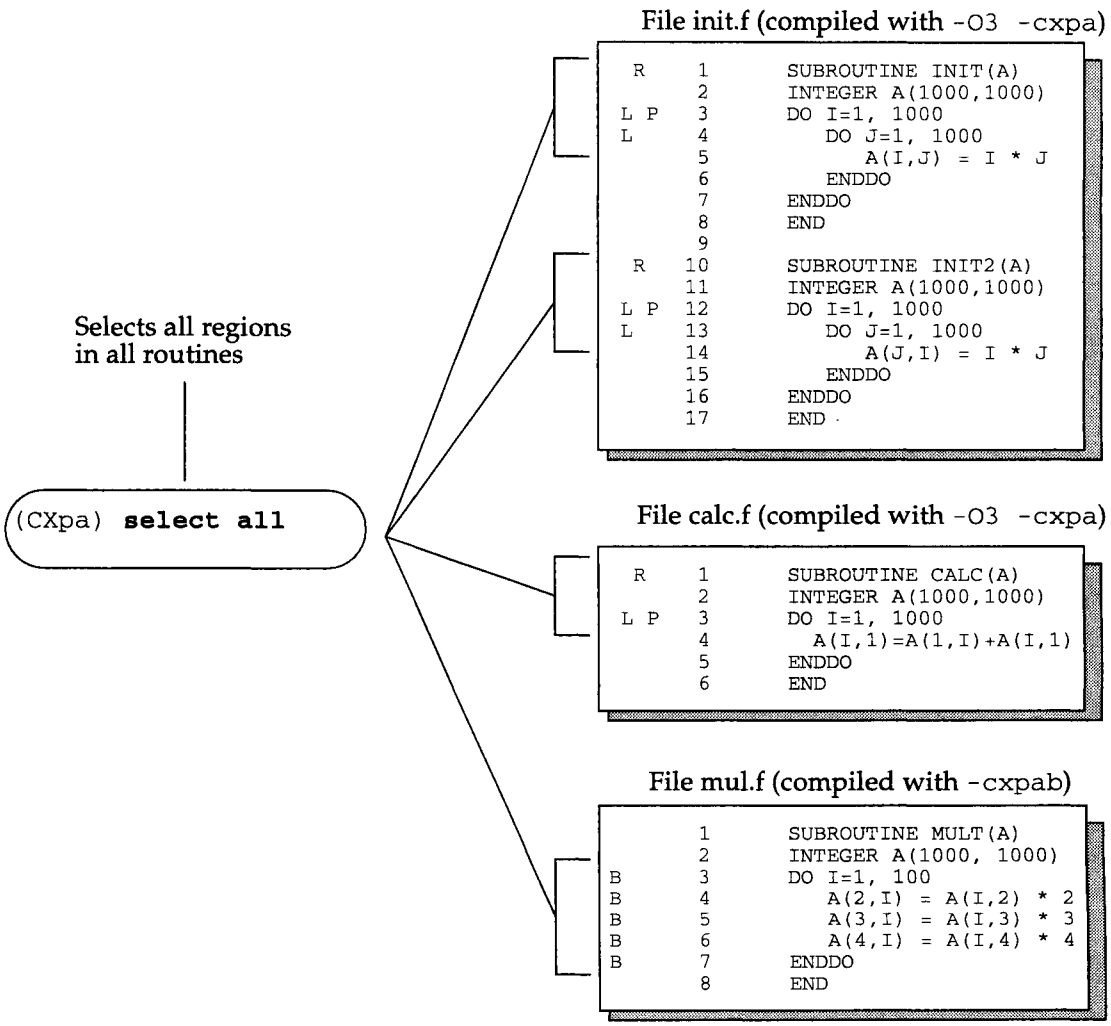
```
        1       SUBROUTINE MULT(A)
        2       INTEGER A(1000, 1000)
b       3       DO I=1, 100
b       4          A(2,I) = A(I,2) * 2
b       5          A(3,I) = A(I,3) * 3
b       6          A(4,I) = A(I,4) * 4
b       7       ENDDO
        8       END
```

Selecting and deselecting regions in line mode

Selecting or deselecting all regions in all routines

Selecting all regions in all routines in your program can significantly increase the amount of time it takes to profile large programs. However, you may want to select all regions in all routines to get a broad picture of where time is being spent in your program.

Use the `select all` command to select all regions throughout your program, as shown in the following figure.



Use the `deselect all` command to deselect all regions in all routines of your program.

Selecting and deselecting regions in line mode

Related Topics	Compiling	Introducing source code regions
Related Commands	`deselect` `select`	`list selectable` `set visibility`

Introducing metrics

After selecting regions of your source code to profile, you can specify the types of performance metrics you want to collect for these regions. Collecting and comparing different metrics can help you discover performance bottlenecks such as:

- Routines and loops that consume the most wall clock or CPU time
- Loops that generate excessive cache misses
- Regions of code that spend a significant amount of their CPU time waiting on memory
- Lack of effective parallelism in a particular loop or routine
- Memory bank-contention and/or cache thrashing among threads in parallel regions
- Uneven distribution of work across threads in parallel regions

The first time you profile your program under CXpa, collect CPU time and wall clock time for all routines in your program. This will enable you to determine which routines take the longest to execute and/or consume the most CPU resources.

The topics discussed in this section include:

- Metrics available on all architectures
- Exemplar SPP Series event metrics:
  - SPP Series event terminology
  - SPP1000 and SPP1600 Series off-processor events
  - SPP1200 and SPP1600 Series on-processor events
- Profiling routines that call uninstrumented routines

Metrics available on all architectures

The following metrics are available on all architectures:

- **CPU Time**—Time the CPUs work on the process.
- **Wall Clock Time**—Time to solution, including process idle time.
- **Dynamic call graph**—Wall clock time and CPU time (inclusive and exclusive), call counts, and metrics for each profiled routine, its parents, and its children.

- **CPU/Wall clock time**—The ratio of CPU time to wall clock time. This metric is computed during analysis if CPU and wall clock time metrics are collected.
  - For serial regions, if the CPU/Wall clock ratio is high (approaches 1.0), the region is compute-bound.
  - For parallel regions, this metric measures the *concurrency factor*, or the speed-up achieved through parallelization. Values that approach *n*, where *n* is the number of processors your program runs on, indicate good parallel concurrency.
  - For both parallel and serial regions, if the CPU/Wall clock ratio is low, this could indicate a performance bottleneck caused by one or more of the following:

    I/O calls—For example, read() or write() calls.

    System calls—For example, open() or close() calls.

    Memory accesses—For example, cache misses. You can compare event metrics and latency for these regions to find out if the bottleneck is due to memory accesses.

- **Execution counts**—Number of times a routine or basic block was executed or, for loops, the number of loop invocations.

- **Iterations**—For serial loops, minimum, maximum, and average number of loop iterations.

- **Chunks**—For parallel loops created by the Convex compilers at optimization level `-O3`, this indicates the number of chunks (or packets of loop iterations) that are assigned to execute on a particular thread.

  Chunk counts can be used to examine relative load balancing across threads in parallel loops. CXpa does not currently report the number of iterations in a chunk (chunk size).

Event metrics

For SPP Series computers, event counts and latency metrics can be collected for memory access events. Memory access events occur when required data or instructions must be retrieved from memory rather than from the processor cache.

Monitoring events such as cache miss counts and latency for "hot" routines on subsequent runs of your program under CXpa can be useful for identifying second-order effects that contribute to poor performance such as ineffective cache utilization or contended access to data among processors on the same node.

To find bottlenecks, you will need to compare and contrast metrics for different events. For example, you may observe a large number of remote memory miss events at a region. However, latency metrics may reveal that even though a large number of misses are occurring in a given region, average latency time is short or total event latency time for that region is not significant.

The type of event metrics that can be collected vary according to machine architecture.

SPP Series event metrics terminology

The following definitions will help you understand and interpret the Exemplar SPP Series events that can be collected using CXpa.

Average clock cycles per instruction

This metric, available on SPP1200 and SPP1600 Series systems only, measures the efficiency of instruction scheduling for the region being profiled. It is computed during analysis if instruction counts and clock cycles are collected. On SPP1200 and SPP1600 Series systems, the maximum number of instructions that can be executed in a single clock cycle is 2. This means that the theoretical peak value for the average clock cycles metric on this architecture is 0.5.

If the value for average clock cycles is high, and it is associated with a frequently called routine that performs only a small amount of work (for example, a routine that simply assigns a new value to a variable and returns), inlining the routine could improve the instruction scheduling by eliminating the routine call overhead.

Code sections that contain many patterns of consecutive loads and stores followed by immediate use of requested operands can also result in high average clock cycles.

In some cases, the instruction scheduling can be improved by compiling the routine at a higher optimization level or, if programming at the assembly level, changing the order of instructions. Refer to the *Hewlett-Packard PA-RISC 1.1 Architecture and Instruction Set Reference Manual* (Manual Part No. 09740-90039) for information on how to achieve optimal instruction scheduling.

Average MIPS rate

The average MIPS (millions of instructions per second) rate is calculated during analysis if instruction counts, clock cycles, and wall clock time are collected. This metric is only available on SPP1200 and SPP1600 Series systems.

The formula CXpa uses to calculate the average MIPS rate is as follows:

$$Average\_MIPS\_rate = \frac{Number\_of\_instructions\_completed}{Wall\_clock\_time\_in\_sec}$$

The theoretical peak MIPS rate for Hewlett-Packard PA-RISC 7100/7200 processors with a 10-ns clock cycle at a clock rate of 100 MHz is 200 MIPS. There is a direct correlation between average clock cycles and average MIPS rates; decreasing average clock cycles will result in increased average MIPS rates.

CPU Agent chip

The CPU Agent chip is the gate array on Exemplar SPP Series systems that provides a high-speed interface between the pairs of PA-RISC processors in a functional block on a hypernode and the hypernode crossbar.

Performance counters (referred to as *off-processor* counters) located on the CPU agent used in SPP1000 and SPP1600 Series systems provide information about locally and remotely resolved data cache misses and latency.

CTI (Coherent Toroidal Interconnect) rings

The ring interconnect that connects all the hypernodes of a multihypernode Exemplar SPP Series system together in a ring topology. While the CTI ring is derived from the IEEE SCI (Scalable Coherent Interface) standard, complete compatibility is sacrificed to provide lower latencies.

Data cache miss

A data cache miss occurs if data to be loaded does not reside in the processor's data cache.

Data cache hit

A data cache hit occurs if data to be loaded resides in the processor's data cache.

Data cache hit rate

This metric, available on SPP1200 and SPP1600 Series systems only, measures the percentage of total data cache accesses that were data cache hits. If the data cache hit rate is low, this indicates cache thrashing.

The data cache hit rate is calculated as follows:

$$data\_cache\_hit\_rate = \frac{total\_data\_cache\_accesses - data\_cache\_misses}{total\_data\_cache\_accesses} \times 100$$

Data TLB misses

Data translation lookaside buffer misses. This metric represents the number of times the address translation from virtual to physical memory for data to be referenced was not found in the translation lookaside buffer (TLB). The TLB is a cache of 120 virtual-to-physical memory address translations for the most recently referenced page table entries.

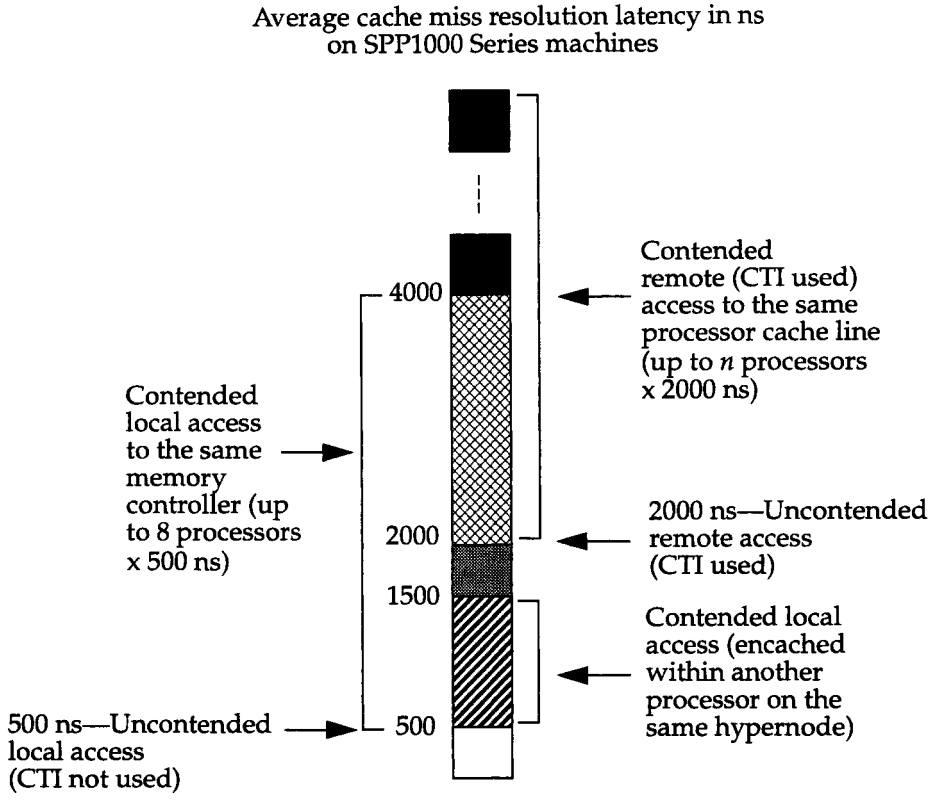
Event counts

The number of times an event, such as a data or instruction cache miss, occurred.

Event latency/counts

Average latency time per event for a region. For example, if total data cache miss counts are collected, then the event latency/counts metric represents the average amount of time it took to resolve a data cache miss.

Average cache miss resolution latency metrics can be very useful when examining regions with large numbers of cache misses and/or latency, and can be characterized on SPP1000 and SPP1600 Series machines as shown in the following figure:



You can use this information to interpret 2D and 3D profile graphs of average cache miss resolution.

Event latency/CPU

Ratio of event latency to CPU time for a region, expressed as a percentage. When this percentage is high, it means that the program spent the majority of its CPU time in the region reaching for data or instructions that were not encached rather than computing with encached data or instructions.

Hypernode

In Exemplar SPP Series systems, a set of up to eight processors and physical memory organized as a symmetric multiprocessor (SMP) running a single image of the operating system microkernel. An SPP system consists of one or more hypernodes, with a high speed CTI ring connecting the hypernodes.

Instruction cache miss

An instruction cache miss occurs if data to be loaded does not reside in the processor's instruction cache.

Instruction TLB misses

Instruction translation lookaside buffer misses. This metric represents the number of times the address translation from virtual to physical memory for an instruction was not found in the translation lookaside buffer (TLB). The TLB is a cache of 120 virtual-to-physical memory address translations for the most recently referenced page table entries.

Latency

As reported by CXpa, the amount of time spent accessing memory to locate data or instructions not found in the processor's data or instruction cache.

Locally resolved cache misses

Cache misses that are resolved by using the hypernode crossbar to access memory found on the same hypernode as the processor; the CTI rings are not used.

Read miss

An instruction or data cache miss caused by a load.

On-processor and off-processor events

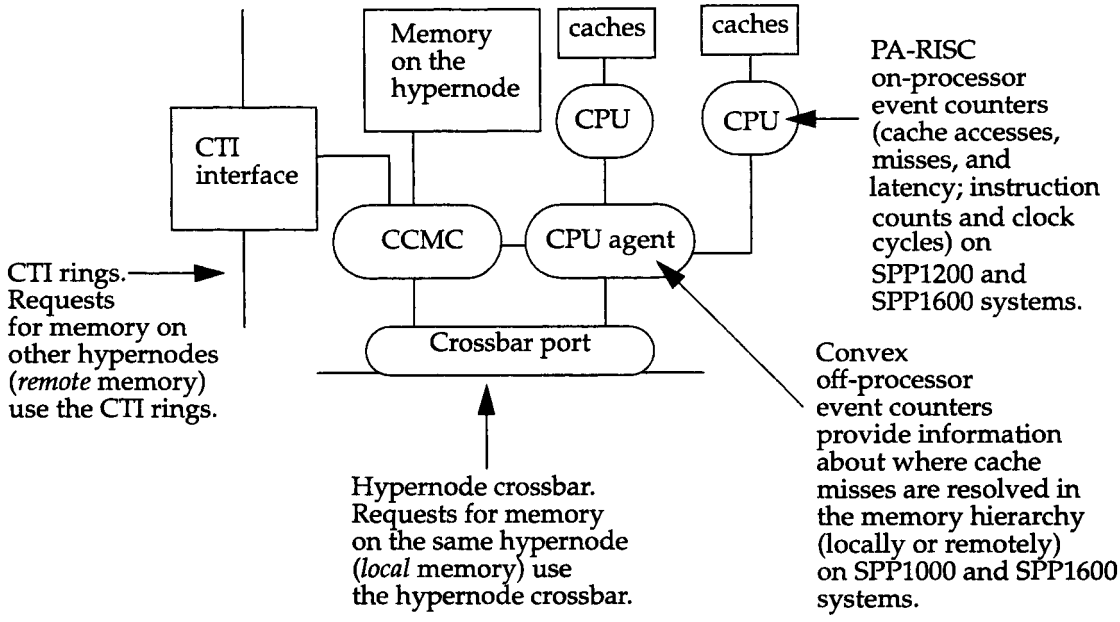
On-processor events are monitored by event counters located on the Hewlett-Packard PA-RISC processors used in SPP1200 and SPP1600 systems. These event counters monitor events from the processor's point of view only.

Off-processor events are monitored by event counters on the SPP1000 Convex CPU agent chip. These event counters can be configured to monitor the number of data cache miss events that are resolved locally and/or remotely (remote miss events imply use of the CTI rings; local miss events do not use the CTI rings) and whether those events occurred due to reads (loads) or writes (stores).

The following diagram shows the location of event counters on Exemplar SPP Series systems. Refer to *Exemplar SPP 1000/1200 Architecture* (DHW-014) or the *Exemplar Programming Guide* (DSW-067) for more information.

NOTE: SPP1200 and SPP1600 Series systems use HP PA-RISC 7200 processors, which have on-processor performance counters for collecting total data cache accesses, misses, and latency; instruction cache misses and latency; and instruction counts and clock cycles.

SPP1000 systems use HP PA-RISC 7100 processors, which have no on-processor event counters. For SPP1000 systems, a latency timer was added as an off-processor event counter to provide this information.



Remotely resolved cache misses

Cache misses that were resolved by using the CTI rings to access memory on another hypernode. Accessing memory on other hypernodes using the CTI rings takes significantly longer than accessing memory on the same hypernode via the hypernode crossbar.

Write miss

An instruction or data cache miss caused by a store or by a load and clear.

SPP1000 and SPP1600 Series off-processor events

On SPP1000 and SPP1600 Series systems, the following off-processor events can be collected. In addition, you can specify whether these events are collected during read accesses (loads), write accesses (stores), or both. The default is both.

NOTE: Collecting remote miss events on single-node SPP Series systems yields zeros.

Locally resolved data cache misses and latency

Configures off-processor event counters to collect the number of times that data not found in the processor cache was found in local memory (memory allocated to that processor's hypernode). Data cache miss latency is also collected.

Remotely resolved data cache misses and latency

Configures off-processor event counters to collect the number of times that data not found in the processor cache was found in remote memory (memory allocated to another hypernode). Data cache miss latency is also collected.

Locally and remotely resolved data cache misses and latency

Collects the number of local and remote memory misses and latency, combined.

SPP1200 and SPP1600 Series on-processor events

On SPP1200 and SPP1600 Series systems, the following on-processor events can be collected:

Data cache access counts, miss counts, and latency

Configures on-processor event counters to collect the total number of data cache accesses, data cache misses, and cache miss latency. Average latency and data cache hit rates are computed during analysis.

Instruction cache miss counts and latency

Configures on-processor event counters to collect the total number of instruction cache misses and latency. Average instruction cache miss latency is computed during analysis.

Instruction counts and clock cycles

Configures the on-processor event counters to collect the number of completed instructions and clock cycles. The average number of clock cycles per instruction is computed during analysis. The average MIPS rate is computed during analysis if wall clock time is also collected.

Data and instruction TLB misses

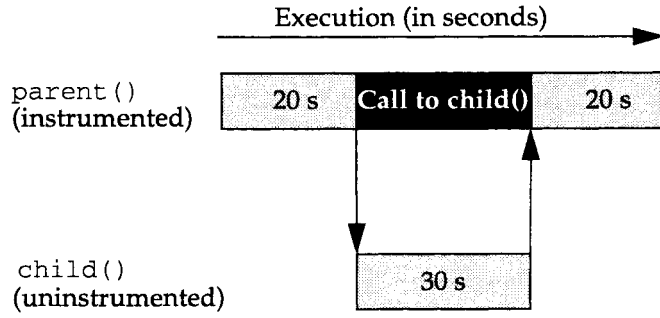
Configures on-processor event counters to collect data and instruction TLB (translation lookaside buffer) misses. The TLB is a cache of 120 virtual-to-physical memory address translations for the most recently referenced page table entries. This metric represents the number of times the virtual-to-physical memory address translations for data or instructions to be referenced were not found in the TLB.

Profiling routines that call uninstrumented routines

If an instrumented routine calls an uninstrumented routine, CXpa will not be able to separate the time spent in the uninstrumented child routine from the time spent in the instrumented parent.

This condition is illustrated in the following figure:

.



In this figure, routine `parent()` has been instrumented for CXpa while routine `child()` has not. The time spent in `parent()` not including children is reported as 70 seconds because CXpa cannot separate time spent in `child()`. If routine `child()` had been instrumented for profiling with CXpa, CXpa would have correctly reported `parent()` as having executed for 40 seconds not including time spent in `child()`.

This condition can produce misleading results in the dynamic call graph. If the example above is extended to show that routine child() calls an instrumented routine sub1(), the dynamic call graph would incorrectly show that routine parent() in the above example called sub1(), and all of the time spent in the uninstrumented routine child() would be attributed to sub1().

For this reason, make sure that all routines in the program are instrumented for profiling when generating a dynamic call graph.

Related Topics

- Dynamic Call Graph report
- Glossary
- Loop reports
- Parallel Region reports
- Profiling strategy
- Reports
- Routine reports
- Selecting metrics in line mode
- Selecting metrics in X window mode

Related Windows

- 2D Profile window
- 3D Profile window
- Analysis Report window
- Call Graph window
- Executable Manager window
- Profile Selection dialog

Related Commands

- `analyze`
- `collect`
- `select`
- `set events`

Introducing metrics

Selecting metrics in X window mode

Once you have selected the regions in your program you want to profile, select the types of metrics you want to collect at those regions when you run your program. By default, CXpa collects CPU time, wall clock time, and iteration/execution counts for the regions in your program you have selected for profiling.

CXpa collects these metrics at the regions of your program that are selected for profiling. You can choose to collect:

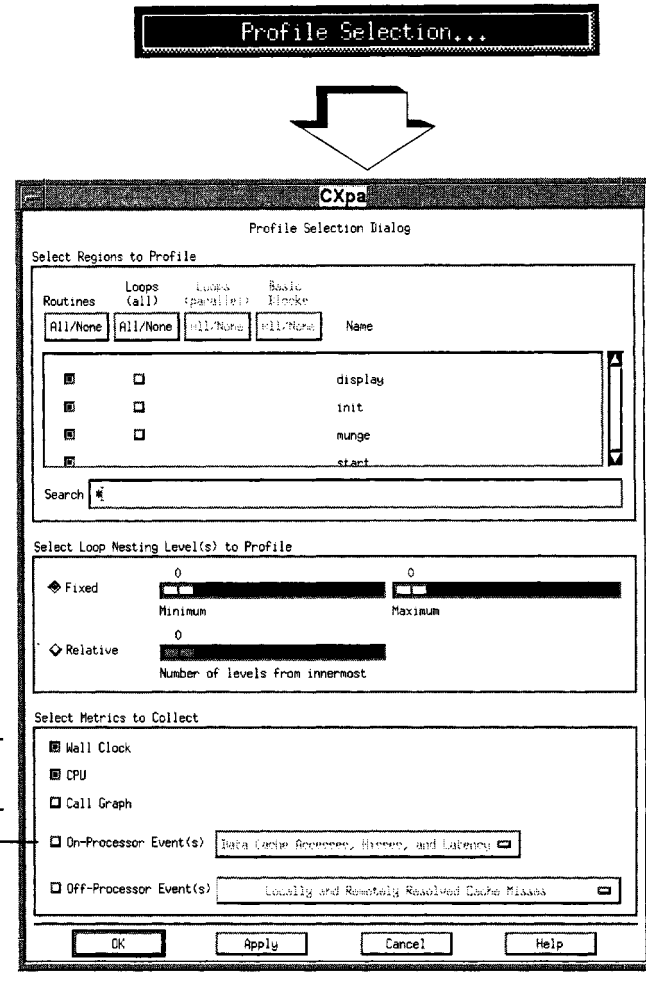
- Wall clock time (default)
- CPU time (default)
- Events
- Dynamic call graph

This section describes the procedure for choosing metrics to collect using CXpa's X window interface.

To specify the type of metrics to collect during profiling, perform the following steps:

1. Press the Profile Selection button in the Executable Manager window to bring up the Profile Selection dialog.

Selecting metrics in X window mode



By default, CXpa collects CPU time and wall clock time for all routines.

On/Off-processor event selection menus vary according to architecture and are desensitized until event collection is enabled.

2. Select the regions of your program you want to profile as described in "Selecting regions in X window mode."
3. Specify the metrics you want to collect by clicking the toggle buttons in the Select Metrics to Collect section of the Profile Selection dialog.

Selecting metrics in line mode

Once you have selected the regions in your program you want to profile, you must specify the types of metrics you want to collect at those regions.

In line mode, you specify the types of metrics you want to collect using the `collect` command and, if you have chosen to collect events, use the `set events` command.

CPU time, wall clock time, and iteration/execution count metrics can be collected on all architectures. Other metrics that you can collect (including events and latency time) differ according to machine architecture.

This section describes the procedure for selecting types of metrics to collect when running CXpa in line mode. Refer to the following online help topics or sections of this book for more information:

- "Introducing metrics"—List of available metrics on each architecture, metric descriptions, and event terminology.
- Reference page for the `collect` command—Complete syntax and examples.
- Reference page for the `set events` command—Complete syntax and examples.

Choosing metrics to collect at the command line

Perform the following steps to select the types of metrics you want to collect:

1. Select the regions in your program that you want to profile using a form of the `select` command. For example:

   ```
   (CXpa) select routine all
   ```

   The above command tells CXpa to select all routine regions in your program for profiling.

NOTE: If you do not select one or more source code regions in your program for profiling with the `select` command, CXpa will not collect any metrics.

2. Enter a form of the `collect` command at the CXpa prompt. For example:

   ```
   (CXpa) collect cpu wall_clock call_graph events
   ```

The above command tells CXpa that you want to collect CPU time, wall clock time, dynamic call graph information, and events at the regions of your program selected for profiling. Refer to the reference page for the `collect` command for more information and a list of valid parameters.

If you chose to collect events, you must use the `set events` command to specify the type of events you want to collect.

3. If you have specified event collection with the `events` parameter of the `collect` command, enter the command `set events` *<event-type>* at the CXpa prompt where *<event-type>* specifies the type of event you want to collect.

   The type and number of events you can collect differ according to machine architecture. Refer to the next section for a list of valid parameters for specifying events for SPP1000, SPP1600, and SPP1200 Series architectures.

   For example:

   ```
   (CXpa) set events local_misses
   ```

   The above command executed on an SPP1000 system tells CXpa that you want to count the number of times that data missed in the processor cache was found in memory on that processor's hypernode (for the profiled regions of your program). By default, events are collected during read and write operations. The `local_misses` parameter is only valid on SPP1000 and SPP1600 Series machines.

NOTE: Each use of the `set events` command overwrites its previous setting.

4. Enter the `run` command at the CXpa prompt to collect the metrics you have specified for the selected regions of your program:

   ```
   (CXpa) run
   ```

Event types

The type and number of events that can be collected per program run differ according to machine architecture:

- On SPP1200 Series systems, you can monitor one set of on-processor events per program run.
- On SPP1000 Series systems, you can monitor one type of off-processor event per program run.
- On SPP1600 Series systems, you can monitor one type of off-processor event and one set of on-processor events per program run.

Valid parameters to the `set events` command for specifying events on each architecture are listed in the following sections.

SPP1000 and SPP1600 Series off-processor events

On SPP1000 and SPP1600 Series systems, use one of the following parameters to the `set events` command to select the type of event you want to collect. You can select only one of the following per program run:

- **`local_misses`**—Number of times that the profiled regions of your program had to access local memory (memory on that processor's hypernode) because of a processor data cache miss.
- **`remote_misses`**—Number of times the profiled regions of your program had to access remote memory (memory on another hypernode) because of a processor data cache miss. This implies use of the CTI (Convex Coherent Toroidal Interconnect) rings. This event is valid for multihypernode configurations only.
- **`local_and_remote_misses`**—Number of locally and remotely resolved data cache misses combined for the profiled regions of your program.

You can use one or both of the following parameters of the `set events` command to specify whether the type of off-processor event you have selected is collected during read operations only, write operations only, or both:

- **`read_only`**—A read miss is a data cache miss caused by a load.
- **`write_only`**—A write miss is a data cache miss cause by a store or a data cache miss caused by a load and clear.

The default is `read_only write_only`.

SPP1200 and SPP1600 Series on-processor events

SPP1200 and SPP1600 Series systems use HP PA-RISC 7200 processors which have on-processor event counters. This enables you to monitor one set of events per program run. Valid on-processor event parameters are listed below:

- **`data_cache`**—Configures on-processor event counters to collect data cache access counts, miss counts, and latency.
- **`instruction_cache`**—Configures on-processor event counters to collect instruction cache miss counts and latency.
- **`instruction_counts`**—Configures on-processor event counters to collect completed instruction counts and clock cycles.
- **`tlb_misses`**—Configures on-processor event counters to collect data and instruction TLB (translation lookaside buffer) misses.

Selecting metrics in line mode

Related Topics	Introducing metrics	Profiling strategy
Related Commands	`collect` `set events`	`select`

Part 2 Reference pages

Part 2 of this book contains reference pages for:

- CXpa's performance reports
- The windows in CXpa's X window interface
- The commands for CXpa's line mode interface
- CXpa messages

You can also access this information through the CXpa online help system.

Reports

4

This chapter provides an overview of the textual reports that CXpa displays for the profiled regions of your program, as well as instructions for creating and viewing reports, report filtering options, and a description of the information contained in the CXpa report header.

Report types

CXpa can display textual performance reports for the following types of source code regions:

- Routines
- All loops
- Parallel loops only
- Basic blocks

The metrics available in performance reports vary according to machine type, source code regions selected for profiling, and the options used when compiling your program. Performance reports that are available for profiled regions are listed below:

- **Counts report**—Iteration/execution counts.
- **Computation report**—CPU time and % total CPU time.
- **Time to solution report**—Wall clock time and CPU/wall clock time.
- **Dynamic Call Graph report** —For each routine, the information displayed includes inclusive wall clock and CPU time (including time spent in child routines) and call counts for the routine, its parents, and its children.
- **Events**—Available reports and metrics differ according to machine architecture and the type of event collected during the run of the program that generated the performance data (PDF) file:
  - Off-processor event reports (SPP1000 and SPP1600 only)—Locally resolved cache misses; remotely resolved

cache misses; or locally and remotely resolved cache misses.

- On-processor event reports (SPP1200 and SPP1600 only)—Data cache misses and latency; data cache accesses; instruction cache misses and latency; data and instruction TLB misses; or instructions completed and clock cycles.

For a detailed discussion of each type of report, refer to the "Routine reports," "Loop reports," "Parallel Region reports," and "Basic Block report," and "Dynamic Call Graph report" online help topics or sections in this book.

For a list of fields, abbreviations, and annotations that can appear in CXpa reports, refer to the "Report fields" online help topic or section of this book.

Filtering thread data in reports

This section describes how you can filter report data to display information for processes (the default) or individual threads.

Line mode

In line mode, you can filter report data with the `set visibility` command:

- `set visibility thread`—Display performance data on a per-thread basis for all reports.
- `set visibility process`—Display performance data on a per-process basis for all reports. This is the default.

To view the current CXpa thread/process visibility settings in line mode, use the `info` command.

X window mode

To filter report data in X window mode:

1. Open an Analysis Report window.
2. From the Options menu in the Analysis Report window, select Filter Report. CXpa opens a Filter Report dialog.

3. Select the level of detail to be displayed in CXpa reports.
   - Choose Thread to display performance data on a per-thread basis for all reports.
   - Choose Process to display performance data on a per-process basis for all reports. This is the default.
4. Choose OK to close the dialog and apply the changes.

Viewing reports

Textual performance reports are available in X window mode and line mode.

X window mode

In X window mode, you can select the types of reports you want to view from the Analysis Report window. You can create an Analysis Report window using one of the following methods:

- Select the Report option from the button at the lower right corner of the Executable Manager window.
- Press the Create Report button in the Analysis Control window.
- Select Report from the Windows menu in the Executable Manager window or the Analysis Control window.

Once you have created an Analysis Report window, use the toggle buttons to select the region level for which you want to create reports, then select and/or deselect appropriate metrics.

You can also create customized reports by specifying a subset of routines that contain regions of the currently selected type by selecting the Subset item from the Select Regions option menu in the Analysis Report window. Refer to the "Region Subset Selection dialog" online help topic or section of this book for more information.

Line mode

In line mode, use a form of the `analyze` command (for example, `analyze`, `analyze loop`, `analyze call_graph`, or `analyze pregion`) to display performance reports. CXpa displays reports in line mode using the pager specified with your `PAGER` environment variable. You can also redirect output from this command to a file.

Report header

When you generate a report, CXpa prefaces the report with a header that contains the following information:

- **Executable**—Executable name for the program being profiled.
- **Profile Data**—Performance data file (PDF) name.
- **Process State**—State of the process when the PDF was created or closed. The states include: `running`, `paused`, `terminated`, `exited`, and `not started`.
- **Metric totals**—Totals for metrics collected across all threads of the process (for example, total wall clock time or CPU time).
- **Architecture**—SPP Series architecture where the PDF was created and related system information.

Related Topics

Basic Block report
Dynamic Call Graph report
Introducing metrics
Parallel Region reports
Report fields
Reports
Routine reports

Related Windows

Analysis Report window
Call Graph window
Filter Report dialog
Region Subset Selection dialog

Basic Block report

Description

The Basic Block report provides performance information for the profiled basic blocks in your program. A basic block is a section of code that has a single entry point and single exit point. One Basic Block Performance Analysis report is displayed for each executed routine with profiled basic blocks. This report can be used to identify routines which have a significant amount of code that is never executed.

CXpa can only generate this report if you use the `-cxpab` option to compile source files that contain basic blocks you wish to profile.

Refer to the "Report fields" online help topic or section of this book for information about fields (columns) that can appear in Basic Block reports.

Report

Metrics displayed in Basic Block reports are as follows:

- Total number of times each basic block was executed
- The starting address for each block (that is, the program counter (PC) value)
- Percentage and number of total blocks executed

You can use the execution metrics to determine unused blocks for test coverage analysis. The following example contains a Basic Block report:

Basic Block report

```
================================================================================
                        Basic Block Performance Analysis
                                  For: start
================================================================================

 Line            PC Value           Times  Exec                              PS
-------        ------------       ---------------                            --
     5          0x0004d408                     1
     5          0x0004d448                     1
     5          0x0004d370                     1
     5          0x0004d3b4                     1
     9          0x0004d510                     2
     9          0x0004d4a0                     1
    10          0x0004d61c                     1
    19          0x0004d670                    10
    22          0x0004d6c8                     4
    25          0x0004d730                     6
    29          0x0004d79c                    10
    34          0x0004d7ec                     1
    37          0x0004d838                     0
    40          0x0004d898                     1
    45          0x0004d934                     1
    45          0x0004d8f4                     1

Total Blocks          : 16
Total Blocks Executed : 15 (93.8%)

================================================================================
```

Context

To view a Basic Block report in X window mode, open an Analysis Report window, then select Basic Blocks as the region type.

To view a Basic Block report in line mode, use the `analyze block` command

Related Commands

`analyze`

Related Topics

Introducing metrics
Parallel Region reports
Reports
Loop reports
Report fields
Routine reports

Related Windows

Analysis Report window
Region Subset Selection dialog

Dynamic Call Graph report

Description

For each profiled routine in your program, the Dynamic Call Graph displays inclusive wall clock and CPU time (including time spent in child routines) and call counts for the routine, its parents, and its children.

The Dynamic Call Graph report is available if:

- Call graph metrics were selected for collection by:
  - Enabling CPU time, wall clock time, and Call Graph metric collection in the Profile Selection dialog (in X window mode).
  - Specifying the `call_graph`, `cpu`, and `wall_clock` parameters of the `collect` command (in line mode). For example:

    ```
    (CXpa) collect cpu wall_clock call_graph
    ```

- All routines were selected for profiling in the Profile Selection dialog (X window mode) or with the command `select routine all` (in line mode).
- The source files were instrumented for profiling at the routine level (compiled with the `-cxpa` or `-cxpar` option of the Convex compilers) or the object files and libraries were instrumented with the `cxoi` utility.

NOTE: When generating a Dynamic Call Graph report, make sure that all routines in your program are instrumented and selected for profiling. Otherwise, the results displayed in the call graph report may be misleading.

For example, if an instrumented routine named `parent()` calls an uninstrumented routine `child()`, and `child()` then calls an instrumented routine `sub1()`, the call graph would incorrectly show that `parent()` called `sub1()`, and all of the time spent in the uninstrumented routine `child()` would be attributed to `sub1()`.

Report

The fields and columns in the Dynamic Call graph report display the following information:

- `Wall (with children)`—Inclusive wall clock time (includes time spent in called routines).
- `CPU (with children)`—Inclusive CPU time (includes time spent in called routines).

- ------(and so on)—Dashed lines represent report section boundaries. The sections are displayed in order, from highest to lowest, ranked by inclusive wall clock time for the section's primary routine.
- >—Indicates the primary routine in each section.
  - The routines listed above the primary routine in each section are the callers of that routine (that is, that routine's parents).
  - The routines listed below the primary routine in each section were called by that routine (that is, that routine's callees, or children).
- `Calls in`—For callers of the primary routine in each section, the number of times the primary routine was called; for the primary routine in each section, the total number of calls made to that routine.
- `Calls out`—For callees of the primary routine in each section, the number of times the routine was called by the primary routine; for the primary routine, the total number of times that it was called.
- `PS`—Profiling status.
- `Routine names`—Names of all profiled routines in your program.

NOTE: All CXpa reports express time in seconds unless the time is annotated with the letter "m" for milliseconds.

Refer to the "Report fields" online help topic or section of this book for information about fields, column headings, abbreviations, and annotations that can appear in Call Graph reports.

Refer to the "Call Graph window" online help topic or section of this book for information about viewing call graph information in X window mode using CXpa's interactive Call Graph window.

The following sample report shows the first two sections from a Dynamic Call Graph report:

```
================================================================================
                          Routine Performance Analysis
================================================================================
                                Dynamic Call Graph
  Wall (with   CPU (with    calls      calls       PS  routine
  children)    children)     in         out           names
--------------------------------------------------------------------------------
>     10.144       6.858          1         12    start
       5.338       4.996                     3       kernel
       2.542       0.440                     4       report
       2.247       1.421                     3       tick
       1.417m      0.208m                    2       second
--------------------------------------------------------------------------------
       5.338       4.996          3                  start
>      5.338       5.022          3         81    kernel
       2.580       1.968                    75       test
       0.721m      0.720m                    3       result
       0.027m      0.027m                    3       space
--------------------------------------------------------------------------------
```

... lines of output omitted.

The primary routine in the first section of the dynamic call graph shown in the above example is `start`, which is the main routine of the program. As shown in the `Calls out of` column, `start` made a total of 12 calls to routines `kernel` (3 calls), `tick` (3 calls), `report` (4 calls), and `second` (2 calls). As shown in the `Wall (with children)` and `CPU (with children)` columns, the largest amount of CPU and wall clock time spent in routines called by `start` is attributed to the `kernel` routine.

To display dynamic call graph information for individual threads in call graph reports:

- In line mode, execute the following commands:
  - `(CXpa)` **`set visibility threads`**
  - `(CXpa)` **`analyze call_graph`**
- In X window mode:
  - Pull down the Options menu in the Analysis Report window and select Filter Report. CXpa opens a Filter Report dialog.
  - Select Threads and press Apply to apply the changes and close the dialog.

Dynamic Call Graph report

Context

To display a Call Graph report in X window mode, open the Analysis Report window and choose Routines as the Region Type and Call Graph from the Metrics list.

To display a dynamic call graph report in line mode, use the command `analyze call_graph`.

Related Topics

Basic Block report
Introducing metrics
Loop reports
Parallel Region reports
Report fields
Reports

Related Windows

Analysis Report window
Call Graph window
Filter Report dialog
Region Subset Selection dialog

Related Commands

`analyze`
`collect`
`select`
`set visibility`

Loop reports

Description

Loop performance analysis reports display metrics for all profiled loop regions in your program.

Loop reports are only available if:

- The routines containing the loop regions you wish to profile are compiled with a Convex compiler at optimization level `-O1` or greater with the `-cxpa` option. If you selected parallel loops only for profiling, the routines must be compiled at optimization level `-O3`.
- Your program contains loops, and they were selected for profiling.

NOTE: The loop nesting level setting affects the number of loops selected for profiling. The default loop nesting level setting (a fixed loop nesting level range with a minimum of 0 and a maximum of 0) only selects loops at nesting level 0 (outermost loops) for profiling.

Refer to the "Profile Selection dialog" or "`set visibility`" command online help topics or sections of this book for more information about loop nesting level settings.

- At least one profiled loop region was executed.

Depending on the architecture on which you created the PDF and the type of metrics collected, the following reports can be displayed for each routine containing profiled loop regions that were executed:

- **Counts**—Iteration/execution counts.
- **Computation**—CPU time, including and excluding time spent in inner loops.
- **Time to solution**—Wall clock time and CPU/wall clock time.
- **Events**—Available event reports and metrics differ according to machine architecture and the type of event collected during the run of the program that generated the PDF file:
  - Off-processor event reports (SPP1000 and SPP1600 Series only)—Locally resolved cache misses, remotely resolved cache misses, or locally and remotely resolved cache misses.
  - On-processor event reports (SPP1200 and SPP1600 Series only)—Data cache misses and latency; data cache accesses; instruction cache misses and latency; instructions completed and clock cycles; and data and instruction TLB (translation lookaside

buffer) misses.

All loop reports display the following information:

- Line number corresponding to the source code for the loop—Line numbers for optimized loops annotated with a lowercase letter indicate that the loop was split into two or more loops during optimization.
- Number of times the loop was executed.
- Resulting nesting level of the loop after optimization.
- The history of the transformations applied by the compiler (shown in the Optimization column) for optimized loops. This provides the most accurate picture of loop performance for your program.

  Refer to the "Report fields" online help topic or section of this book for a listing of the abbreviations shown in the Optimization column and their meaning.

  For a complete discussion of automatic optimizations performed by Convex compilers and manual optimization techniques for Convex SPP Series machines, refer to the *Exemplar Programming Guide* (Order No. DSW-067).
- Inclusive metric values—Includes values for inner loops (plus inner).
- Exclusive metric values—Does not include values for inner loops (less inner).

For parallel loops, the data in loop performance analysis reports is summed across all threads of the loop. To view information for individual threads in parallel loops, select the Loops (parallel only) option on the Region Type selection panel in the Analysis Report window or use the `analyze pregion` command to create parallel region reports.

Refer to the "Report fields" section online help topic or section of this book for information about fields (columns), abbreviations, and annotations that can appear in loop reports.

Refer to the "Reports" or "`set visibility`" online help topics or sections of this book for information about filtering options for reports.

NOTE: All CXpa reports express time in seconds unless the time is annotated with the letter "m" for milliseconds.

Reports

For loop regions, four types of reports are available: Iteration Counts, Computation, Time to Solution, and Events. These are described in the following sections, along with sample reports.

Iteration counts

The metrics in the Iteration Counts report for loops can be used to examine the following:

- Number of times the loop was executed.
- Number of iterations per invocation (total, minimum, maximum, and average).

An Iteration Counts report for loops is shown in the following example. The Optimization column of the report shows that the loop at line 129 was split into two loops, and that one of those loops was partially unrolled, with a loop unrolling factor of 5 (`pU:5`).

```
================================================================================
                          Loop Performance Analysis
                                  For: init
================================================================================
Optimized Loops:
                                                          Iteration Counts
                            Times
 Line     NL Optimization   Exec       Min        Max        Avg        Total     PS
-------  -- -----------  --------  ---------  ---------  ---------  -------------  --
   128    0              1000000          5          9        9.0        8980000
   129a   1 pU:5         8980000          1          1        1.0        8980000
   129b   1              8962040          1          4        4.0       35740400
```

Computation

Loop computation reports are displayed for each routine containing profiled loop regions that were executed. The metrics in the Computation report for loops can be used to examine the amount of CPU time spent executing each loop:

- Excluding time spent in inner loops
- Including time spent in inner loops

A sample loop Computation report is shown in the following example:

```
================================================================================
                          Loop Performance Analysis
                                  For: init
================================================================================

Optimized Loops:
                                        Computation
                             Times        (less inner)          (plus inner)
 Line     NL Optimization    Exec       CPU Time              CPU Time            PS
-------  -- -----------  ---------  ----------            ----------            --
   128    0              1000000      219.794               356.863
   129a   1 pU:5         8980000       68.728                68.728
   129b   1              8962040       68.340                68.340
```

Time to solution

The metrics in the Time to Solution report for loop regions can be used to examine the following (assuming you have collected wall clock time):

- Total wall clock time spent in loops
- Ratio of CPU time to wall clock time

For all loops, if the CPU/wall clock ratio is low, it indicates that there may be some type of performance bottleneck caused by one or more of the following:

- I/O calls (for example, read() or write() calls).
- System calls (for example, open() or close() calls).
- Memory accesses (for example, cache misses). You can compare event metrics and latency for these loops to find out if the bottleneck is due to memory accesses.

For serial loops, if the CPU/wall clock ratio is high (approaches 1.0), the region is compute-bound.

For parallel loops, the CPU/wall clock ratio is the concurrency factor for the parallel loop. (Parallel loops are annotated with a "P" in the Optimization column.) Values for CPU/wall clock time that approach *n*, where *n* is the number of processors used by your program, indicate good parallel concurrency.

For example, as you increase the number of processors or the amount of work (data set size), the concurrency factor should increase proportionately. This would indicate that the parallel loop region is scaling well in parallel.

Time to Solution reports for loops are displayed for each routine containing profiled loop regions that were executed. The following example shows a Time to Solution report. The high CPU/Wall ratio for the loops in this region (7.76 to 7.64) indicates near peak parallel concurrency This program was run on an SPP 1200 subcomplex with 8 CPUs.

```
================================================================================
                          Loop Performance Analysis
                              For: convolregion
================================================================================
Optimized Loops:
                                    Time to Solution
                              Times       (less inner)          (plus inner)
 Line    NL Optimization      Exec     Wall Clock CPU/Wall  Wall Clock CPU/Wall   PS
------- -- ----------- --------  ---------- --------  ---------- --------  --
   128   0             1000000      16.370     1.00       27.864     7.76
   129a  1 pU:5         8980000       5.717     1.00        5.717     7.76
   129b  1             8962040       5.778     1.00        5.778     7.64
```

Events

If you have chosen to collect events, CXpa displays event reports for loops. The types of event reports displayed vary according to machine architecture and the type of event or events collected for the program run that generated the PDF file.

- Refer to the *Exemplar SPP 1000/1200/1600 Architecture* (Order No. DHW-014) reference for more information about these architectures.
- Refer to the "Introducing metrics" online help topic or section of this book for more details on the types of event metrics that can be collected on a specific architecture.

Cache misses and latency

Cache miss and latency reports vary according to the architecture and the exact type of cache miss event collected for the run of the program that generated the PDF file being analyzed.

On SPP1000 and SPP1600 Series machines, you can configure off-processor performance counters to collect cache miss counts and latency time for total cache misses, cache misses that were resolved locally (on the same hypernode as the processor—CTI not used), or cache misses that were resolved remotely (on a different hypernode—CTI used). The cache miss report heading indicates the type of event collected for that run of your program, and can be one of the following:

- Locally resolved cache misses and latency (read only, write only, or both)
- Remotely resolved cache misses and latency (read only, write only, or both)
- Locally and remotely resolved cache misses and latency (read only, write only, or both)

On SPP 1200 and SPP1600 Series machines, you can configure on-processor performance counters to collect data cache accesses, misses, and latency, or instruction cache misses and latency. The cache misses and latency report heading indicates the type of event collected, and can be one of the following (data cache accesses are displayed in a separate report):

- Data cache misses and latency
- Instruction cache misses and latency

Cache misses and latency reports for loops enable you to examine:

- Total number of cache miss events that occurred in a loop.
- Latency—The total wall clock time spent accessing memory to locate data or instructions not found in the processor's cache.
- % CPU—Ratio of latency time to CPU time, expressed as a percentage.

  The % CPU value indicates how much of your computational work is being performed vs. the memory latency you are incurring in a source region for the active thread. If the percentage is low, it means that the CPU found all of the data it needed to do its job in the cache (close at hand). If the percentage is high, it means the CPU had to spend a lot of time asking the memory system to retrieve the data it needed relative to the amount of work it had to do.

  This percentage must be looked at in light of the amount of CPU work available to make a significant observation about program performance in light of cache effects. For example, if the event latency/CPU (% CPU) is 75%, and the overall CPU time is 25 secs for the routine, then it is probably safe to say that cache contention is occurring. You could then try to search out the offending memory access pattern in the region and correct it. If the event latency/CPU (% CPU) is 75%, but the overall CPU time is only 25 milliseconds, then the data is probably not significant.
- Differences in latency and cache miss counts among threads can indicate data access patterns for threads that cause memory bank contention among threads or cache thrashing.

The following sample cache miss report for loops was generated on an SPP 1000 system. For this program run, locally resolved cache misses were collected for both read and write operations. Locally resolved cache miss counts indicate the number of cache misses that are resolved by using the hypernode crossbar to access memory found on the same hypernode as the processor. The Convex CTI (Coherent Toroidal Interconnect) is not used.

```
================================================================================
                          Loop Performance Analysis
                              For: convolregion
================================================================================
Optimized Loops:
            Locally and Remotely Resolved Cache Misses and Latency
                          Times                    (less inner)
 Line     NL Optimization  Exec       Number of        Latency       % CPU     PS
-------   -- -----------  --------   ---------------  ------------- --------  --
   128     0                160000           398597          0.226      0.13%
   129a    1 pU:5          7192000          3746200          2.081      3.16%
   129b    1               7015760           294035          0.174      0.33%

                          Times                    (plus inner)
 Line     NL Optimization  Exec       Number of        Latency       % CPU     PS
-------   -- -----------  --------   ---------------  ------------- --------  --
   128     0                160000          4438832          2.481      0.85%
   129a    1 pU:5          7192000          3746200          2.081      3.16%
   129b    1               7015760           294035          0.174      0.33%

================================================================================
```

Data cache accesses (SPP1200 and SPP1600 Series only)

On SPP1200 and SPP1600 Series systems, you can configure on-processor event counters to collect data cache misses, accesses, and latency. A separate Data Cache Accesses report provides the following information:

- Total number of data cache accesses
- Data cache hit rate (`% Hits` column)—The data cache hit rate is calculated as follows:

$$data\_cache\_hit\_rate = \frac{total\_data\_cache\_accesses - data\_cache\_misses}{total\_data\_cache\_accesses} \times 100$$

If the data cache hit rate (`% Hits`) is low, this indicates cache thrashing.

A sample Data Cache Accesses report for loops is shown below:

```
================================================================================
                          Loop Performance Analysis
                              For: convolregion
================================================================================
Optimized Loops:
                                Data Cache Accesses
                            Times                    (less inner)
 Line     NL Optimization   Exec       Number of                    % Hits    PS
-------   -- -----------  --------   ---------------               --------  --
   128     0               1000000        8845854107                  98.9%
   129a    1 pU:5          8980000        1926684484                  97.7%
   129b    1               8962040        1859999803                  97.5%

                            Times                    (plus inner)
 Line     NL Optimization   Exec       Number of                    % Hits    PS
-------   -- -----------  --------   ---------------               --------  --
   128     0               1000000       12632538394                  98.5%
   129a    1 pU:5          8980000        1926684484                  97.7%
   129b    1               8962040        1859999803                  97.5%
```

Instructions completed and clock cycles (SPP1200 and SPP1600 Series only)

On SPP1200 and SPP1600 Series systems, you can configure on-processor event counters to collect instructions completed and clock cycles. A separate Instructions Completed and Clock Cycles report provides the following information:

- Number of instructions completed
- Average clock cycles (cycles per instruction)
- Average MIPS (millions of instructions per second) rate, calculated only if wall clock time is also collected

The average clock cycles metric measures the efficiency of instruction scheduling for the region being profiled. It is computed during analysis if instruction counts and clock cycles are collected. On SPP1200 systems, the maximum number of instructions that can be executed in a single clock cycle is 2. This means that the theoretical peak value for the average clock cycles metric on this architecture is 0.5.

If the value for average clock cycles is high, and it is associated with a frequently called routine that performs only a small amount of work (for example, a routine that simply assigns a new value to a variable and returns), inlining the routine could improve the instruction scheduling by eliminating the routine call overhead.

Code sections that contain many patterns of consecutive loads and stores followed by immediate use of requested operands can also result in high average clock cycles.

In some cases, the instruction scheduling can be improved by compiling the routine at a higher optimization level or, if programming at the assembly level, changing the order of instructions. Refer to the *Hewlett-Packard PA-RISC 1.1 Architecture and Instruction Set Reference Manual* (Manual Part No. 09740-90039) for information on how to achieve optimal instruction scheduling.

The average MIPS (millions of instructions per second) rate is calculated during analysis if wall clock time is also collected. The formula CXpa uses to calculate the average MIPS rate is as follows:

$$Average\_MIPS\_rate = \frac{Number\_of\_instructions\_completed}{Wall\_clock\_time\_in\_sec}$$

The theoretical peak MIPS rate for Hewlett-Packard PA-RISC 7100/7200 processors with a 10-ns clock cycle at a clock rate of 100 MHz is 200 MIPS. There is a direct correlation between average clock cycles and average MIPS rates; decreasing average clock cycles will result in increased average MIPS rates.

A sample Instructions Completed and Clock Cycles report for loops is shown below:

```
================================================================================
                          Loop Performance Analysis
                              For: convolregion
================================================================================
Optimized Loops:
                  Instructions Completed and Clock Cycles
                                                (less inner)
                           Times                      Avg Clock   Avg MIPS
 Line    NL Optimization   Exec      Number of          Cycles      Rate     PS
------- -- ----------- --------  ---------------  ------------- --------  --
   128    0             1000000       14263931087           1.6        63
   129a   1 pU:5        8980000        3838782979           1.9        54
   129b   1             8962040        3624657999           2.0        51

                                                (plus inner)
                           Times                      Avg Clock   Avg MIPS
 Line    NL Optimization   Exec      Number of          Cycles      Rate     PS
------- -- ----------- --------  ---------------  ------------- --------  --
   128    0             1000000       21727372065           1.7        59
   129a   1 pU:5        8980000        3838782979           1.9        54
   129b   1             8962040        3624657999           2.0        51

================================================================================
```

Data and instruction TLB misses (SPP1200 and SPP1600 Series only)

On SPP1200 and SPP1600 Series machines, you can configure on-processor event counters to collect data and instruction TLB (translation lookaside buffer) misses for profiled regions.

The TLB is a hardware structure in each CPU in an SPP Series system that contains information necessary to translate a virtual memory reference to a physical page and to validate memory accesses. The TLB contains 120 entries that represent address translations from virtual to physical memory for the most recently referenced page table entries.

TLB miss metrics represent the number of times the address translation from virtual to physical memory for data or an instruction to be referenced was not found in the TLB and could not be resolved through hardware handling.

When a TLB miss occurs, the operating system must then perform the address translation and store it in the TLB so that it can determine if the data is resident in memory:

- If the number of data TLB misses is high, this can indicate poor data locality. To correct the problem, try laying out frequently referenced data structures in an application closer together and not crossing page boundaries. In addition, focus on making the most of each data structure referenced by processing it completely before proceeding. This supports locality of references and maximizes use of the TLB.
- If the number of instruction TLB misses is high, try changing the link order so that routines that exhibit high TLB miss counts are placed next to each other on the application's link line. A more permanent source alternative is to cut-and-paste source code for routines with high TLB miss counts into one source file and relink it into your application.

Refer to the *Exemplar SPP1000/1200/1600 Architecture* (Order No. DHW-014) reference for more information about the TLB; refer to the *Exemplar Programming Guide* (Order No. DSW-067) for more information on maximizing data locality.

The following example shows data and instruction TLB miss reports for loops:

```
================================================================================
                          Loop Performance Analysis
                              For: convolregion
================================================================================

Optimized Loops:
                                    Data TLB Misses
                           Times                    (less inner)
 Line     NL Optimization  Exec        Number of                                PS
-------  -- -----------  --------   ---------------                            --
   128    0                10000                0
   129a   1 pU:5           223000                0
   129b   1                212112                0

                           Times                    (plus inner)
 Line     NL Optimization  Exec        Number of                                PS
-------  -- -----------  --------   ---------------                            --
   128    0                10000                0
   129a   1 pU:5           223000                0
   129b   1                212112                0

Optimized Loops:
                                  Instruction TLB Misses
                           Times                    (less inner)
 Line     NL Optimization  Exec        Number of                                PS
-------  -- -----------  --------   ---------------                            --
   128    0                10000              501
   129a   1 pU:5           223000              174
   129b   1                212112              124

                           Times                    (plus inner)
 Line     NL Optimization  Exec        Number of                                PS
-------  -- -----------  --------   ---------------                            --
   128    0                10000              799
   129a   1 pU:5           223000              174
   129b   1                212112              124

================================================================================
```

Context

To display Loop reports in X window mode from the Analysis Report window, select Loops (all) as the region level.

To display Loop reports in line mode, use the `analyze loop` command.

Related Commands

`analyze`

`set visibility`

Related Topics

Basic Block report
Dynamic Call Graph report
Introducing metrics
Parallel Region reports
Report fields
Reports
Routine reports

Related Windows

Analysis Report window

Region Subset Selection dialog

Parallel Region reports

Description

Parallel region performance analysis reports display metrics for profiled parallel loop regions in your program. Parallel loops are created by the Convex compilers at optimization level `-O3`.

Parallel region reports are only available if:

- The source files containing regions you wish to profile at the parallel region level are compiled with a Convex compiler at optimization level `-O3` with the `-cxpa` option. At optimization levels other than `-O3`, the compiler does not parallelize loops.
- Your program contains parallel loops, and they were selected for profiling.

NOTE: The loop nesting level setting affects the number of loops selected for profiling. The default loop nesting level setting (a fixed loop nesting level range with a minimum of 0 and a maximum of 0) only selects loops at nesting level 0 (outermost loops) for profiling.

Refer to the "Profile Selection dialog" or "`set visibility`" command online help topics or sections of this book for more information about loop nesting level settings.

- At least one profiled parallel loop region was executed.

Depending on the architecture on which you created the PDF (performance data file) and the type of metrics collected, the following reports can be displayed for each routine executed in your program that contains profiled parallel loops:

- **Time to solution**—Includes wall clock time, CPU/wall clock time, and chunk counts.
- **Events**—Available event reports and metrics differ according to machine architecture and the type of event collected during the run of the program that generated the PDF file:
  - Off-processor event reports (SPP1000 and SPP1600 Series only)—Locally resolved cache misses, remotely resolved cache misses, or locally and remotely resolved cache misses.
  - On-processor event reports (SPP1200 and SPP1600 Series only)—Data cache misses and latency; data cache accesses; instruction cache misses and latency; instructions completed and clock cycles; and data and instruction TLB misses.

Each parallel loop region report contains two sections:

- `Optimized Loops (cumulative, including spawn/join overhead)`—These metrics are cumulative across all threads executing in the parallel region and include spawn and join overhead. These values are graphed in the 2D Profile window for parallel loops.
- `Optimized Loops (by thread, excluding spawn/join overhead)`—These metrics are calculated on a per-thread basis for all threads executing in the parallel region and do not include spawn and join overhead. These values are graphed in the 3D Profile window for parallel loops.

Refer to the "Report fields" online help topic or section of this book for information about fields (columns), abbreviations, and annotations that can appear in parallel region reports.

Refer to the "Reports" or "`set visibility`" online help topics or sections of this book for information about filtering options for reports.

NOTE: All CXpa reports express time in seconds unless the time is annotated with the letter "m" for milliseconds.

Reports

For parallel regions, two types of reports are available: Time to Solution and Events. The output of these reports are described in the following sections, along with sample reports.

Time to solution

The metrics in the Time to Solution report for parallel loops can be used to examine the following for each parallel loop:

- Total wall clock time for each parallel loop or each thread of a parallel loop.
- Total iteration counts (summed across all threads of the parallel loop).
- Distribution of work across threads—By looking at CPU time, wall clock time, and/or chunk counts, you can spot parallel loop regions where the load does not appear to be balanced across threads. You can also examine event metrics for those regions to see whether performance bottlenecks are due to cache effects.

  A *chunk* is a unit of work executed on a single thread in a parallel loop. This unit of work corresponds to a packet of iterations of a parallelized loop assigned to execute on a single thread. CXpa currently does not track the number of iterations in a chunk (chunk size).

- Ratio of CPU time to wall clock time.

  If the CPU/wall clock ratio is high (approaches 1.0 for serial regions or single threads or, for parallel regions, approaches *n*, where *n* is the number of processors used by the program), the region is compute-bound.

  If the CPU/wall clock ratio is low, it indicates that there may be some type of performance bottleneck caused by one or more of the following:

  - I/O calls (for example, read() or write() calls).
  - System calls (for example, open() or close() calls).
  - Memory accesses (for example, cache misses). You can compare event metrics and latency for these loops to find out if the bottleneck is due to memory accesses.

  For parallel loops, the CPU/wall clock ratio is the concurrency factor for the parallel loop. (Parallel loops are annotated with a "P" in the Optimization column.) Values that approach *n*, where *n* is the number of processors being used by your program, indicate good use of resources within a parallel region.

  For example, as you increase the number of processors or the amount of work (data set size), the concurrency factor should increase proportionately. This would indicate that the region is scaling well in parallel.

A sample Time to Solution report for a parallel loop region is shown below. The cumulative CPU/wall clock ratio for all threads indicates good parallel concurrency, and a comparison of metrics for individual threads indicates an even distribution of work among threads for this loop.

```
================================================================================
                      Parallel Loop Performance Analysis
                                  For: convol
================================================================================

Optimized Loops (cumulative, including spawn/join overhead):

                                    Time to Solution
 Line      Times Exec   Iterations        CPU          Wall Clock   CPU/Wall  PS
-------  ------------ ------------ ---------------  -------------  --------  --
    76a             1         1000          29.964          6.587      4.55

Optimized Loops (by thread, excluding spawn/join overhead):

                                    Time to Solution
 Line     TID  Chunks                      CPU          Wall Clock   CPU/Wall  PS
-------  ---  --------              ---------------  -------------  --------  --
    76a    0         1                      3.734          6.212      0.60
           1         1                      3.701          5.418      0.68
           2         1                      3.716          5.591      0.66
           3         1                      3.723          5.741      0.65
           4         1                      3.762          6.586      0.57
           5         1                      3.727          6.370      0.59
           6         1                      3.728          6.397      0.58
           7         1                      3.698          5.454      0.68
================================================================================
```

Events

If you have chosen to collect events, CXpa displays event reports for parallel loop regions. The types of event reports displayed vary according to machine architecture and the type of event or events collected for the program run that generated the PDF file.

- Refer to the *Exemplar SPP 1000/1200/1600 Architecture* (Order No. DHW-014) reference for more information about these architectures.
- Refer to the "Introducing metrics" online help topic or section of this book for more details on the types of event metrics that can be collected on a specific architecture.

Cache misses and latency

Cache misses and latency reports vary according to the architecture and the exact type of cache miss event collected for the run of the program that generated the PDF file being analyzed.

On SPP1000 and SPP1600 Series machines, you can configure off-processor performance counters to collect cache miss counts and latency time for total cache misses, cache misses that were resolved locally (on the same hypernode as the processor—CTI not used), or cache misses that were resolved remotely (on a different hypernode—CTI used). The cache miss report heading indicates the type of event collected for that run of your program, and can be one of the following:

- Locally resolved cache misses and latency (read only, write only, or both)
- Remotely resolved cache misses and latency (read only, write only, or both)
- Locally and remotely resolved cache misses and latency (read only, write only, or both)

On SPP1200 and SPP1600 Series machines, you can configure on-processor performance counters to collect data cache accesses, misses, and latency or instruction cache misses and latency. The cache misses and latency report heading indicates the type of event collected, and can be one of the following (data cache accesses are displayed in a separate report):

- Data cache misses and latency
- Instruction cache misses and latency

Cache misses and latency reports for loops enable you to examine:

- Total number of cache miss events that occurred in a loop.
- Latency—The total wall clock time spent accessing memory to locate data not found in the cache.
- % CPU—Ratio of latency time to CPU time, expressed as a percentage.

  The % CPU value indicates how much of your computational work is being performed vs. the memory latency you are incurring in a source region for the active thread. If the percentage is low, it means that the CPU found all of the data it needed to do its job in the cache (close at hand). If the percentage is high, it means the CPU had to spend a lot of time asking the memory system to retrieve the data it needed relative to the amount of work it had to do.

This percentage must be looked at in light of the amount of CPU work available to make a significant observation about program performance in light of cache effects. For example, if the event latency/CPU (% CPU) is 75%, and the overall CPU time is 25 secs for the routine, then it is probably safe to say that cache contention is occurring. You could then try to search out the offending memory access pattern in the region and correct it. If the event latency/CPU (% CPU) is 75%, but the overall CPU time is only 25 milliseconds, then the data is probably not significant.

- Balance of work distributed among threads—Chunk counts directly indicate how well work is distributed across threads.
- Differences in latency and cache miss counts among threads can indicate data access patterns for threads that cause memory bank contention among threads or cache thrashing.

The following sample cache miss report for loops was generated on an SPP1000 Series system. For this program run, locally resolved cache misses were collected for both read and write operations. Locally resolved cache miss counts indicate the number of cache misses that are resolved by using the hypernode crossbar to access memory found on the same hypernode as the processor (the CTI is not used).

```
================================================================================
                        Parallel Loop Performance Analysis
                                    For: munge
================================================================================

Optimized Loops (cumulative, including spawn/join overhead):

                          Local Cache Miss Events
 Line      Times Exec    Iterations      Number of        Latency       % CPU     PS
-------  ------------ ------------ ---------------  ------------- --------  --
    36a             1         1000          394419         0.196     14.2%

Optimized Loops (by thread, excluding spawn/join overhead):
                          Local Cache Miss Events
 Line     Thread Id      Number of        Latency         Chunks        % CPU     PS
-------  ----------  -------------  -------------  -------------  --------  --
    36a             0         394419          0.196              1      56.6%
                    1         394504          0.192              1      56.2%
                    2         391414          0.194              1      56.4%
                    3         389436          0.201              1      57.2%
================================================================================
```

Data cache accesses (SPP1200 and SPP1600 Series only)

On SPP1200 and SPP1600 Series systems, you can configure on-processor event counters to collect data cache misses, accesses, and latency. A separate Data Cache Accesses report provides the following information:

- Total number of data cache accesses
- Data cache hit rate (`% Hits` column)—The data cache hit rate is calculated as follows:

$$data\_cache\_hit\_rate = \frac{total\_data\_cache\_accesses - data\_cache\_misses}{total\_data\_cache\_accesses} \times 100$$

If the data cache hit rate (`% Hits`) is low, this indicates cache thrashing.

A sample Data Cache Accesses report for a parallel loop is shown below:

```
================================================================================
                    Parallel Loop Performance Analysis
                                For: convol
================================================================================
Optimized Loops (cumulative, including spawn/join overhead):

                              Data Cache Accesses
 Line      Times Exec   Iterations      Number of                    % Hits   PS
-------  ------------ ------------ ---------------                 --------  --
    76a             1         1000       794645275                    98.5%

Optimized Loops (by thread, excluding spawn/join overhead):

                              Data Cache Accesses
 Line     TID  Chunks                Number of                     % Hits   PS
-------  --- --------             ---------------                 --------  --
    76a    0        1                  99815818                    98.5%
           1        1                  99019296                    98.5%
           2        1                  99020036                    98.5%
           3        1                  99032853                    98.5%
           4        1                  99046744                    98.5%
           5        1                  99026766                    98.5%
           6        1                  99032982                    98.5%
           7        1                  98690604                    98.5%
================================================================================
```

Instructions completed and clock cycles (SPP1200 and SPP1600 Series only)

On SPP1200 and SPP1600 Series systems, you can configure on-processor event counters to collect instructions completed and clock cycles. A separate Instructions Completed and Clock Cycles report provides the following information:

- Number of instructions completed
- Average clock cycles (cycles per instruction)
- Average MIPS (millions of instructions per second) rate, which is computed only if wall clock time is also collected

On SPP1200 and SPP1600 Series systems, the maximum number of instructions that can be executed in a single clock cycle is 2. This means that the theoretical best value for the average clock cycles metric on these architectures is 0.5.

Code sections that contain many patterns of consecutive loads and stores followed by immediate use of requested operands can also result in high average clock cycles.

In some cases, the instruction scheduling can be improved by compiling the routine at a higher optimization level or, if programming at the assembly level, changing the order of instructions. Refer to the *Hewlett-Packard PA-RISC 1.1 Architecture and Instruction Set Reference Manual* (Manual Part No. 09740-90039) for information on how to achieve optimal instruction scheduling.

The average MIPS (millions of instructions per second) rate is computed during analysis if wall clock time is also collected. The formula CXpa uses to calculate the average MIPS rate is as follows:

$$Average\_MIPS\_rate = \frac{Number\_of\_instructions\_completed}{Wall\_clock\_time\_in\_sec}$$

The theoretical peak MIPS rate for Hewlett-Packard PA-RISC 7100/7200 processors with a 10-ns clock cycle at a clock rate of 100 MHz is 200 MIPS. There is a direct correlation between average clock cycles and average MIPS rates; decreasing average clock cycles will result in increased average MIPS rates.

A sample instructions and clock cycles report for a parallel loop is shown below:

```
================================================================================
                        Parallel Loop Performance Analysis
                                    For: convol
================================================================================
Optimized Loops (cumulative, including spawn/join overhead):

                    Instructions Completed and Clock Cycles
                                                          Avg Clock    Avg MIPS
 Line      Times Exec    Iterations      Number of          Cycles       Rate     PS
-------  ------------ ------------ ---------------  ------------- --------  --
    76a             1       1000       2119724437             1.4        72

Optimized Loops (by thread, excluding spawn/join overhead):

                    Instructions Completed and Clock Cycles
                                                          Avg Clock    Avg MIPS
 Line     TID  Chunks                  Number of          Cycles       Rate     PS
-------  ---- --------              ---------------  ------------- --------  --
    76a     0         1                  251029382             1.4        45
            1         1                  250018696             1.4        34
            2         1                  250125491             1.4        44
            3         1                  250087228             1.4        47
            4         1                  250059551             1.4        42
            5         1                  250077437             1.4        43
            6         1                  250021793             1.4        34
            7         1                  248867823             1.4        46

================================================================================
```

Data and instruction TLB misses (SPP1200 and SPP1600 Series only)

On SPP1200 and SPP1600 Series machines, you can configure on-processor event counters to collect data and instruction TLB (translation lookaside buffer) misses for profiled regions.

The TLB is a hardware structure in each CPU in an SPP Series system that contains information necessary to translate a virtual memory reference to a physical page and to validate memory accesses. The TLB contains 120 entries that represent address translations from virtual to physical memory for the most recently referenced page table entries.

TLB miss metrics represent the number of times the address translation from virtual to physical memory for data or an instruction to be referenced was not found in the TLB and could not be resolved through hardware handling. When a TLB miss occurs, the operating system must perform the address translation and store it in the TLB so that it can determine if the data is resident in memory:

- If the number of data TLB misses is high, this can indicate poor data locality. To correct the problem, try laying out frequently referenced data structures in an application closer together and not crossing page boundaries. In addition, focus on making the most of each data structure referenced by processing it completely before proceeding. This supports locality of references and maximizes use of the TLB.
- If the number of instruction TLB misses is high, try changing the link order so that routines that exhibit high TLB miss counts are placed next to each other on the application's link line. A more permanent source alternative is to cut-and-paste source code for routines with high TLB miss counts into one source file and relink it into your application.

Refer to the *Exemplar SPP1000/1200/1600 Architecture* (Order No. DHW-014) reference for more information.

The following example contains data and instruction TLB miss reports for parallel loops:

```
================================================================================
                    Parallel Loop Performance Analysis
                              For: initialize
================================================================================
Optimized Loops (cumulative, including spawn/join overhead):

                                  Data TLB Misses
 Line      Times Exec   Iterations     Number of                              PS
-------  ------------ ------------ ---------------                            --
   152a             1          100              31

Optimized Loops (by thread, excluding spawn/join overhead):

                                  Data TLB Misses
 Line    TID  Chunks                   Number of                              PS
-------  --- --------              ---------------                            --
   152a    0        1                          7
           1        1                          3
           2        1                          4
           3        1                          5
           4        1                          6
           5        1                          2
           6        1                          1
           7        1                          2

Optimized Loops (cumulative, including spawn/join overhead):

                              Instruction TLB Misses
 Line      Times Exec   Iterations     Number of                              PS
-------  ------------ ------------ ---------------                            --
   152a             1          100              83

Optimized Loops (by thread, excluding spawn/join overhead):

                              Instruction TLB Misses
 Line    TID  Chunks                   Number of                              PS
-------  --- --------              ---------------                            --
   152a    0        1                         13
           1        1                          7
           2        1                         11
           3        1                          9
           4        1                         13
           5        1                          4
           6        1                          4
           7        1                          8
================================================================================
```

Parallel Region reports

Context

To view parallel loop region reports from the Analysis Report window in X window mode, select Loops (parallel) as the region type. To view parallel region reports in line mode, use the `analyze pregion` command.

Related Topics

Introducing metrics
Loop reports
Reports
Dynamic Call Graph report
Report fields
Routine reports

Related Windows

Analysis Report window
Region Subset Selection dialog
Call Graph window

Related Commands

`analyze`
`set visibility`

Report fields

This section lists and describes column headings, abbreviations, annotations, and other terms that appear in CXpa reports. These are listed in alphabetical order.

NOTE: All CXpa reports express time in seconds unless the time is annotated with the letter "m" for milliseconds.

- `% CPU`—Ratio of cache miss latency to CPU time, expressed as a percentage.
- `% Hits`—Data cache hit rate. SPP1200/SPP1600 Data Cache Accesses report only.
- `Avg clock cycles`—Average number of clock cycles per instruction. SPP1200/SPP1600 Instructions Completed and Clock cycles report only.
- `Avg MIPS rate`—Average number of MIPS (millions of instructions per second). SPP1200/SPP1600 Instructions Completed and Clock cycles report only.
- `Calls in`—For callers of the primary routine in each section of the Dynamic Call Graph report, the number of times the primary routine was called; for the primary routine in each section, the total number of calls made to that routine.
- `Calls out`—For callees of the primary routine in each section of the Dynamic Call Graph Report, the number of times the routine was called by the primary routine; for the primary routine, the total number of times that it was called.
- `Chunks`—Lists the total number of chunks executed by a single thread in the parallel region. A *chunk* is a unit of work executed on a single thread in a parallel loop. This unit of work corresponds to a packet of iterations of a parallel loop assigned to execute on a single thread. CXpa currently does not track the number of iterations in a chunk (chunk size).
- `CPU Time`—CPU time spent executing the region (accumulated time for all threads).
- `CPU/Wall`—For serial code, the ratio of CPU time to wall clock time measures CPU utilization. For parallel regions, this metric indicates the concurrency achieved through parallelism.

- `Data TLB Misses`—Number of times the address translation from virtual to physical memory for data to be referenced was not found in the translation lookaside buffer (TLB).
- `Instruction TLB Misses`—Number of times the address translation from virtual to physical memory for an instruction was not found in the translation lookaside buffer (TLB).
- `Iteration Count`—Minimum, maximum, and average loop iteration counts are shown because the iteration count can vary from one invocation of a loop to another:
  - `Min`—Fewest number of iterations of this loop for a single invocation.
  - `Max`—Greatest number of iterations of this loop for a single invocation.
  - `Avg`—Average number of iterations of this loop for a single invocation.
- `Latency`—The amount of time spent accessing memory to locate data or instructions not found in the processor's cache.
- `(less children)`—Does not include values for called routines. However, if an instrumented routine calls an uninstrumented routine, CXpa will not be able to separate the time spent in the uninstrumented child routine from the time spent in the instrumented parent.
- `(less inner)`—Excluding time spent in inner loops.
- `Line`—Source line number of the region.
  - Basic blocks—Starting source file line number for the basic block. The starting line number helps to trace a basic block back to the original source code. Due to optimizations, it is possible for many basic blocks to begin at the same line number.
  - Routines—Starting source file line number of the routine.
  - Serial and parallel loops—Line numbers for optimized loops annotated with a lowercase letter indicate that the loop was split into two or more loops during optimization. For parallel loops, the line number is the starting line number that maps back to the original source code.
- `Locally Resolved Cache Misses`—Cache misses that are resolved by using the hypernode crossbar to access memory found on the same hypernode as the processor; the CTI rings are not used.
- `m`—Time is expressed in milliseconds.
- `NL`—Nesting level of the loop after optimization.
- `Number of`—Number of times that the selected event occurred.

- `Optimization`—Abbreviation for the transformation(s) that Convex compilers perform on loops. The abbreviations possible are:
  - `B:`*n*—Loop blocking; *n* is the blocking factor, which is the number of iterations that were blocked together.
  - `cU:`*n*—The loop was completely unrolled; *n* is the loop unrolling factor, which is the number of iterations that were unrolled.
  - `D`—Distributed.
  - `Ds`—Dynamic selection.
  - `Hs`—Hoisted.
  - `I`—Interchanged.
  - `P`—Parallel.
  - `PS`—Parallel strip-mined.
  - `pU:`*n*—The loop was partially unrolled. *n* is the loop unrolling factor, which is the number of iterations that were unrolled.
  - `UL`—Uninstrumentable.

  For more information about automatic optimizations performed by the compiler and manual optimization techniques for Convex Exemplar SPP Series machines, refer to the *Exemplar Programming Guide* (DSW-067).
- `Optimized Loops (cumulative, including spawn/join overhead)`—These metrics are cumulative across all threads executing in the parallel region and include spawn and join overhead. These values are graphed in the 2D Profile window for parallel loops.
- `Optimized Loops (by thread, excluding spawn/join overhead)`—These metrics are calculated on a per-thread basis for all threads executing in the parallel region and do not include spawn and join overhead. These values are graphed in the 3D Profile window for parallel loops.
- `PC Value`—Program counter value. Starting address of a basic block.
- `plus children`—Includes values for called routines.
- `plus inner`—Including time spent in inner loops.
- `PS`—Displays the profiling status. If this column is blank, then the region executed normally. Other possible profiling statuses are as follows:

Profiling status	Meaning
`e`	The program exited at this point.
`g`	This region could not be timed due to the granularity of the clock supported on the architecture.

`m` Invalid time management was detected for this region due to an unprofilable code construct, an unprofilable command such as an `exec` or `fork`, or incorrect instrumentation in your program or in a library routine. To work around incorrect instrumentation:

- Deselect regions in your routines that are listed with a profiling status of `m`.
- Choose not to profile library routines if a library routine is listed with a profiling status of `m`. By default, library routines are not profiled, so this will only occur if you used the `-cxpalib` compiler option to include library routines.

`p` The program was paused at this point, and the timing information is incomplete.

`t` The program terminated at this point.

`u` This region was uninstrumentable because it was too small to gather timing data or contains an unrecognized construct.

`x` CPU time (excluding called routines and/or inner loops) and ratio(s) cannot be computed accurately.

`y` Wall clock time (excluding called routines and/or inner loops) and ratio(s) cannot be computed accurately.

`z` Latency time (excluding called routines and/or inner loops) and ratio(s) cannot be computed accurately.

- `read only`—Cache miss event collection was specified for misses that occurred during reads (loads) only.
- `Remotely Resolved Cache Misses`—Cache misses that were resolved by using the CTI rings to access memory on another hypernode.
- `TID`—Kernel thread ID number for each thread executing the parallel region.
- `Times Exec`—Number of times the routine or basic block was executed or, for loops, the number of loop invocations.
- `Total Blocks`—Total number of basic blocks in a routine.

- `Total Blocks Executed`—Total number of blocks that were executed and the percentage of blocks executed.
- `Wall Clock`—Time to solution for all threads executing the region. Wall clock time includes time when threads are idle.
- `write only`—Cache miss event collection was specified for misses that occurred during writes (stores) only.

Related Topics

Basic Block report
Dynamic Call Graph report
Introducing metrics
Loop reports
Parallel Region reports
Reports
Routine reports

Related Windows

Analysis Report window
Call Graph window
Region Subset Selection dialog

Routine reports

Description

Routine performance analysis reports display metrics for profiled routines in your program.

Routine reports are only available if the source files containing regions you wish to profile at the routine level are instrumented for profiling at the routine level (compiled with the `-cxpa` or `-cxpar` option of the Convex compilers) or if the object files were instrumented with the `cxoi` utility).

Depending on the architecture on which you created the PDF (performance data file) and the type of metrics collected, the following reports can be displayed for each routine executed in your program that contains profiled routines:

- **Call counts**—Routine execution counts.
- **Computation**—CPU time and the percentage of total CPU time (% column), including and excluding time spent in called routines.
- **Time to Solution**—Wall clock time, percentage of total wall clock time, (% column), and CPU/wall clock time.
- **Events**—Available event reports and metrics differ according to machine architecture and the type of event collected during the run of the program that generated the PDF file. These reports include:
  - Off-processor event reports (SPP1000 and SPP1600 Series only)—Locally resolved cache misses, remotely resolved cache misses, or locally and remotely resolved cache misses.
  - On-processor event reports (SPP1200 and SPP1600 Series only)—Data cache misses and latency; data cache accesses; instruction cache misses and latency; instructions completed and clock cycles; and data and instruction TLB (translation lookaside buffer) misses.

For all routine reports, metrics are displayed:

- Excluding values for called routines (less children).
- Including values for called routines (plus children).

NOTE: All CXpa reports express time in seconds unless the time is annotated with the letter "m" for milliseconds.

Refer to the "Report fields" online help topic or section of this book for information about fields, column headings, abbreviations, and annotations that can appear in Routine reports.

Reports

For routines, four types of reports are available: Call Counts, Computation, Time to Solution, and Events. These reports are described in the following sections, along with sample reports.

Call counts

The Call Counts report displays the number of times each profiled routine in your program was executed (called). A sample Call Counts report is shown below:

```
================================================================================
                        Routine Performance Analysis
================================================================================
                                  Call Counts
   Times Exec     PS                        Routine Name
---------------- -- ---------------------------------------------------------
         1000000    convolregion
               1    initialize
               1    convol
               1 e  start
               1    matcon

(e) incomplete, contains exit.
================================================================================
```

Computation

The metrics in the Computation report for routines can be used to examine:

- Total CPU time spent in each profiled routine
- Percentage of program's total CPU time for each profiled routine

Analyzing this information at the routine level can help you identify which routines require the greatest portion of total execution time. You can then profile and analyze these routines in greater detail.

A sample Computation report for routines is shown below:

```
================================================================================
                        Routine Performance Analysis
================================================================================
                                   Computation
        (less children)       (plus children)
  CPU Time      %                CPU Time      %                PS Routine Name
------------  -----            ------------  -----              -- ------------
      22.219   53.4%                 22.219   53.4%                 convolregion
       2.573    6.2%                 41.276   99.3%                 convol
       0.040    0.1%                  0.306    0.7%                 initialize
       2.422m   0.0%                 41.585  100.0%              e  start
       0.765m   0.0%                 41.583  100.0%                 matcon

(e) incomplete, contains exit.
================================================================================
```

Time to solution

The metrics in the Time to Solution report for routines can be used to examine the following:

- Total wall clock time spent in each profiled routine
- Percentage of total wall clock time spent in each profiled routine
- The ratio of CPU time to wall clock time for each profiled routine

If the CPU/wall clock ratio is low, it indicates that there may be some type of performance bottleneck caused by one or more of the following:

- I/O calls (for example, read() or write() calls).
- System calls (for example, open() or close() calls).
- Memory accesses (for example, cache misses). You can compare event metrics and latency for these loops to find out if the bottleneck is due to memory accesses.

For serial regions, if the CPU/wall clock ratio is high (approaches 1.0), the region is compute-bound.

For parallel regions, the CPU/wall clock ratio is the concurrency factor for the parallel region. Values for CPU/wall clock time that approach *n*, where *n* is the number of processors used by your program, indicate good parallel concurrency.

For example, as you increase the number of processors or the amount of work (data set size), the concurrency factor should increase proportionately. This would indicate that the region is scaling well in parallel.

A sample Time to Solution report for routines is shown below. The program that generated the PDF contained regions that executed in parallel on 8 CPUs. Routine `convolregion` (which perform the core computation and executes in parallel) exhibits good parallel concurrency.

```
================================================================================
                          CXpa Version 3.2 Profile

Executable       : /src/demos/convol/convol.-O3.exe
Profile Data     : /src/demos/convol/convol.-O3.exe.pdf
Process State    : exited
CPU Time         : 258.553  secs
Wall Clock Time  : 55.352  secs
Architecture     : CONVEX SPP-1200 (8 cpus)
================================================================================
                        Routine Performance Analysis
================================================================================

                                 Time to Solution
        (less children)                    (plus children)
 Wall Clock      %     CPU/Wall    Wall Clock      %     CPU/Wall    PS Routine Name
------------  -----  --------- ------------  -----  ---------  -- ------------
      47.888  86.5%       5.34        47.888  86.5%       5.34     convolregion
       6.615  11.9%       0.05        48.238  87.1%       5.36     convol
       6.584  11.9%       0.00        55.344 100.0%       4.67  e  start
       0.513   0.9%       0.01         0.513   0.9%       0.11     initialize
       9.270m  0.0%       0.09        48.760  88.1%       5.30     matcon

(e) incomplete, contains exit.
================================================================================
```

Events

If you have chosen to collect events, CXpa displays event reports for routines. The types of event reports displayed vary according to machine architecture and the type of event or events collected for the program run that generated the PDF file.

- Refer to the *Exemplar SPP 1000/1200/1600 Architecture* (Order No. DHW-014) reference for more information about these architectures.

- Refer to the "Introducing metrics" online help topic or section of this book for more details on the types of event metrics that can be collected on a specific architecture.

Cache misses and latency

Cache misses and latency reports vary according to the architecture and the exact type of cache miss event collected for the run of the program that generated the PDF file being analyzed.

On SPP1000 and SPP1600 Series machines, you can configure off-processor performance counters to collect cache miss counts and latency time for total cache misses, cache misses that were resolved locally (on the same hypernode as the processor—CTI not used), or cache misses that were resolved remotely (on a different hypernode—CTI used). The cache miss report heading indicates the type of event collected for that run of your program, and can be one of the following:

- Locally resolved cache misses and latency (read only, write only, or both)
- Remotely resolved cache misses and latency (read only, write only, or both)
- Locally and remotely resolved cache misses and latency (read only, write only, or both)

On SPP1200 and SPP1600 Series machines, you can configure on-processor performance counters to collect data cache accesses, misses, and latency or instruction cache misses and latency. The cache misses and latency report heading indicates the type of event collected, and can be one of the following (data cache accesses are displayed in a separate report):

- Data cache misses and latency
- Instruction cache misses and latency

Cache misses and latency reports for routines enable you to examine:

- Total number of cache miss events that occurred in a routine or routines.
- Latency—The total wall clock time spent accessing memory to locate data or instructions not found in the processor's cache.
- % CPU—Ratio of latency time to CPU time, expressed as a percentage.

The % CPU value indicates how much of your computational work is being performed vs. the memory latency you are incurring in a source region for the active thread. If the percentage is low, it means that the CPU found all of the data it needed to do its job in the cache (close at hand). If the percentage is high, it means the CPU had to spend a lot of time asking the memory system to retrieve the data it needed relative to the amount of work it had to do.

This percentage must be looked at in light of the amount of CPU work available to make a significant observation about program performance in light of cache effects. For example, if the event latency/CPU (% CPU) is 75%, and the overall CPU time is 25 secs for the routine, then it is probably safe to say that cache contention is occurring. You could then try to search out the offending memory access pattern in the region and correct it. If the event latency/CPU (% CPU) is 75%, but the overall CPU time is only 25 milliseconds, then the data is probably not significant.

- Differences in latency and cache miss counts indicate data access patterns for routines that cause memory bank contention among threads or cache thrashing.

The following sample cache miss report for routines was generated on an SPP1000 Series system. For this program run, locally resolved cache misses were collected for both read and write operations. Locally resolved cache miss counts indicate the number of cache misses that are resolved by using the hypernode crossbar to access memory found on the same hypernode as the processor; the Convex CTI (Coherent Toroidal Interconnect) rings are not used.

```
================================================================================
                        Routine Performance Analysis
================================================================================

                 Locally Resolved Cache Misses and Latency
        (less children)                    (plus children)              Routine
  Number of     Latency    % CPU    Number of     Latency    % CPU  PS  Name
- ------------ ----------  -----  ------------ ----------  -----  -- -------
       395101       0.221   16.6%       395101       0.221   16.6%     init
       394777       0.196   14.2%       394777       0.196   14.2%     munge
         1802       0.926m  47.8%       794315       0.420   15.4% e   start
         2635       1.312m  12.5%         2635       1.312m  12.5%     display

(e) incomplete, contains exit.

================================================================================
```

Data cache accesses (SPP1200 and SPP1600 Series only)

On SPP1200 and SPP1600 Series systems, you can configure on-processor event counters to collect data cache misses, accesses, and latency. A separate data cache accesses report provides the following information:

- Total number of data cache accesses
- Data cache hit rate (`% Hits` column)—The data cache hit rate is calculated as follows:

$$data\_cache\_hit\_rate = \frac{total\_data\_cache\_accesses - data\_cache\_misses}{total\_data\_cache\_accesses} \times 100$$

If the data cache hit rate (`% Hits`) is low, this indicates cache thrashing.

A sample Data Cache Accesses report for routines is shown below.

```
================================================================================
                        Routine Performance Analysis
================================================================================
                              Data Cache Accesses
        (less children)                    (plus children)              Routine
   Number of              % Hits     Number of              % Hits  PS  Name
---------------           ------  ---------------           ------ --  -------
       12834277             99.6%        12834277             99.6%     convolreg
        6109895             98.9%        18944172             99.4%     convol
        3438050             99.9%         3438050             99.9%     initial
          22505             92.4%        22409251             99.4% e   start
           4524             92.1%        22386746             99.4%     matcon

(e) incomplete, contains exit.
```

Instructions completed and clock cycles (SPP1200 and SPP1600 Series only)

On SPP 1200 and SPP1600 Series systems, you can configure on-processor event counters to collect instructions completed and clock cycles. A separate Instructions Completed and Clock Cycles report provides the following information:

- Number of instructions completed
- Average clock cycles (cycles per instruction)
- Average MIPS (millions of instructions per second) rate, which is only calculated if wall clock time is also collected

The average clock cycles metric measures the efficiency of instruction scheduling. On SPP 1200 and SPP1600 Series systems, the maximum number of instructions that can be executed in a single clock cycle is 2. This means that the theoretical peak value for the average clock cycles metric on this architecture is 0.5.

If the value for average clock cycles is high, and it is associated with a frequently called routine that performs only a small amount of work (for example, a routine that simply assigns a new value to a variable and returns), inlining the routine could improve the instruction scheduling by eliminating the routine call overhead.

Code sections that contain many patterns of consecutive loads and stores followed by immediate use of requested operands can also result in high average clock cycles.

In some cases, the instruction scheduling can be improved by compiling the routine at a higher optimization level or, if programming at the assembly level, changing the order of instructions. Refer to the *Hewlett-Packard PA-RISC 1.1 Architecture and Instruction Set Reference Manual* (Manual Part No. 09740-90039) for information on how to achieve optimal instruction scheduling.

The average MIPS (millions of instructions per second) rate is calculated during analysis if wall clock time is also collected. The formula CXpa uses to calculate the average MIPS rate is as follows:

$$Average\_MIPS\_rate = \frac{Number\_of\_instructions\_completed}{Wall\_clock\_time\_in\_sec}$$

The theoretical peak MIPS rate for Hewlett-Packard PA-RISC 7100/7200 processors with a 10-ns clock cycle at a clock rate of 100 MHz is 200 MIPS. There is a direct correlation between average clock cycles and average MIPS rates; decreasing average clock cycles will result in increased average MIPS rates.

A sample Instructions Completed and Clock Cycles report for routines is shown below:

```
================================================================================
                        Routine Performance Analysis
================================================================================
                    Instructions Completed and Clock Cycles
        (less children)                      (plus children)
                  Avg Clock Avg MIPS                  Avg Clock Avg MIPS Routine
      Number of      Cycles  Rate        Number of     Cycles  Rate PS  Name
-------------------- ------ ----- -------------------- ------ ----- -- -------
            32912416    1.2   103            32912416    1.2   103    convolreg
             8126678    1.9    62            41039094    1.3    91    convol
              513145    2.1     7              513145    2.1     7    initial
               57797    5.1     0            41621472    1.3     4 e  start
               11436    5.6     3            41563675    1.3    90    matcon

(e) incomplete, contains exit.
================================================================================
```

Data and instruction TLB misses (SPP1200 and SPP1600 Series only)

On SPP1200 and SPP1600 Series machines, you can configure on-processor event counters to collect data and instruction TLB (translation lookaside buffer) misses for profiled regions.

The TLB is a hardware structure in each CPU in an SPP Series system that contains information necessary to translate a virtual memory reference to a physical page and to validate memory accesses. The TLB contains 120 entries that represent address translations from virtual to physical memory for the most recently referenced page table entries.

TLB miss metrics represent the number of times the address translation from virtual to physical memory for data or an instruction to be referenced was not found in the TLB and could not be resolved through hardware handling. When a TLB miss occurs, the operating system must perform the address translation and store it in the TLB so that it can determine if the data is resident in memory:

- If the number of data TLB misses is high, this can indicate poor data locality. To correct the problem, try laying out frequently referenced data structures in an application closer together and not crossing page boundaries. In addition, focus on making the most of each data structure referenced by processing it completely before proceeding. This supports locality of references and maximizes use of the TLB.

- If the number of instruction TLB misses is high, try changing the link order so that routines that exhibit high TLB miss counts are placed next to each other on the application's link line. A more permanent source alternative is to cut-and-paste source code for routines with high TLB miss counts into one source file and relink it into your application.

Refer to the *Exemplar SPP1000/1200/1600 Architecture* (Order No. DHW-014) reference for more information on the TLB. Refer to the *Exemplar Programming Guide* (Order No. DSW-067) for more information about programming on SPP Series systems.

A sample data and instruction TLB misses report for routines is shown below:

```
================================================================================
                        Routine Performance Analysis
================================================================================

                                Data TLB Misses
    (less children)                    (plus children)                Routine
       Number of                          Number of          PS        Name
-------------------------       -------------------------   --  --------------
                        9                              9       init
                        5                             15   e  start
                        1                              1       display
                        0                              0       munge

(e) incomplete, contains exit.

                             Instruction TLB Misses
    (less children)                    (plus children)                Routine
       Number of                          Number of          PS        Name
-------------------------       -------------------------   --  --------------
                       19                             43   e  start
                       13                             13       display
                       10                             10       init
                        1                              1       munge

(e) incomplete, contains exit.
```

Context

To display Routine reports in X window mode, open the Analysis Report window and choose Routines as the region type.

To display Routine reports in line mode, use the `analyze routine` command.

Related Topics

- Basic Block report
- Dynamic Call Graph report
- Introducing metrics
- Loop reports
- Parallel Region reports
- Report fields
- Reports

Related Windows

- Analysis Report window
- Region Subset Selection dialog

Related Commands

`analyze`

Windows

5

This chapter contains help pages for all CXpa windows and dialogs. These pages are in alphabetical order by title. Each help page is divided into the following sections:

- **Description**—Explains the purpose and functionality of the window or dialog.
- **Fields**—Describes the purpose of each field that appears in the window or dialog.
- **Buttons**—Describes the function of each button that appears in the window or dialog.
- **Context**—Describes the action that makes this window or dialog appear.
- **Related Windows, Topics, or Commands**—Lists sections of this document online help topics that contain related information.

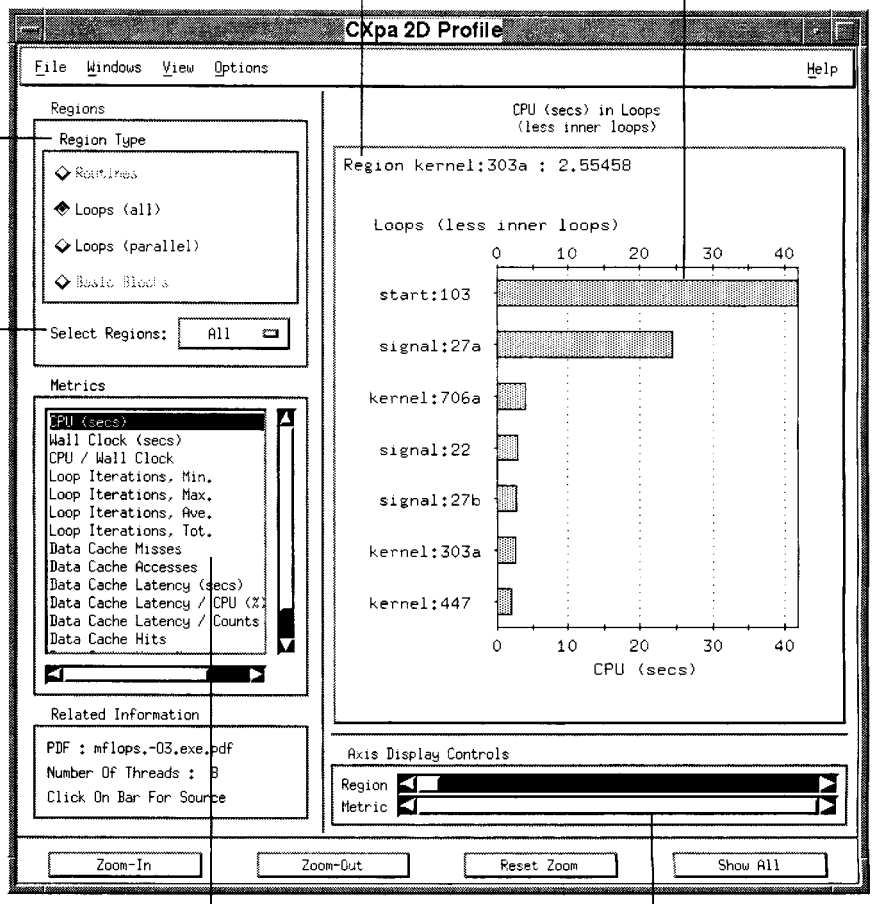
2D Profile window

Interactive data value display updates as you move the mouse over the graph, enabling you to view exact data values for regions in the graph.

Click with the left mouse button on any bar in the graph to view source code associated with a region.

Select the type of region to graph.

Select all regions of the selected type or a subset to graph.



Select the type of metric to graph.
The list is updated as different source code regions are selected, depending on the metrics available in the current PDF file.

Independently scroll Region and Metric axes.

2D Profile window

Description

The 2D Profile window displays a customizable two-dimensional graph of performance data for the selected regions of your program. This graph displays data for the entire process. To display performance data for individual threads, use the 3D Profile window.

In the 2D Profile window you can:

- Dynamically select different regions and metrics to graph.
- Click with the left mouse button on any bar in the graph to display associated source code.
- View exact data values for regions in the graph by moving the mouse over regions in the graph (data values are displayed in the upper left corner of the graph).
- Save 2D profile graphs in PostScript, xwd, or ASCII formats (select the Save Profile option from the File menu).
- Sort regions in 2D profile graphs by fixed metric, alphabetically, by load order, or by data values for the current metric (from lowest to highest or from highest to lowest). The default sort order is by data values for the current metric, from highest to lowest. To access sort options, select Sort from the View menu. Refer to the "Sort dialog" online help topic or section of this book for more information.
- View or specify the range of metric values displayed or the number of regions displayed at one time in the 2D graph using the Zoom dialog or buttons along the bottom of the window. This can be useful when there are a large number of data items to graph and you want to focus on a subset of the data.

  To access the Zoom dialog, select the Zoom option from the View menu.
- Use the scrollbars in the Axis Display Controls panel to scroll the Region and Metric axes independently.

By default, CXpa graphs metric values for all selected regions or for the maximum number of regions for which labels can legibly be displayed, whichever is less. If all selected regions are not displayed, use the Region Axis Display Control scrollbar to navigate the graph or use one of the other zoom options to change the graph display.

Menus

Name	Meaning
File	Contains items for saving the graph in a PostScript, ASCII, or xwd file format and closing the window.

Windows	Contains items for creating additional CXpa windows for viewing 2D or 3D profile graphs, performance reports, call graphs, or source files.
View	Contains items for sorting (Sort) and changing the range of values or source code regions displayed in the graph (Zoom).
Options	Contains an item (Filter Profile) that enables you to include or exclude values for called routines and/or inner loops in the graph.
Help	Contains items for invoking the CXpa help system.

Regions

Contains buttons that change the type of source code region to graph on the Region axis.

Name	Meaning
Routines	Graph selected metric for routines.
Loops (all)	Graph selected metric for loops.
Loops (parallel)	Graph selected metric for parallel loops only.
Basic Blocks	Graph selected metric for basic blocks.
Select Regions	Option menu containing two items: **All**—Graph profiling data for all regions of the type specified above. **Subset**—Brings up the Region Subset Selection dialog where you can specify a customized list of routines to graph profiling data for.

Metrics

Contains a scrolled list of metrics available in the current PDF where you can select the type of metric graphed on the Metric axis.

The available metric choices depend on the regions selected for profiling and the metrics that were collected for the run of your program that produced the PDF file.

Refer to the "Introducing metrics" online help topic or section of this book for metric descriptions and a list of metrics available by architecture.

Related Information

Displays the name of the PDF, the number of threads, and directions for displaying source code associated with any bar in the 2D profile graph.

2D Profile window

Axis Display Controls

Using the scrollbars in the Axis Display Controls panel, you can scroll the Region and Metrics axes independently.

Buttons

Name	Meaning
Reset Zoom	Restores the default graph display. By default, CXpa graphs metric values for all selected regions or for the maximum number of regions for which labels can legibly be displayed, whichever is less. If all selected regions are not displayed, use the Region Axis Display Control scrollbar to navigate the graph or use one of the other zoom options to change the graph display.
Zoom-In	Reduces the number of regions displayed in the 2D graph at one time by half.
Zoom-Out	Doubles the number of regions displayed in the 2D graph at one time.
Show All	Displays the entire graph. If the number of regions is so large that the region labels cannot be displayed legibly, labels are not displayed. If this happens, click the Reset Zoom or Zoom-In button to restore the labels and use scrollbars to navigate the graph.

Context

Use one of the following methods to open a 2D Profile window:

- Press the Create 2D Profile button in the Analysis Control window or the 2D Profile button in the Executable Manager window.
- Select 2D Profile from the Windows menu in any CXpa window.
- Invoke CXpa with the name of a PDF file only (without specifying an executable), if you have set the X application resource `Cxpa*defaultWindow` to `2DProfile` or specified `-windows 2DProfile` when invoking CXpa on the command line.

Related Topics

Introducing metrics

Related Windows

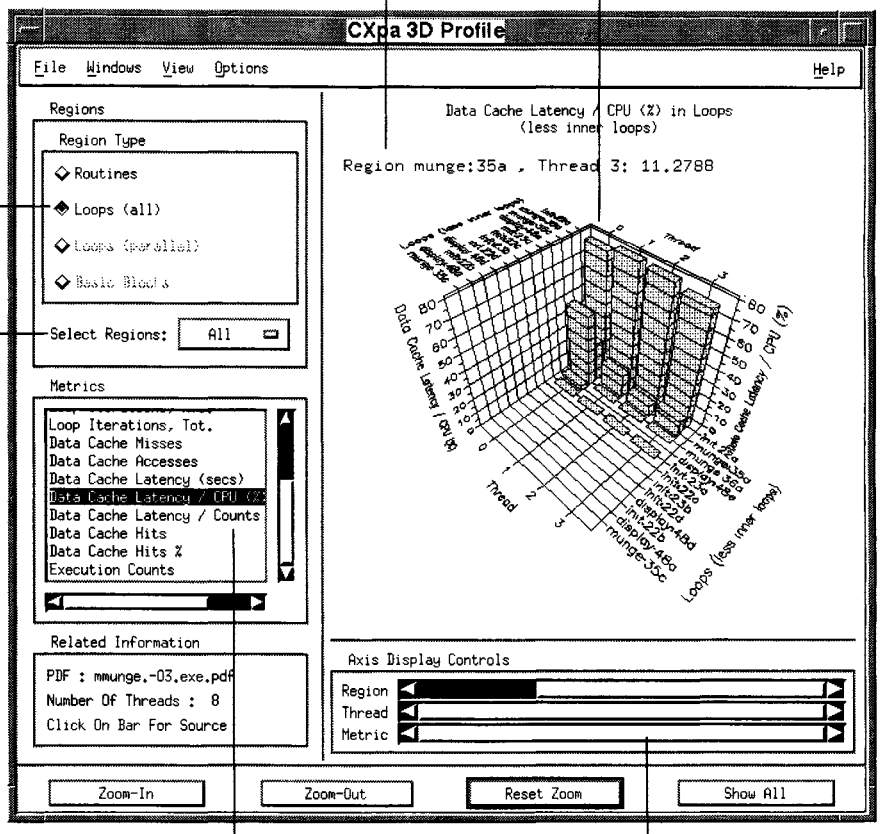
3D Profile window
Analysis Control window
Analysis Report window
Call Graph window
Executable Manager window
Filter Profile dialog
Profile Selection dialog
Region Subset Selection dialog
Save Profile dialog
Sort dialog
Source Code window
Zoom dialog

2D Profile window

3D Profile window

Interactive data value display updates as you move the mouse over the graph, enabling you to view exact data values for regions in the graph.

Click with the left mouse button on any bar in the graph to view source code associated with a region.



Select the type of region to graph.

Select all regions of the selected type or a subset to graph.

Select a metric to graph on the Metric axis. The list is updated as different source code regions are selected, depending on the metrics available in the current PDF file.

Independently scroll Region, Thread, and Metric axes.

3D Profile window

Description

The 3D Profile window displays a three-dimensional graph of various kinds of parallel performance data (which vary according to architecture) for the profiled regions of your program. Performance data is graphed on a per-thread basis.

In the 3D profile window, you can:

- Dynamically select different regions and metrics to graph.
- Click with the left mouse button on any bar in the graph to display source code associated with the corresponding region.
- Save 3D profile graphs in PostScript, xwd, or ASCII file formats (select the Save Profile option from the File menu).
- View or specify the range of metric values displayed or the number of regions or threads displayed at one time in the 3D graph using the Zoom dialog or buttons along the bottom of the window. This can be useful when there are a large number of data items to graph and you want to focus on a subset of the data.

  To access the Zoom dialog, select the Zoom option from the View menu.
- View exact data values for regions in the graph by moving the mouse over regions in the graph. Data values are displayed in the upper left corner of the graph.
- Use the scrollbars in the Axis Display Controls panel to scroll the Region, Thread, and Metric axes independently.
- Sort regions in 3D profile graphs by fixed metric, alphabetically, by load order, or by data values for the currently selected metric (from lowest to highest or from highest to lowest). The default sort order is by data values for the current metric, from highest to lowest.

  To access sort options, select the Sort option from the View menu. Refer to the "Sort dialog" online help topic or section of this book for more information on sorting options.
- Rotate the graph by placing the mouse pointer over the graph and holding down the middle mouse button.
  - To restrict the rotation to a single axis, press the **x**, **y**, or **z** key after pressing the mouse button, but before moving the mouse to rotate the graph.
  - To return the graph to its original position, press the Reset Zoom button.

By default, CXpa graphs metric values for all selected regions or for the maximum number of regions for which labels can legibly be displayed, whichever is less. If all selected regions or threads are not displayed, use the Region or Thread Axis Display Control scrollbars to navigate the graph or use one of the other zoom options to change the graph display.

Menus

Name	Meaning
File	Contains items for saving the graph in a PostScript, ASCII, or xwd file format and closing the window.
Windows	Contains items for creating additional CXpa windows for viewing 2D and 3D profile graphs, performance reports, and source files.
View	Contains items for sorting the data (Sort) and changing the range of values, number of source code regions, or number of threads displayed in the 3D graph (Zoom).
Options	Contains an item for including or excluding values for called routines and/or inner loops in the 3D graph.
Help	Contains options for invoking the CXpa help system.

Regions

Contains buttons that change the type of program region to graph on the Region axis.

Region level option	Action
Routines	Graph selected metric for routines.
Loops (all)	Graph selected metric for loops.
Parallel (parallel)	Graph selected metric for parallel loops only.
Basic Blocks	Graph selected metric for basic blocks.
Select Regions	Option menu containing two items: **All**—Graph profiling data for all regions of the type specified above. **Subset**—Brings up the Region Subset Selection dialog where you can specify a customized list of routines to graph profiling data for.

3D Profile window

Metrics

Contains a scrolled list of metrics available in the current PDF where you can select the type of metric graphed on the Metric axis.

The available metric choices depend on the regions selected for profiling and the metrics that were collected for the run of your program that produced the PDF file.

Refer to the "Introducing metrics" online help topic or section of this book for metric descriptions and a list of metrics available by architecture.

Related Information

Displays the name of the PDF, the number of threads, and directions for displaying source code associated with any bar in the 3D profile graph.

Axis Display Controls

Using the scrollbars in the Axis Display Controls panel, you can scroll the Region, Thread, and Metrics axes independently.

Buttons

Name	Meaning
Reset Zoom	Restores the default graph display. By default, CXpa graphs metric values for all selected regions or for the maximum number of regions for which labels can legibly be displayed, whichever is less. If all selected regions or threads are not displayed, use the Region or Thread Axis Display Control scrollbars to navigate the graph or use one of the other zoom options to change the graph display.
Zoom-In	Reduces the number of regions displayed in the 3D graph at one time by half. The number of threads displayed remains constant.
Zoom-Out	Doubles the number of regions displayed in the 3D graph at one time. The number of threads displayed remains constant.
Show All	Displays the entire graph. If the number of regions or threads is so large that the region labels cannot be displayed legibly, labels are not displayed. If this happens, click the Reset Zoom or Zoom-In button to restore the labels and use the scrollbars to navigate the graph.

3D Profile window

Context

Use one of the following methods to open a 3D Profile window:

- Press the Create 3D Profile button in the Analysis Control window or the 3D Profile button in the Executable Manager window.
- Select 3D Profile from the Windows menu of any CXpa window.
- Invoke CXpa with the name of a PDF file only (without specifying an executable), if you have set the X application resource `Cxpa*defaultWindow` to `3DProfile` or specified `-windows 3DProfile` when invoking CXpa on the command line.

Related Topics

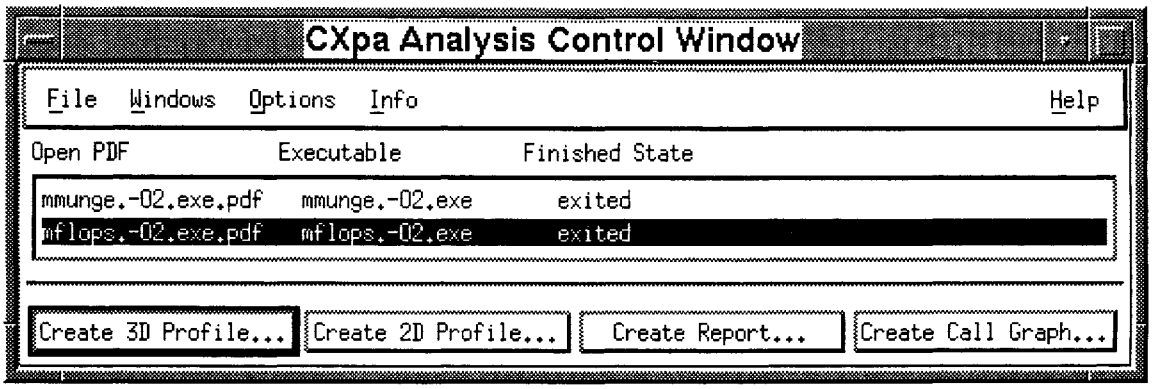
Introducing metrics

Related Windows

2D Profile window
Analysis Report window
Executable Manager window
Profile Selection dialog
Save Profile dialog
Zoom dialog
Analysis Control window
Call Graph window
Filter Profile dialog
Region Subset Selection dialog
Sort dialog

3D Profile window

Analysis Control window



Description

The Analysis Control window appears when you invoke CXpa with the names of one or more existing PDF files only (without specifying the name of an executable file). For example:

```
% /usr/convex/bin/cxpa *.pdf &
```

In this "analysis-only" mode of CXpa, you can view previously collected performance data, but you cannot instrument or run your application (to instrument and/or run your program under CXpa, invoke CXpa with the name of an executable file).

The current PDF is always highlighted. To analyze the data in the current PDF, press the Create 3D Profile, Create 2D Profile, Create Report or Create Call Graph button at the bottom of the window.

From the Analysis Control window you can:

- Create and view a dynamic call graph, performance reports or 2D and 3D profile graphs from the information in any number of PDFs, including PDFs created on different architectures or from different executables.
- Open multiple call graphs, profile graphs, and reports per PDF to compare performance analysis information.

- Merge data from multiple PDF files generated by the same executable into a single PDF file for analysis. This feature is useful for analyzing PDF files generated from PVM (parallel virtual machine) applications or for comparing performance data across multiple runs of an application with different data sets.

  Refer to the "Profiling PVM applications with CXpa," online help topic or section of this book for more information.

- View source files for your application by selecting the Source Code item from the Windows menu.

NOTE: You can use a CXpa X application resource to specify automatic creation of a profile or report window when you invoke CXpa with a PDF file only (in "analysis mode").

The resource is `Cxpa*defaultWindow`, and it can accept one of six values: `All`, `None`, `2DProfile`, `3DProfile`, `Report`, or `Source`. The default is `None`.

Selecting a different PDF file to analyze

To select a different PDF file to analyze, click on the name of a PDF listed in the Open PDF column. The name of the PDF file is highlighted, indicating that it is the currently selected PDF.

You can then press the Create 3D Profile, Create 2D Profile, Create Report, or Create Call Graph button to analyze the data in the current PDF.

Opening additional PDF files for analysis

To open a new PDF and make it the current PDF:

1. Select Open PDF from the File menu. This opens an Open PDF dialog for specifying the name of the new PDF file.
2. Specify the name of an existing PDF file by selecting it from the Files list in the Open PDF dialog or by explicitly typing it in the PDF file field.

   If you do not specify a relative or full path, CXpa looks for the PDF file in the current directory.
3. Press OK to select the PDF file. The name of the specified file is displayed in the Open PDF column in the Analysis Control window, and it is highlighted, indicating that it is the currently selected PDF.

   You can now use the Create 3D Profile, Create 2D Profile, Create Report, or Create Call Graph button to analyze the new PDF.

Invoking CXpa with multiple PDF files for analysis

You can invoke CXpa from the shell in X window mode with the names of multiple PDF files. For example:

```
% /usr/convex/bin/cxpa  *.pdf &
```

When you do so, each of the specified PDF files is automatically listed in the Open PDF column in the Analysis Control window, and the last PDF file specified is highlighted (selected for analysis). To select or deselect a PDF file, click on its name in the list.

Menus

Name	Meaning
File	Contains items for opening an existing PDF, merging data from multiple PDF files into a single PDF file, and exiting CXpa.
Windows	Contains items for creating additional windows for viewing 2D and 3D profile graphs, performance reports, dynamic call graphs, or source files.
Options	Contains items for changing CXpa's source code search path or setting visibility for library and application routines.
Info	Contains an item for displaying information on the current PDF or your current session.
Help	Contains items for invoking the CXpa help system.

Fields

Name	Meaning
Open PDF	Lists the names of available PDFs. The current PDF is always highlighted.
Executable	Lists the name of the executable that created the PDF.
Finished State	Lists the state of the executable (for example, exited, stopped, terminated, and so on).

Buttons

Name	Action
Create 3D Profile	Opens a window containing a 3D profile graph.
Create 2D Profile	Opens a window containing a 2D profile graph.

Analysis Control window

Create Report	Displays a window containing textual performance reports.
Create Call Graph	Opens a window containing an interactive dynamic call graph display.

Context

The Analysis Control window appears when you invoke CXpa with the name of a PDF file only (without specifying an executable file).

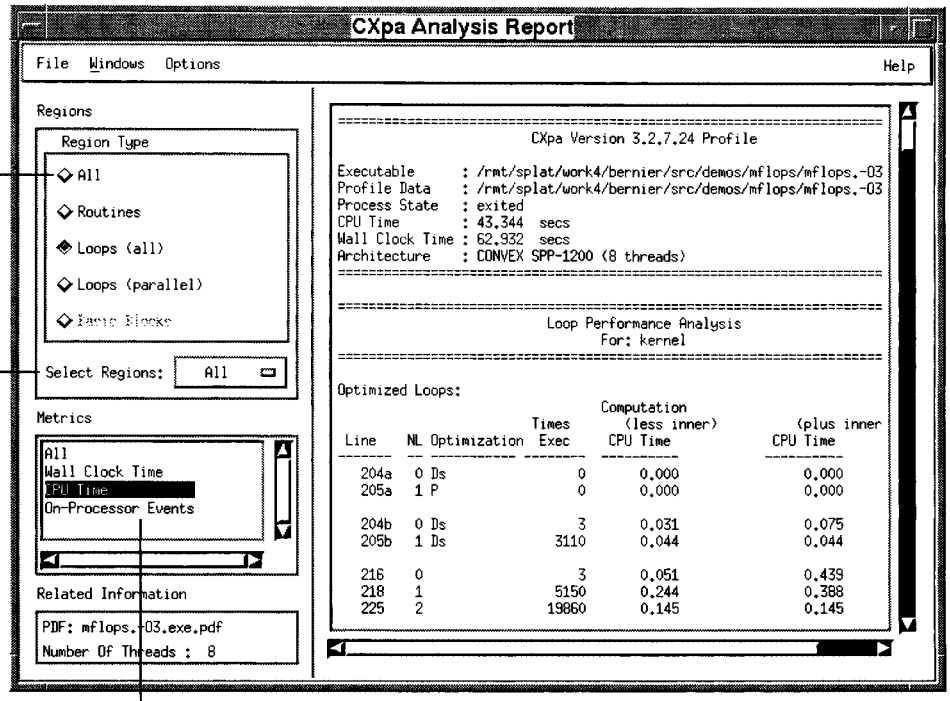
Related Topics

Analyzing PDFs only
Profiling PVM applications with CXpa
Setting the PDF
Using pre-instrumented executables

Related Windows

2D Profile window
Analysis Control window
Call Graph window
Open PDF dialog
Info Session dialog
Source Code window
3D Profile window
Analysis Report window
Merge PDFs dialog
Info PDF dialog
Source Code Selection dialog
Source Search Path dialog

Analysis Report window



Select the type of region for which you you want to view profile reports.

Select all routines or a subset of routines containing regions of the type selected above.

Select the type of metrics to view in profile reports. The list is updated as different source code regions are selected, depending on the metrics available in the current PDF file.

Description

The Analysis Report window displays textual performance reports generated from the data in the active PDF. You can create multiple Analysis Report windows, allowing you to compare information among several PDFs or to examine different types of analysis reports for a single PDF. By default, when you first bring up the Analysis Report window, all available metrics are displayed for all profiled regions of your program.

Analysis Report window

You can display specific metrics for various types of source code regions by clicking one of the buttons in the Region Type section and then highlighting one of the metrics selections in the scrolled list. You can also create customized reports by specifying a subset of routines that contain regions of the currently selected type (refer to the "Region Subset Selection dialog" online help topic or section in this book for more information).

You can select whether you want to display performance data in reports on a per-process basis (the default) or on a per-thread basis, by selecting the Filter Report option from the Options menu. Threaded data in reports is displayed on a per-routine basis for each thread, with the number of the thread displayed in the report heading for each routine.

For more information on the types of reports available at each region level and the metrics displayed in each type of report, refer to the following online help topics or sections in this book: "Reports," "Dynamic Call Graph report," "Loop reports," "Parallel Region reports," "Routine reports," and "Basic Block report."

Menus

Name	Options
File	Contains items for saving the report in the window to a file and closing the window.
Windows	Contains items for creating additional windows for viewing 2D and 3D profile graphs, performance reports, call graphs, or source files.
Options	Contains an item for filtering performance report data on a per-process basis (the default) or on a per-thread basis.
Help	Contains various items for invoking the CXpa help system.

Regions

Contains options to change the type of source code region for which reports are displayed.

Region Type option	Action
All	Report selected metrics for all profiled regions.
Routines	Report selected metrics for routines.
Loops (all)	Report selected metrics for all profiled loops.
Loops (parallel)	Report selected metrics parallel loops only.
Basic blocks	Report selected metrics for basic blocks.

Select Regions	Contains an option menu with two items: **All**—Report profiling data for all regions of the type specified above. **Subset**—Bring up the Region Subset Selection dialog where you can specify a subset of routines that contain regions of the currently selected type to include profiling data for in reports.

Metrics

Contains a scrolled list of metrics available in the current PDF where you can select the type of metrics you want to view in CXpa profile reports.

The available metric choices depend on the regions selected for profiling and the metrics that were collected for the run of your program that produced the PDF file.

Refer to the "Introducing metrics" online help topic or section of this book for metric descriptions and a list of metrics available by architecture.

Related Information

Label	Meaning
PDF	Displays the name of the file in which the current performance data is stored.
Number of Threads	Displays the number of threads in your program.

Context

The Analysis Report window appears when you

- Press the Report button on the Executable Manager window or the Create Report button on the Analysis Control window.
- Select the Report option from the Windows menu in any CXpa window.
- Invoke CXpa with the name of a PDF file only (without specifying an executable), if you have set the X application resource `Cxpa*defaultWindow` to `Report` or specified `-windows Report` when invoking CXpa from the command line.

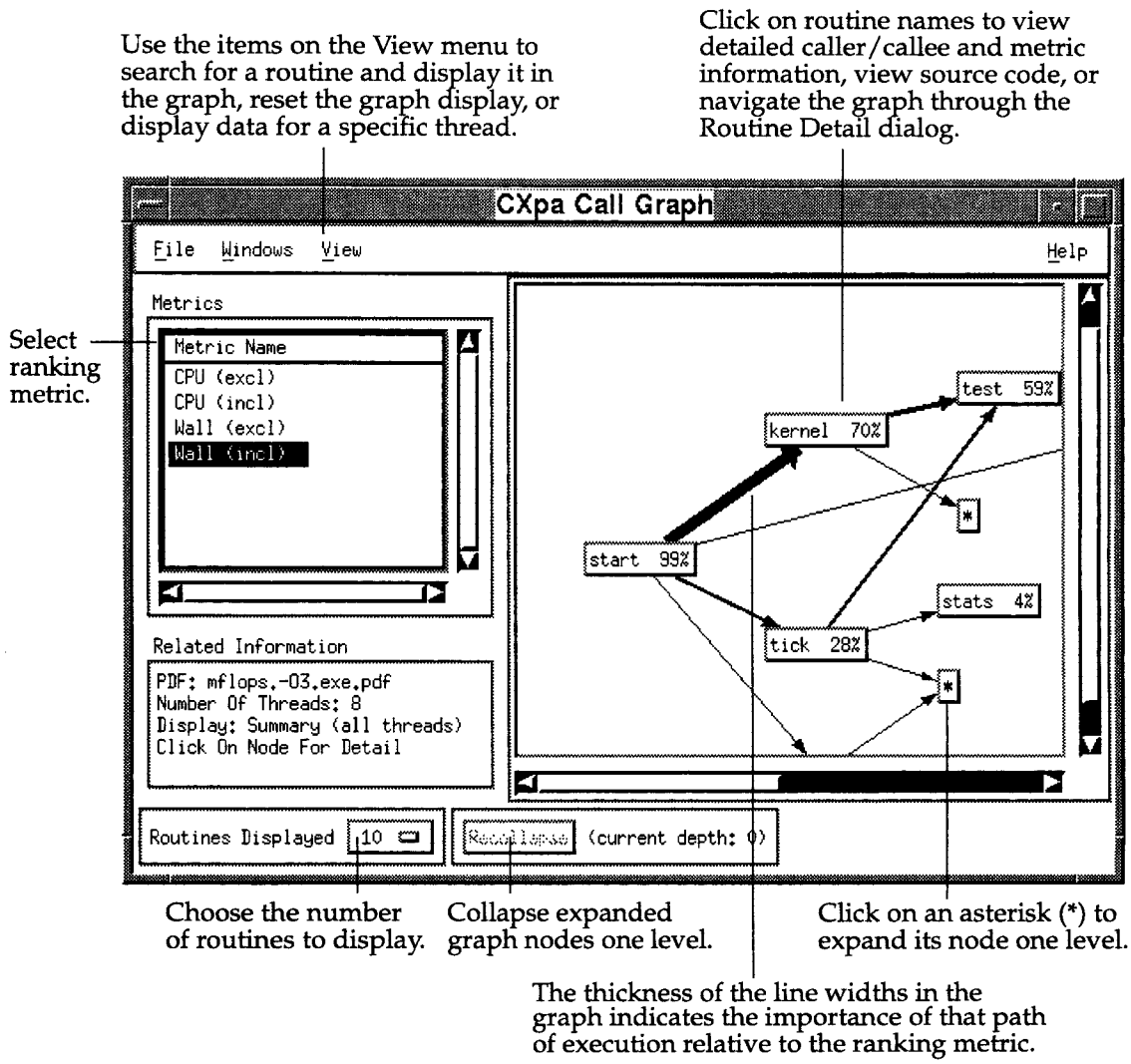
Related Windows

2D Profile window
Analysis Control window
Region Subset Selection dialog
Filter Report dialog
Save Report dialog
3D Profile window
Call Graph window
Executable Manager window
Profile Selection dialog

Related Topics

Basic Block report
Dynamic Call Graph report
Introducing metrics
Loop reports
Parallel Region reports
Report fields
Reports
Routine reports
Selecting metrics in X window mode

Call Graph window



Description

The Call Graph window displays a dynamic call graph of the routines in your program.

Call Graph window

The dynamic call graph is available if:

- Call graph metrics were selected for collection by:
  - Enabling CPU Time, Wall Clock, and Call Graph metric collection in the Profile Selection dialog (in X window mode).
  - Specifying the `call_graph`, `cpu`, and `wall_clock` parameters of the `collect` command (in line mode).
- All routines were selected for profiling in the Profile Selection dialog (X window mode) or with the command `select routine all` (in line mode).
- The source files were instrumented for profiling at the routine level (compiled with the `-cxpa` or `-cxpar` option of the Convex compilers) or the object files and libraries were instrumented with the `cxoi` utility.

NOTE: When generating a dynamic call graph, make sure that all routines in your program are instrumented and selected for profiling. Otherwise, the results displayed in the call graph may be misleading.

For example, if an instrumented routine named `parent()` calls an uninstrumented routine `child()`, and `child()` then calls an instrumented routine `sub1()`, the call graph would incorrectly show that `parent()` called `sub1()`, and all of the time spent in the uninstrumented routine `child()` would be attributed to `sub1()`.

When a call graph is first opened, the top 10 routines, ranked by inclusive wall clock time (that is, including time spent in called routines) are displayed.

The percentage of the program total for the selected metric that is attributed to each of the top 10 routines is displayed to the right of the routine name.

The rest of the routines are collapsed into nodes that are indicated by asterisks (*) in the graph. The width of lines in the graph indicate the most important path of execution for the selected metric.

Collapsed nodes can be expanded and viewed by clicking on asterisks with the mouse. When a collapsed node is expanded, the top *n* routines in the collapsed node (still ranked by the currently selected metric) are displayed. The number of routines displayed is controlled by the Routines Displayed option menu at the bottom of the window. The default is 10 routines.

To change the number of routines displayed in the graph:

1. Position the mouse over the Routines Displayed option menu at the bottom of the Call Graph window. Hold down the left mouse button and drag the mouse to make a selection.
2. When you release the mouse, the call graph display updates to show the chosen number of routines, ranked by the currently selected metric.

To recollapse an expanded node one level, press the Recollapse button in the lower right-hand corner of the Call Graph window. The current depth is displayed to the right of the Recollapse button.

Selecting a different metric to rank routines

You can change the metric used to rank the routines. Available metric choices are wall clock time and CPU time (inclusive or exclusive).

To change the ranking metric, select a metric from the Metrics list in the upper left corner of the Call Graph window. The selected metric is highlighted.

The call graph display updates to display currently selected number of routines, ranked by the selected metric.

Viewing detailed information and source code for routines

To view detailed information and source code for a routine in the Call Graph window, click on the name of the desired routine to open a Routine Detail dialog. From this dialog you can:

- View values for all metrics collected for the selected routine.
- View lists of callers and callees and their call counts for the selected routine.
- Press the Show in Source button to open a Source Code window displaying source code for the selected routine.
- Select different routines to display in the Call Graph window.

Searching for a routine

To search for a routine and display it in the Call Graph window:

1. Pull down the View menu and select Find Routine to open a Find Routine dialog.
2. Select the routine to display in the Call Graph window by clicking on its name in the list. The routine name is highlighted.

If the program contains a large number of routines, you can specify a string in the Find field to search for, then press Find to locate the first routine name containing that string. CXpa scrolls the routine list so that the matching routine name is placed at the top of the list (or, if it is near the end of the list, it is visible in the list).

Press Find again to locate the next routine that contains the specified string and scroll the list, and so on. The search will wrap to the beginning of the list. Be sure to click on the routine name to select it after executing the search.

3. Press OK to close the Find Routine dialog and display the routine in the Call Graph window.

   CXpa highlights the routine name in the Call Graph window and, if necessary, scrolls the window so that the currently selected routine is showing. If the selected routine is in a node that is currently collapsed, its node is expanded until the routine is displayed.

   The information associated with the selected routine is displayed in the Routine Detail dialog. If a Routine Detail dialog is not currently open, CXpa opens one.

Displaying information for specific threads

By default, the dynamic call graph displays summary information for all threads of the process. To display information for a specific thread:

1. Select Thread from the View menu to open a Thread Selection dialog that contains a scrolling list of thread ID numbers.
2. Click on a thread ID number in the list to select it. The selected thread is highlighted. You can select one thread or All Threads.
3. Press OK to close the dialog and update the call graph display.

Menus

Name	Meaning
File	Contains an item for closing the window.
Windows	Contains items for creating additional CXpa windows for viewing 2D and 3D profile graphs, performance reports, and source files.
View	Contains items for resetting the call graph display, searching for a specific routine to display, and displaying data for a specific thread in the call graph.
Help	Contains items for invoking the CXpa help system.

Buttons and Fields

Name	Meaning
Metric	Contains a scrolling list of metric names to select as the ranking metric for routines displayed in the Call Graph window. The selected metric is highlighted.
Related Information	Displays the name of the current PDF file, the total number of threads in the program, and whether data is displayed for all threads or for a specific thread.
Routines Displayed	Option menu for specifying the number of routines to be displayed. The default is the top routines, ranked by inclusive wall clock time. Available choices are 10, 15, 20 or all.
Recollapse	Collapse all expanded Call Graph nodes one level. This button is desensitized when all nodes are collapsed (depth 0).

Context

To open a Call Graph window:

- Press the Create Call Graph button in the Analysis Control window or the Call Graph button in the Executable Manager window.
- Select Call Graph from the Windows menu of any CXpa window.

Related Topics

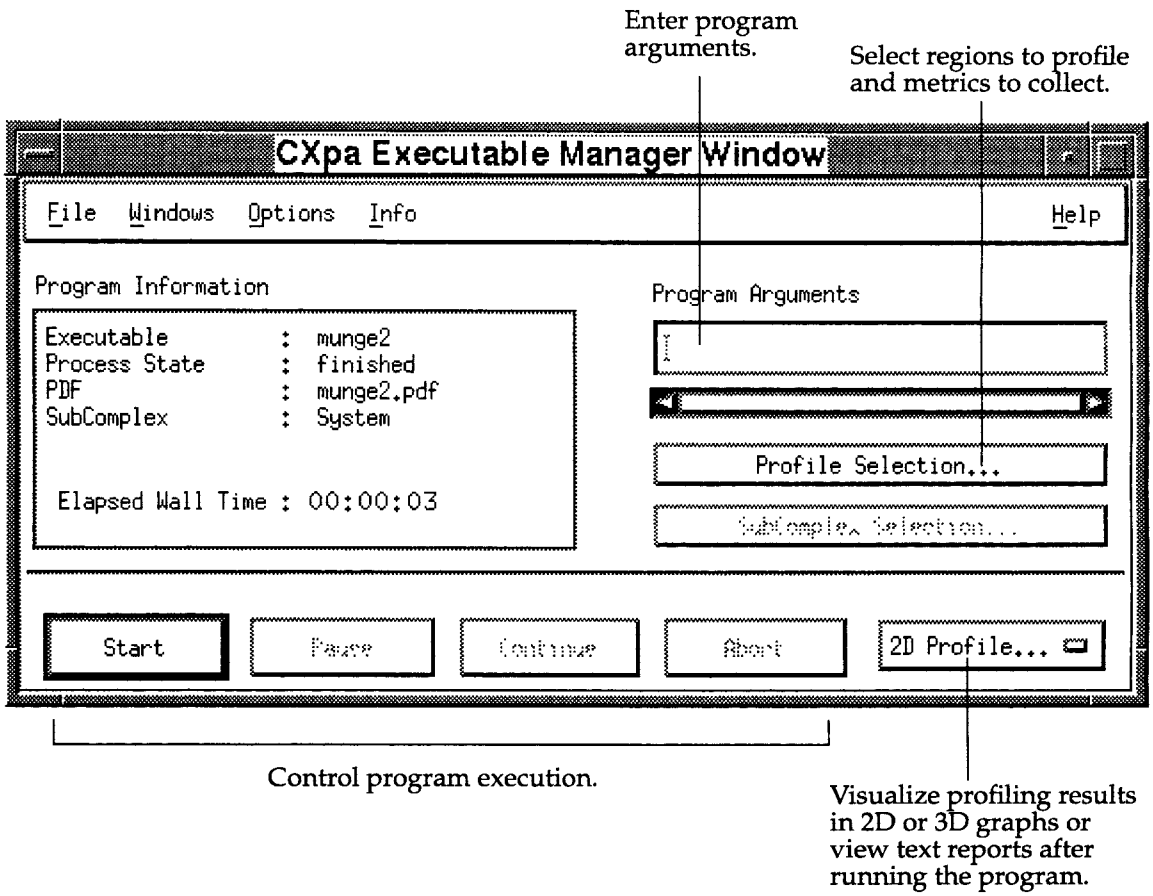
Dynamic Call Graph report

Related Windows

Find Routine dialog
Routine Detail dialog
Thread Selection dialog

Call Graph window

Executable Manager window



Description

The Executable Manager window appears when you invoke CXpa with an executable. From this window, you can profile a program that has been prepared for profiling with CXpa.

From the Executable Manager window you can:

- Select source code regions for profiling and metrics to collect.
- Specify arguments to the program you are profiling.

- Execute and profile your program.
- Display textual performance reports and 2D or 3D profile graphs.
- View source files for your application.
- Specify a new PDF name to prevent overwriting an existing PDF.
- Overwrite any existing PDF by specifying the name of that PDF.

From the Executable Manager window, you cannot display performance reports and profiles from PDFs created in a previous session, generated from a different executable, or generated on a different architecture.

To display performance reports and profiles from previously created PDFs, including PDFs created on other architectures or with different executables, invoke CXpa with the name of one or more existing PDF files only (without specifying an executable file name).

Profiling a program

After you have compiled your program with one of the profiling options, perform the following steps to profile your program:

1. Invoke CXpa with the name of your executable:

   ```
   % /usr/convex/bin/cxpa a.out
   ```

   The Executable Manager window appears.

2. If you are running CXpa on an SPP Series system and want to run your process on a different subcomplex, press the Subcomplex Selection button to bring up the Subcomplex Selection dialog. Select the name of the subcomplex on which you want your process to run.

3. Enter any arguments to the program you are profiling in the Program Arguments field.

4. By default, CXpa collects CPU time, wall clock time, and execution counts for all routines in your program. Use these defaults the first time you profile your program under CXpa. To use these defaults, skip to step 6. To select different source code regions (such as loops and parallel regions only) for profiling and/or collect different metrics, continue with step 5.

5. Press the Profile Selection button. The Profile Selection Dialog appears. Perform the following actions to select different metrics and regions for profiling:

   – Select the source code regions and routines you want to profile by clicking the toggle buttons in the Select Regions to Profile section of the dialog.

   – To change the default metrics (CPU time, wall clock time, and

execution counts), click the toggle buttons in the Select Metrics to Collect section of the dialog to select/deselect metrics.

- On SPP Series systems, you can collect hardware event metrics. If you wish to collect event metrics, select Events as one of your metrics choices and use the Event Counter(s) option menu to select the type of event that you want to collect.
- Press the OK button in the Profile Selection dialog to apply the region and metrics settings and close the dialog. You are now ready to profile your program.

6. Press the Start button to run the program you are profiling. A window appears that displays your program's input and output.

   While your program runs, CXpa collects performance data. When your program completes execution, the Process State field shows a state of `finished`.

   You can use the Pause button at the bottom of the Executable Manager window to suspend your program's execution during profiling.

NOTE: To obtain the most accurate profiling data, you should not pause your program during profiling. For best results, run the program to completion in a standalone environment (on a "quiet" or dedicated subcomplex).

   Once your program is paused, you can:

   - View an intermediate 2D or 3D profile graph or text report, as shown in step 7.
   - Abort your program.
   - Continue your program's execution.

7. To display performance information, select one of the options (2D Profile, 3D Profile, Report, or Call Graph) from the option menu button at the bottom-right corner of the window.

   Choose an option by releasing the mouse button while the pointer is over the option you want.

   You can also display performance information by choosing an item from the Windows menu.

8. Exit CXpa by choosing the Exit item from the File menu.

Menus

Name	Meaning
File	Contains items for opening a new PDF or exiting CXpa.
Windows	Contains items for creating additional windows for viewing 2D and 3D profile graphs, performance reports, call graphs, or source files.

Options	Contains the Source Search Path item, which opens a Source Search Path dialog where you can change the source code search path.
Info	Lists items that display information about the PDF, the executable being profiled, and your current CXpa session.
Help	Contains items for invoking the CXpa help system.

Fields

Name	Meaning
Executable	Lists the executable you are profiling.
Process State	List the process state for the program you are profiling. These states include: `Running`, `Paused`, `Finished`, and `Terminated`.
PDF	Lists the name of the performance data file (PDF) where performance data will be stored.
SubComplex	Lists the name of the subcomplex on which your executable will run.
Elapsed Wall Time	Presents the actual time that has passed since you pressed the Start button.
Program Arguments	Allows you to specify command-line arguments to the program you are profiling and file redirection operations.

Buttons

Name	Action
Profile Selection	Displays the Profile Selection dialog that allows you to select regions to profile and metrics to collect.
SubComplex Selection	Displays the Subcomplex Selection dialog that allows you to choose the subcomplex that your executable will run on.
Start	Runs the executable and initiates profile data collection.
Pause	Pauses the executable and profile data collection.
Continue	Continues a paused program and resumes profile data collection.

Abort	Terminates the program and stops profile data collection.
2D Profile	Click this button to display an option menu for displaying additional windows. The choices are 2D Profile, 3D Profile, Report, and Call Graph. The default is 2D Profile.

Context

The Executable Manager window appears when you start CXpa with the name of an executable file. If you do not specify any options, CXpa looks for the file named a.out in the current directory.

Related Windows

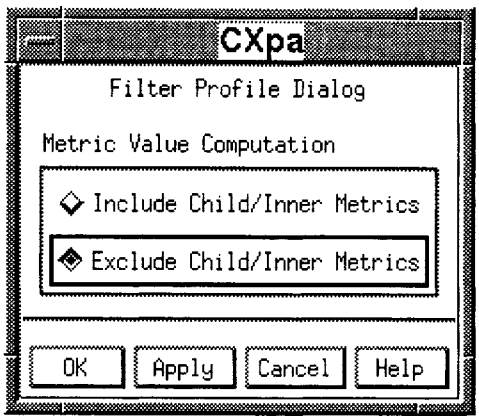
2D Profile window
Analysis Control window
Call Graph window
Info PDF dialog
Info Session dialog
Source Code window
Subcomplex Selection dialog
3D Profile window
Analysis Report window
Info Executable dialog
New PDF dialog
Profile Selection dialog
Source Search Path dialog

Related Topics

Analyzing PDFs only
Learning CXpa quickly
Introducing metrics
Introducing source code regions
Reports
Selecting metrics in X window mode
Selecting regions in X window mode
Setting the PDF

Executable Manager window

Filter Profile dialog



Description

The Filter Profile dialog contains toggle buttons for specifying whether metrics graphed in the 2D Profile and 3D Profile windows include values for called routines (child routines) and/or inner loops. By default, they are excluded (Exclude Child/Inner Metrics).

Buttons

Heading	Meaning
Metric Value Computation	
Include Child/Inner	For routines, include metrics for called routines (child routines) when computing values for the 2D and 3D Profile graphs. For loops, include metrics for inner loops when computing values.
Exclude Child/Inner	For routines, exclude metrics for called routines (child routines) when computing values for the 2D and 3D Profile graphs. For loops, exclude metrics for inner loops when computing values.

Buttons

Name	Action
OK	Accepts the new settings, closes the dialog, and updates the graphs displayed in 2D and 3D Profile windows.

Filter Profile dialog

Apply	Applies the new settings without closing the dialog, and updates the graphs displayed in 2D and 3D Profile windows.
Cancel	Closes this dialog without making any changes.
Help	Displays a help page for this dialog.

Context

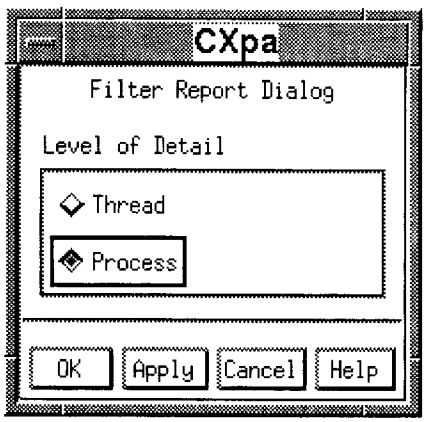
To open a Filter Profile dialog, select Filter Profile from the Options menu in the 2D Profile window or the 3D Profile window.

Related Windows

2D Profile window

3D Profile window

Filter Report dialog



Description

The Filter Report dialog contains toggle buttons for specifying whether information presented in CXpa reports is presented at the process level or the thread level. The default setting is Process.

Buttons

Name	Action
Level of Detail	
Thread	Sets the level of detail for information presented in performance analysis reports to include data for individual threads in all reports.
Process	Sets the level of detail for information presented in performance analysis reports to the process level. Performance data is summed across all threads of the process (except in parallel region reports).
OK	Accepts the new settings and closes the dialog. Updates the reports displayed in existing Report windows.
Apply	Applies the new settings without closing the dialog. Updates the reports displayed in the Analysis Report window.

Filter Report dialog

Cancel	Closes this dialog without making any changes.
Help	Displays a help page for this dialog.

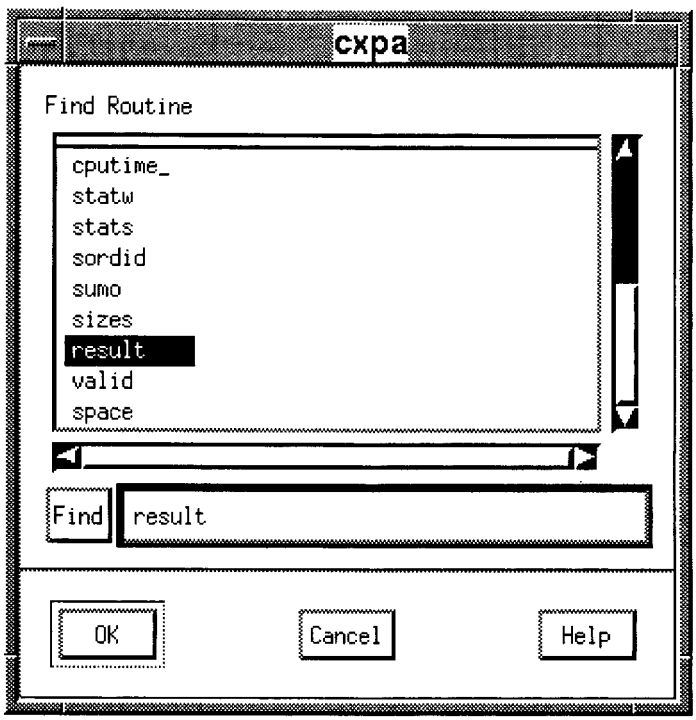
Context

To open a Filter Report dialog, select Filter Report from the Options menu in the Analysis Report window.

Related Windows

Analysis Report window
Save Report dialog
Region Subset Selection dialog

Find Routine dialog



Description

Use the Find Routine dialog to locate a routine and display it in the Call Graph window. When the Find Routine dialog is first opened, it displays a scrolling list of all profiled routines in your program.

To locate and display a routine:

1. Select the routine to display in the Call Graph window by clicking on its name in the list. The routine name is highlighted. You can select only one.

   If the program contains a large number of routines, you can specify a string in the Find field to search for, then press Find to locate the first routine name containing that string. CXpa scrolls the routine list so that the matching routine name is placed at the top of the list (or, if it is near the end of the list, it is visible in the list).

Press Find again to locate the next routine that contains the specified string and scroll the list so that it is placed at the top of the list, and so on. The search will wrap to the beginning of the list. Be sure to click on the routine name to select it after executing the search.

2. Press OK to close the dialog and display the routine in the Call Graph window.

   CXpa highlights the routine name in the Call Graph window and, if necessary, scrolls the window so that the currently selected routine is showing. If the selected routine is in a node that is currently collapsed, its node is expanded until the routine is displayed.

   The information associated with the selected routine is displayed in the Routine Detail dialog. If a Routine Detail dialog is not currently open, CXpa opens one.

Fields

Heading	Meaning
Find Routine	Contains a scrolled list of the profiled routines in your program. Left click with the mouse on a routine in the list to select it.

Buttons

Name	Action
Find	Searches the list of routine names for occurrences of the string specified in the text entry field opposite the Find button. If a match is found, the routine list scrolls so that the first matching routine name is placed at the top of the list (or, if it is near the end of the list, it is visible in the list). Press Find again to locate the next routine that contains the specified string and scroll the list so that it is placed at the top of the list, and so on. The search will wrap to the beginning of the list
OK	Highlights the routine name in the Call Graph window and, if necessary, scrolls the window so that the currently selected routine is showing. If a Routine Detail dialog is not currently open, CXpa opens one that displays information for the selected routine.
Cancel	Closes the dialog.
Help	Displays a help page for this dialog.

Find Routine dialog

Context

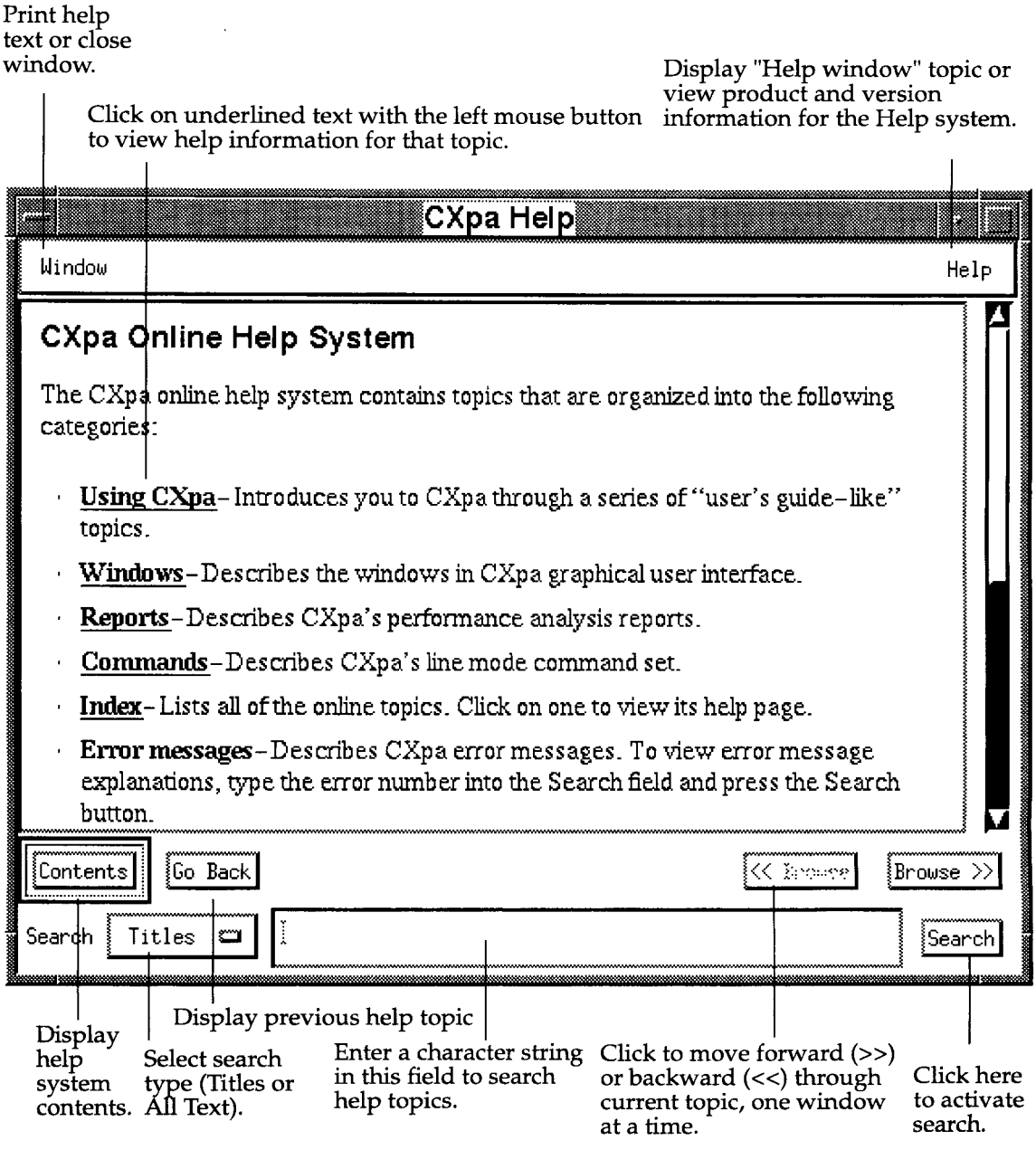
To open a Find Routine dialog, select Find Routine from the View menu in the Call Graph window.

Related Windows

Call Graph window
Thread Selection dialog
Routine Detail dialog

Find Routine dialog

Help window


Print help text or close window.
Click on underlined text with the left mouse button to view help information for that topic.
Display "Help window" topic or view product and version information for the Help system.
CXpa Help
Window
Help
CXpa Online Help System
The CXpa online help system contains topics that are organized into the following categories:
Using CXpa – Introduces you to CXpa through a series of "user's guide–like" topics.
Windows – Describes the windows in CXpa graphical user interface.
Reports – Describes CXpa's performance analysis reports.
Commands – Describes CXpa's line mode command set.
Index – Lists all of the online topics. Click on one to view its help page.
Error messages – Describes CXpa error messages. To view error message explanations, type the error number into the Search field and press the Search button.
Contents
Go Back
Browse >>
Search
Titles
Search
Display help system contents.
Select search type (Titles or All Text).
Display previous help topic
Enter a character string in this field to search help topics.
Click to move forward (>>) or backward (<<) through current topic, one window at a time.
Click here to activate search.

Help window

Description

Using the CXpa Help window, you can navigate the CXpa online Help system, print help text, search help topics (by title or full text), display instructions for using the Help system, and display version information for the help system.

To display online help for CXpa messages, enter the message number (for example, A35) in the Search string field.

Menus

Name	Items
Window	Contains the following items: **Print Text**—Pipes a formatted ASCII text version (without graphics) of the current help topic to the `lpr` command. The `lpr` command looks for the printer specified in your `PRINTER` environment variable. If this variable is not set, nothing is printed. **Close**—Closes the Help window.
Help	Contains the following items: **On Help**—Displays instructions for using the CXpa Help system. **On Version**—Displays a Product Information dialog that identifies the version of the CXpa Help system (Convex Interactive Documentation Toolkit) you are using.

Buttons

Name	Action
Contents	Displays a hyperlinked table of contents for the CXpa online help system.
Go Back	Displays the previous topic stored in the help history. The help history contains all the topics you viewed during the current session.
Browse >>	Lets you move forward through the current help topic, one window length at a time. This button is deactivated when you reach the end of a topic.
<< Browse	Lets you move backward through the current help topic, one window length at a time. This button is deactivated when you reach the beginning of a topic.

Search	Searches for the character string you entered in the Search field.
Titles/All Text	Lets you select whether to search only the topic titles or the full text of all topics.

Context

To open a Help window:

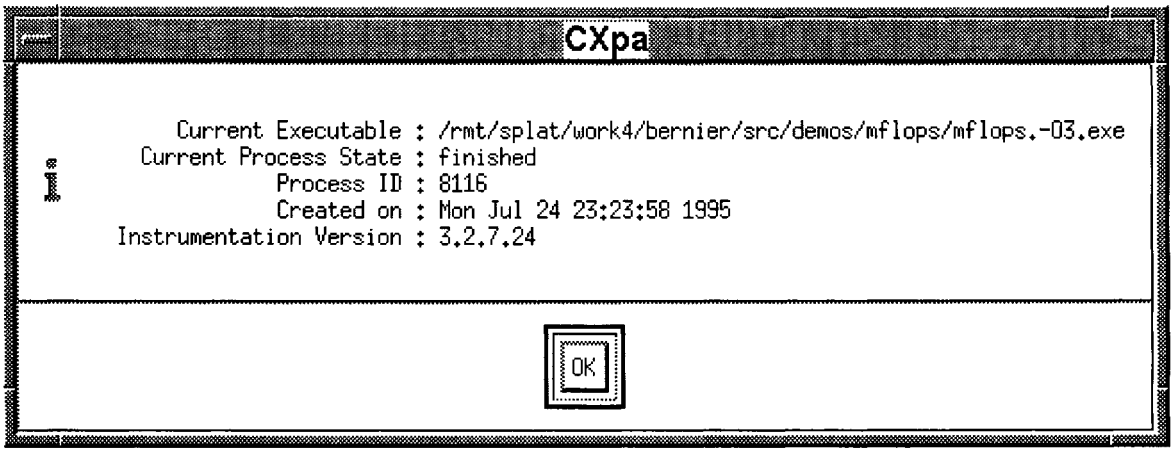
- Select Window Overview, CXpa Overview, Using Help, or Tutorial from the Help menu in the upper right corner of any CXpa window.
- Press the Help button on any CXpa dialog.
- Execute a `help` command from the command line at the `(CXdb)` prompt in the Command window.

Related Topics

Using online help

Help window

Info Executable dialog



Description

The Info Executable dialog displays information about the executable you are profiling.

Fields

Name	Meaning
Current Executable	Lists the executable that you are profiling.
Current Process State	Lists the current state of the process you are profiling. The states include `running`, `paused`, `terminated`, `exited`, and `finished`.
Process ID	List the process ID for the program you are profiling.
Created on	Lists the date that the executable was created.
Instrumentation Version	Lists the version of the CXpa profiling routines (cxpamon.o) linked into your program with a CXpa compiler option (`-cxpa`, `-cxpar`, `-cxpab`).

Info Executable dialog

Buttons

Name	Action
OK	Closes this dialog.

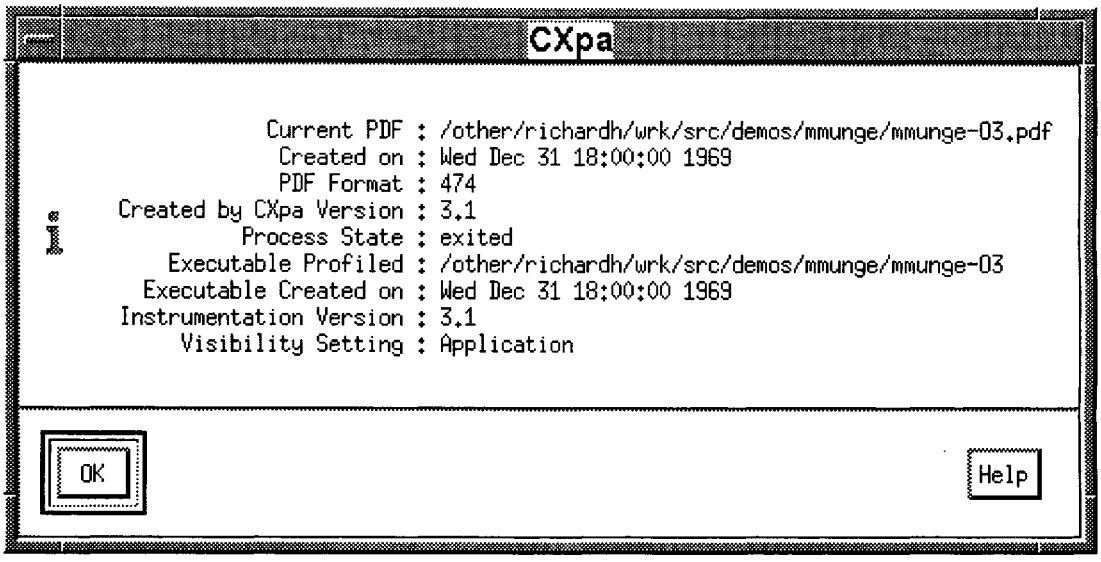
Context

To open the Info Executable dialog, select Executable from the Info menu in the Executable Manager window.

Related Windows

Executable Manager window
Info Session dialog
Info PDF dialog
New PDF dialog

Info PDF dialog



Description

The Info PDF dialog displays information on the currently selected performance data file (PDF).

Fields

Name	Meaning
Current PDF	Lists the name of the current performance data file (PDF).
Created on	Lists the date and time that the PDF was created.
PDF Format	Lists the format version number of the PDF.
Created by CXpa Version	Lists the version number of CXpa that created the PDF.
Process State	Lists the process state recorded in the PDF.
Executable Profiled	Lists the name of the executable you are profiling.
Executable Created on	Lists the date that the executable was created.

Info PDF dialog

Instrumentation Version	Lists the version of the CXpa profiling routines linked to the executable when the PDF was created.

Buttons

Name	Action
OK	Closes this dialog.

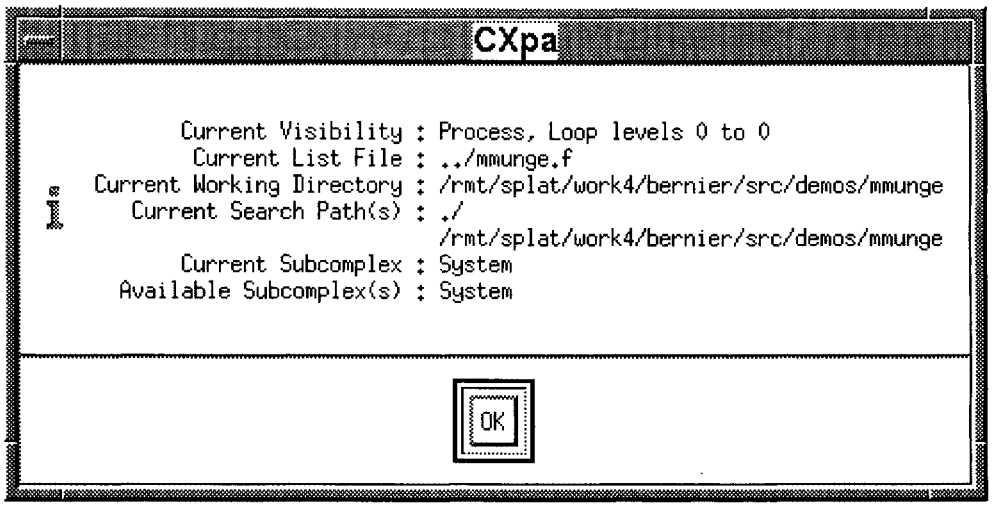
Context

To open the Info PDF dialog, select PDF from the Info menu in the Executable Manager or Analysis Control window.

Related Windows

Analysis Control window
Executable Manager window
Info Executable dialog
Info Session dialog
New PDF dialog

Info Session dialog



Description

The Info Session dialog displays information about your CXpa session.

Fields

Name	Meaning
Current Visibility	Lists current visibility settings—process or thread-level reporting and loop nesting levels.
Current List File	Lists the name of the file used when you display the Source Code window.
Current Working Directory	Lists the current directory.
Current Search Path(s)	Lists the directories CXpa uses to find source files to display in the Source Code window.
Current Subcomplex	Lists the name of the subcomplex that your process is set to run on.
Available Subcomplex(s)	Lists available subcomplexes on your system.

Info Session dialog

Buttons

Name	Action
OK	Closes this dialog.

Context

To open the Info Session dialog, select Session from the Info menu in the Executable Manager or Analysis Control window.

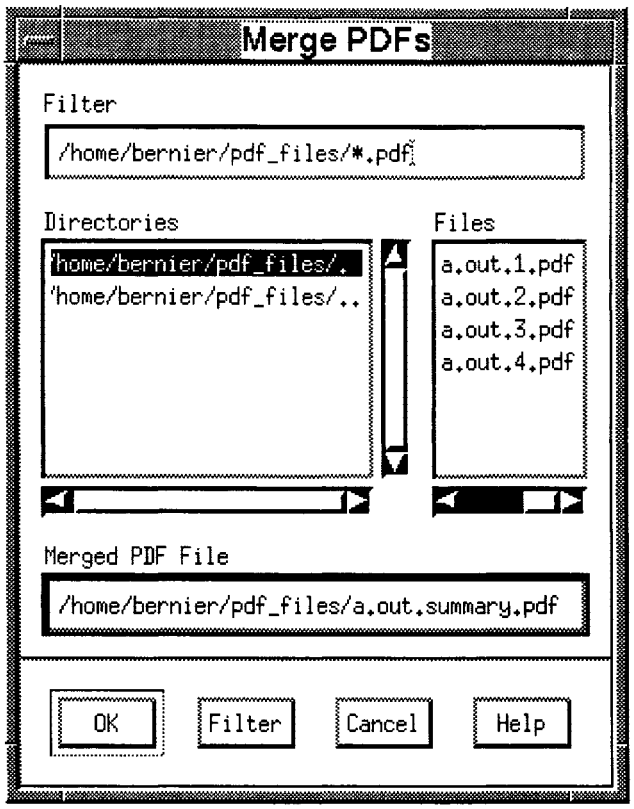
Related Windows

Analysis Control window
Executable Manager window
Info Executable dialog
Info PDF dialog
Profile Selection dialog
Subcomplex Selection dialog

Related Commands

`info` `set visibility`

Merge PDFs dialog



Description

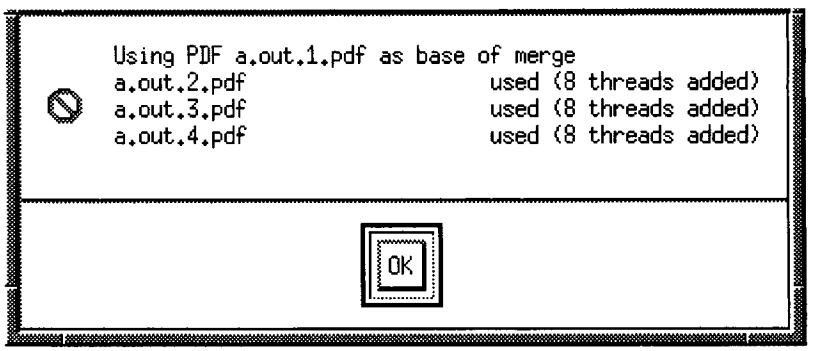
Use the Merge PDFs dialog to combine profiling data from multiple PDF files generated from the same executable into a single PDF file for analysis.

The PDF files to be merged must be generated from the same executable. In X window mode, CXpa uses the executable file associated with the first PDF file specified in the Open PDF list in the Analysis Control window. If an invalid PDF is encountered, an error message is displayed, and CXpa continues to merge the data from valid PDF files in the PDF list.

Merge PDFs dialog

When you select OK, CXpa merges all PDF files listed in the Open PDF list in the Analysis Control window into a single PDF file, using the file name specified in the Merged PDF file field, then closes the Merge PDFs dialog. If an invalid PDF is encountered, an error message is displayed, and CXpa continues to merge the data from valid PDF files.

When the merge is complete, CXpa displays a dialog that lists the name of the base PDF file associated with the new, merged PDF and the name of each PDF file merged. The base PDF file specifies the executable file associated with the merged PDF. For example:



The name of the new PDF file is displayed at the bottom of the list, is highlighted, and becomes the active PDF. To analyze the profiling data in the new PDF file, press one of the buttons at the bottom of the Analysis Control window (Create 2D Profile, Create 3D Profile, or Create Report).

Use the merge feature when analyzing CXpa profiling data generated from PVM (parallel virtual machine) applications.

Refer to the "Profiling message-passing applications with CXpa" section of this book for information about profiling PVM or MPI applications with CXpa.

Fields

Heading	Meaning
Filter	Displays a search pattern (usually a path and a search pattern containing wildcards) that is applied to the Files and Directories lists when you press the Filter button.
Directories	Lists all subdirectories in the directory specified in the Filter field. Click once on a directory name in this list to insert it into the path in the Filter field.

	Double-click on a directory name in this list to insert the directory name into the path in the Filter field, search for files that match the filter search pattern, and display them in the Files list.
Files	Lists all files and/or subdirectories in the directory that match the pattern in the Filter field. Click on the name of a file in this list to insert it into the PDF File field.
Merged PDF File	Contains the full path name of the PDF file that will contain the merged profiling data.

Buttons

Name	Action
OK	Merges the data from the files in the PDF list to the file specified in the PDF File field.
Filter	Searches the directory in the Filter field for files that match the filter search pattern and displays them in the Files list.
Cancel	Closes the dialog without creating a new PDF file.
Help	Displays a help page for this dialog.

Context

To open a Merge PDFs dialog, select Merge from the File menu in the Analysis Control window.

Related Concepts

Analyzing PDFs only
Performance data files (PDFs)
Profiling message-passing applications with CXpa
Using pre-instrumented executables

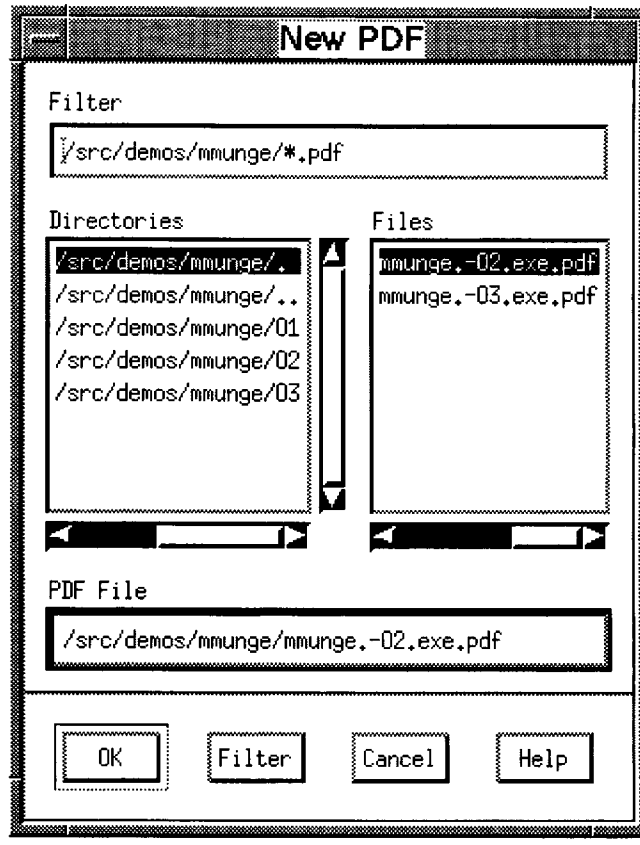
Related Windows

Analysis Control window Open PDF dialog

Related Commands

`merge`

New PDF dialog



Description

The New PDF dialog allows you to choose the name of the performance data file (PDF). A PDF is a file in which CXpa stores performance data for a single run of your program. CXpa uses the data in a PDF to create 2D and 3D Profile graphs and textual performance reports.

If you have invoked CXpa with the name of an executable file, when you run your program, CXpa overwrites all of the data in the PDF. If you do not want this to occur, you must change the name of the PDF between runs of your program using the New PDF dialog.

If the file you specify does not exist, CXpa creates it. If you do not set the PDF name, CXpa uses the default PDF name of *<executable>*.pdf, where *<executable>* is the name of the executable file for your program.

Selecting a new PDF file name

Use any of the following methods to specify or select a new PDF file name:

- Double-click on a file name in the Files list.
- Highlight a file in the Files list and press OK.
- Type the full path name to the file in the PDF Selection field and press OK or **RETURN**.

Fields

Heading	Meaning
Filter	Displays a search pattern (usually a path and a search pattern containing wildcards) that is applied to the Files and Directories lists when you press the Filter button.
Directories	Lists all subdirectories in the directory specified in the Filter field. Click once on a directory name in this list to insert it into the path in the Filter field. Double-click on a directory name in this list to insert the directory name into the path in the Filter field, search for files that match the filter search pattern, and display them in the Files list.
Files	Lists all files and/or subdirectories in the directory that match the pattern in the Filter field. Click on the name of a file in this list to insert it into the PDF File field.
PDF File	Contains the file name to use as the PDF. Collected profiling data is placed in this file.

Buttons

Name	Action
OK	Accepts the file name in the PDF selection field as the new PDF and closes the dialog.
Filter	Searches the directory in the Filter field for files that match the filter search pattern and displays them in the Files list.
Cancel	Closes this dialog without selecting a new PDF.

Help	Displays a help page for this dialog.

Context

To open a New PDF dialog, select New PDF from the File menu in the Executable Manager window.

Use the New PDF dialog when you do not want to use the default PDF name of <*executable*>.pdf.

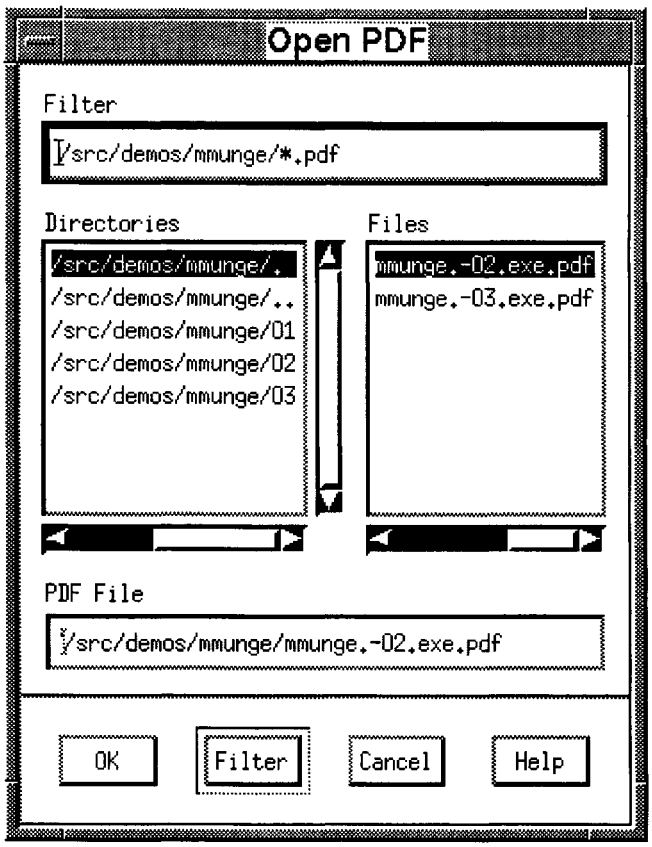
Related Windows

Analysis Control window
Executable Manager window
Filter Profile dialog
Merge PDFs dialog
Open PDF dialog

Related Topics

Analyzing PDFs only
Performance data files (PDFs)

Open PDF dialog



Description

The Open PDF dialog allows you to add a PDF (performance data file) to the PDF list in the Analysis Control window.

A PDF is a file that CXpa uses to store performance data for a single run of your program. CXpa uses the data in the PDF to calculate the performance information that appears when you display a performance report or a 2D or 3D profile graph.

You can select PDFs created in a previous CXpa session, including PDFs created on other architectures or PDFs created from different executables.

Selecting a file

You can select a PDF to open using any one of the following methods:

- Double-click on a file name in the Files list.
- Highlight a file in the Files list and press OK.
- Type the full path name to the file in the PDF File field and press OK or **RETURN**.

Fields

Heading	Meaning
Filter	Displays a search pattern (usually a path and a search pattern containing wildcards) that is applied to the Files and Directories lists when you press the Filter button.
Directories	Lists all subdirectories in the directory specified in the Filter field. Click once on a directory name in this list to insert it into the path in the Filter field. Double-click on a directory name in this list to insert the directory name into the path in the Filter field, search for files that match the filter search pattern, and display them in the Files list.
Files	Lists all files and/or subdirectories that match the search pattern in the Filter field. Click on the name of a file in this list to insert it into the PDF File field.
PDF file	Specifies the name of the PDF file to open.

Buttons

Name	Action
OK	Adds the file name in the PDF File field to the PDF list in the Analysis Control window.
Filter	Searches the directory in the Filter field for files that match the filter search pattern and displays them in the Files list.
Cancel	Closes this dialog without opening a new PDF file.
Help	Displays a help page for this dialog.

Context

To display the Open PDF dialog, select Open from the File menu in the Analysis Control window.

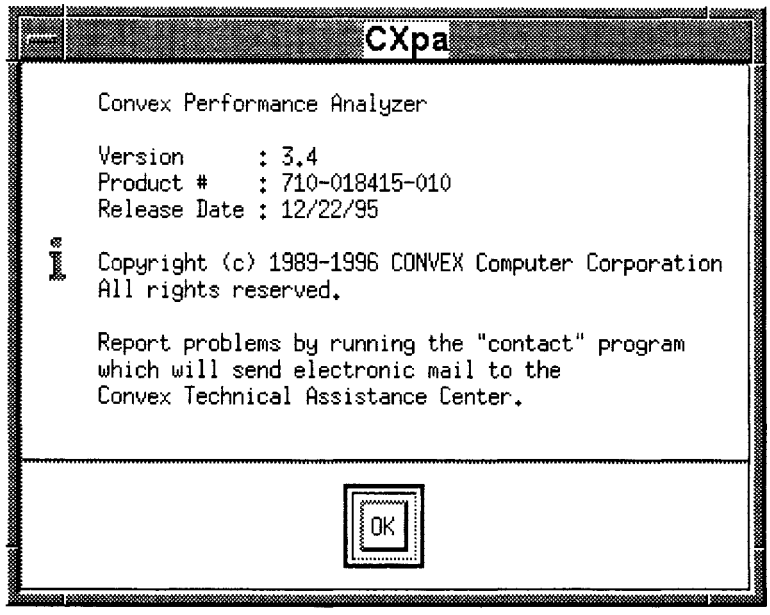
Related Windows

Analysis Control window
Filter Profile dialog
Info PDF dialog
Merge PDFs dialog
New PDF dialog

Related Topics

Analyzing PDFs only
Performance data files (PDFs)

Product Information dialog



Description

The Product Information dialog displays release information:

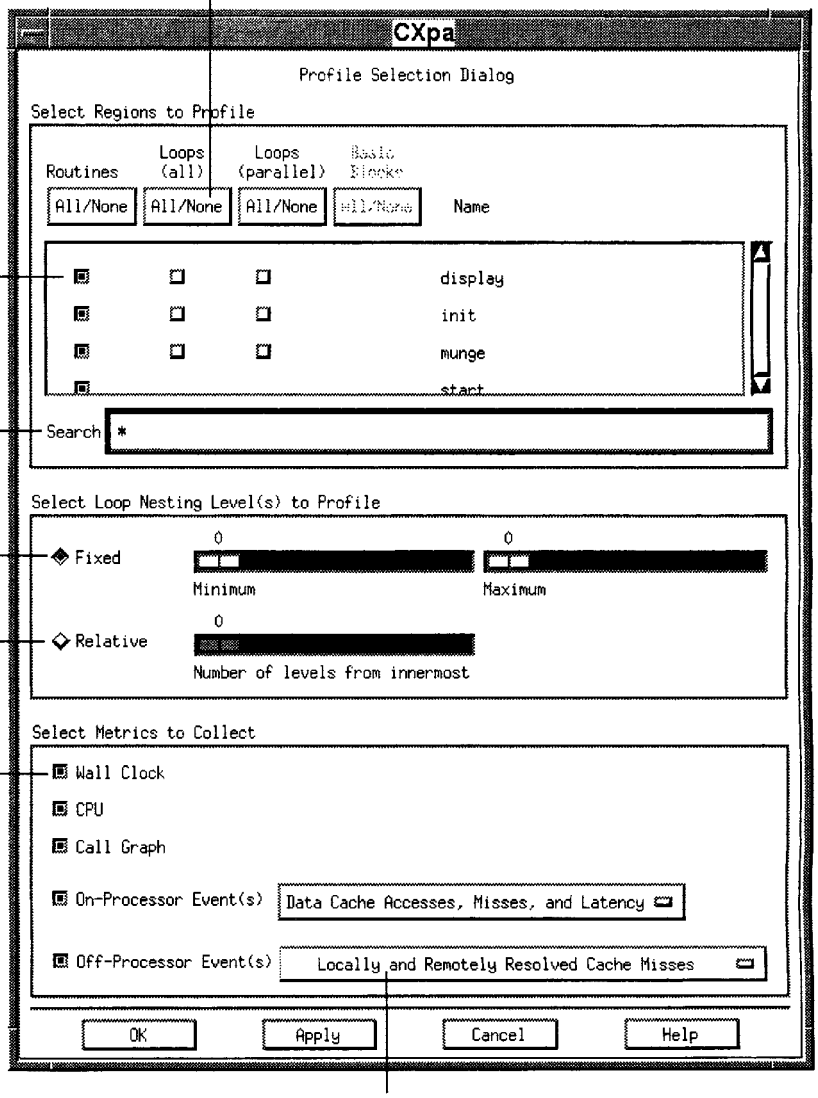
- CXpa's version number
- The release date of this version of CXpa
- The product number
- Copyright information
- Information about using the `contact` utility to report problems

Context

To open a Product Information dialog, select Product Information from the Help menu on any CXpa window.

Profile Selection dialog

Click All/None buttons to select or deselect all routines containing the corresponding source code region.



Click toggle buttons to select/deselect regions to profile in specific routines.

Enter a routine name to search for (you can use * or ? wildcards).

Specify a range of loop nesting levels to profile.

Specify the number of loop nesting levels from the innermost (deepest) nesting level to profile.

Click toggle buttons to select or deselect wall clock time, CPU time, call graph, and event(s) metrics for collection.

Click on event selection option menu(s) to select the type of events to collect for a single run of your program. These menus are enabled only when On-Processor or Off-Processor Event(s) are selected. Available events vary according to machine architecture.

Profile Selection dialog

Description

Use the Profile Selection dialog to select or deselect source code regions for profiling and to specify the types of metrics (including events) to collect for the these regions during profiling.

You do not have to recompile your program to select or deselect regions for profiling.

You can select/deselect different types of source code regions in all routines or limit region and metric selection to specific routines.

Guidelines for selecting regions and metrics for profiling

By using a top-down profiling strategy, you will minimize the number of regions and metrics selected for profiling during each run of your program. This will significantly reduce the amount of *profiling intrusion* and increase the accuracy of the results. Profiling intrusion refers to time delays that are introduced by the overhead of sampling hardware timers and storing profiling data while your program is running. This time is attributed to the region being profiled.

Region selection should proceed from coarse-grained (all routines) to fine-grained (loops or parallel loops in specific routines) as code regions that exhibit performance problems are identified. You should collect only the metrics you are interested in per program run (for example, do not enable event collection for a run unless you really need to examine cache performance or instruction metrics).

Refer to the "Profiling strategy" section of this book for more information about profiling intrusion, and a step-by-step strategy for profiling.

NOTE: Selecting all source code regions in all routines for profiling is not recommended, due to increased profiling time and the amount of profiling intrusion that may be incurred.

NOTE: Profiling time increases with the number of regions and metrics selected for profiling. In general, selecting loop regions at all nesting levels for profiling increases execution time more than selecting routine regions. This is because the number of sampled data points in the loop nest grows by a factor of 2 x the number of iterations with each level of nesting.

Selecting source code regions to profile

The upper panel of the Profile Selection dialog (Select Regions to Profile) is where you select the types of source code regions you want to profile and specify a set of routines that contain these regions to profile during a specific run of your program. You can specify either all routines or a subset of routines. The metrics you select will only be collected at these regions in the specified set of routines.

Depending on how you compiled your program, four different types of source code regions can be selected for profiling:

- Routines
- All loops (including parallel loops)
- Parallel loops only—parallel loops created by Convex compilers at optimization level `-O3`
- Basic blocks

NOTE: Only routine regions can be profiled for object files and archive libraries instrumented for profiling with the `cxoi` utility.

Only types of regions that actually appear in your program can be selected (for example, if none of the routines in your program contain loops that were parallelized by the compiler, parallel loop regions will not be selectable).

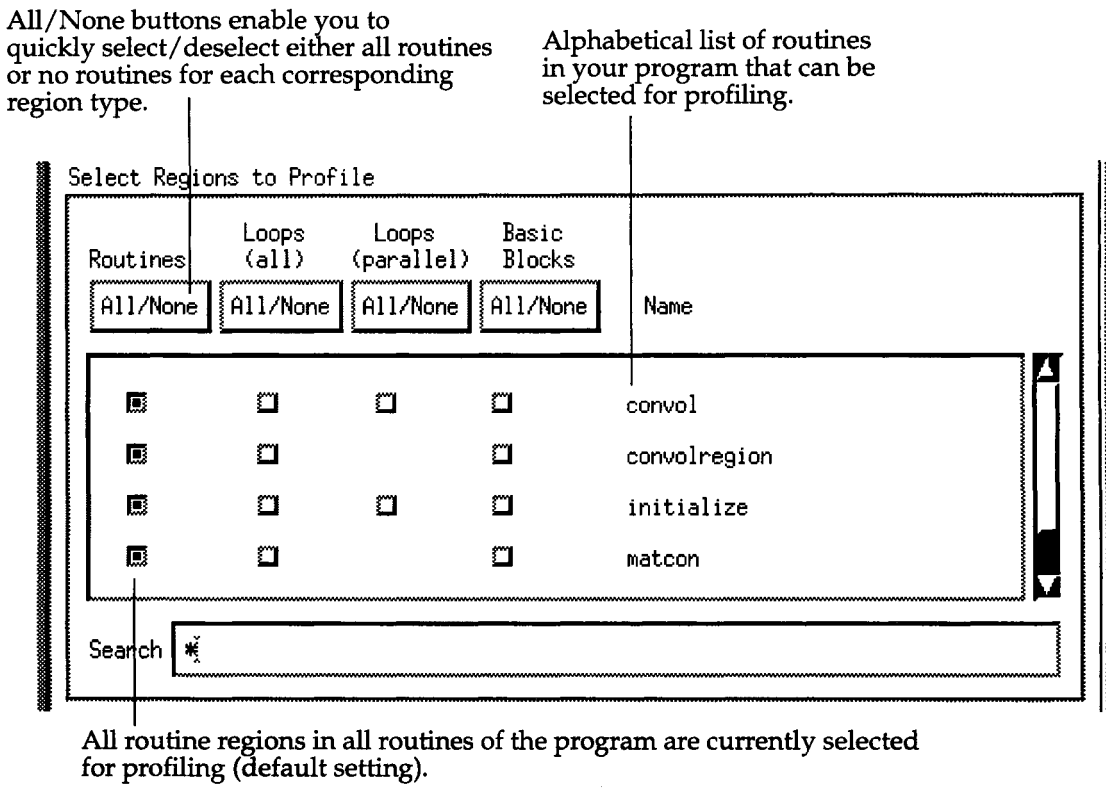
The routines in your program that can be selected for profiling are displayed in alphabetical order, and toggle buttons are displayed opposite each routine name. If a toggle button is not displayed for a particular region type for a routine, it means that no regions of that type can be profiled for that routine. For example, loop regions are not available for profiling unless the routine is compiled with a Convex compiler at optimization level `-O1` or greater with the `-cxpa` option.

If your program contains a large number of routines, you can:

- Use the scrollbar to move through the routine list.
- Type the name of a routine in the Search field, then press **RETURN** to scroll the routine list so that the desired routine is displayed at the top of the list.

Default setting—Selecting routine regions in all routines

The default region selection setting, which selects all available routine regions for profiling at the routine level, is shown in the following figure. This is the recommended setting for the first time you run your program under CXpa, and will identify the routines that take the longest to execute. Because no loop regions are selected for profiling, loop nesting level settings are ignored.

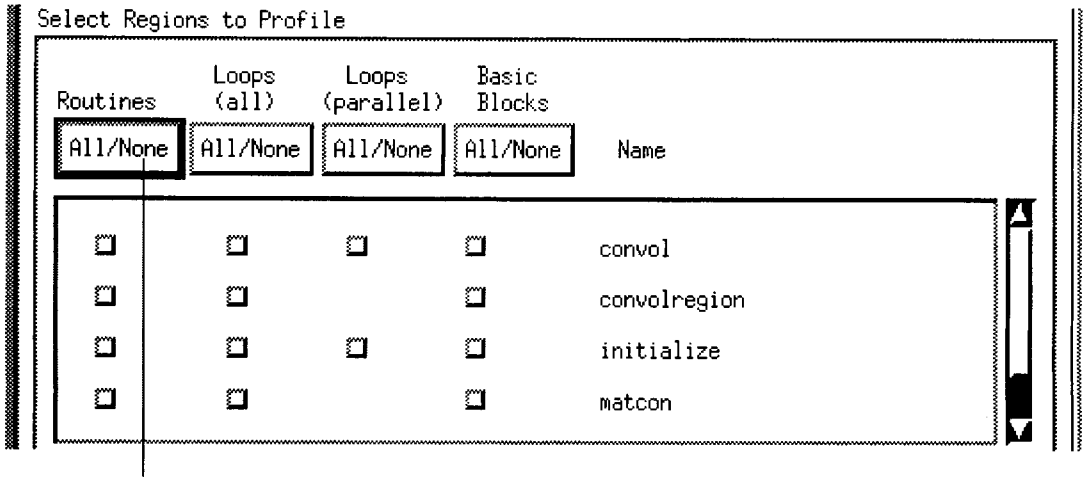


If you have changed the settings, but want to return the settings to this default, use the All/None buttons at the top of the region columns to select/deselect other types of source code regions so that routine regions are again selected for all routines.

Selecting source code regions in specific routines

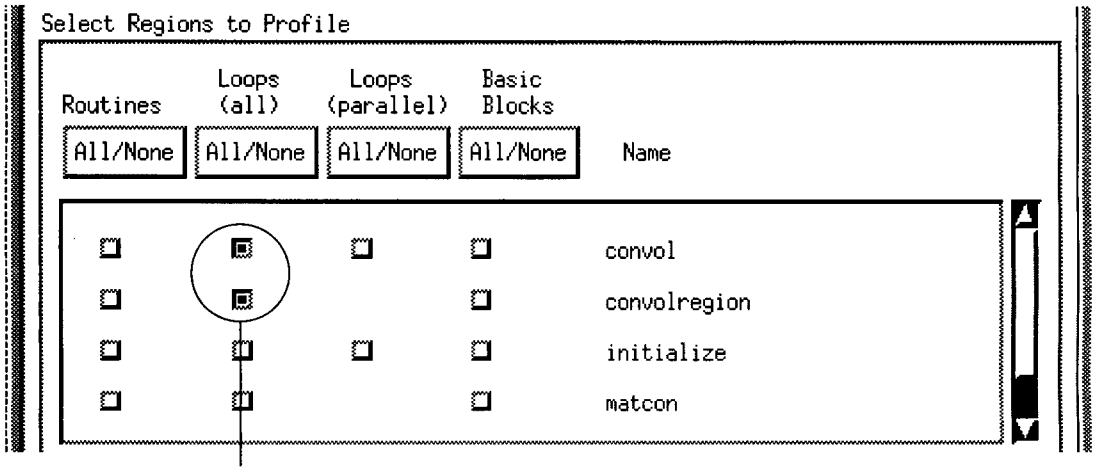
Once you have determined which routines take the longest time to execute, you will want to profile other source code regions (loops) within those routines to further isolate performance problems. To select regions in specific routines:

1. Click on the All/None buttons at the top of each region column to ensure that all regions and routines are deselected.



All source code regions in all routines are deselected for profiling.

2. Click the toggle button corresponding to the desired region type opposite the routine you want to profile. The following example figure shows all loops are selected for profiling in routines `convol` and `convolregion` only:



All loops at the currently selected loop nesting level in routines `convol` and `convolregion` only are selected for profiling.

Do not select all available source code regions for every routine (that is, do not, select every toggle button). The amount of profiling intrusion introduced can produce invalid results.

If you selected loop regions for profiling (as in the above example), the current loop nesting level setting applies to all loops. If no loops in a routine fall within the specified loop nesting level range, then no loops in that routine are selected for profiling.

The loop nesting level setting is displayed in the Select Loop Nesting Level(s) to Profile panel in the Profile Selection dialog. Refer to the next section for information about selecting loop nesting levels.

Selecting loop nesting levels

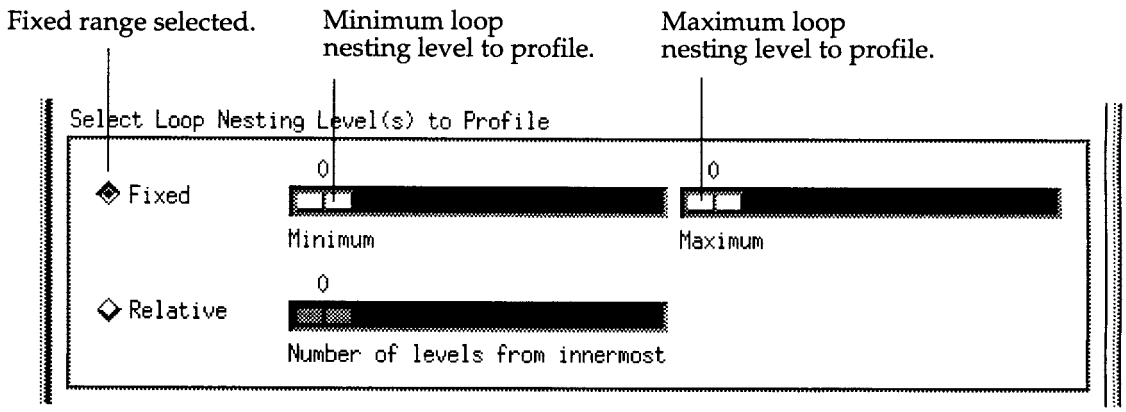
If you have chosen to profile loop regions, you can optionally specify either a fixed range of loop nesting levels to profile or the number of loop nesting levels to profile relative to each loop nest's innermost level.

The loop nesting level setting applies to all loops selected for profiling and is only active when loop regions are selected for profiling.

CXpa determines the number of loop nesting levels in your program and sets the maximum loop nesting levels and the maximum number of levels from the innermost loop appropriately. These nesting levels correspond to the loops that are created by the compiler, and may not correspond directly to your original source code due to optimizations performed.

Default loop nesting level range settings

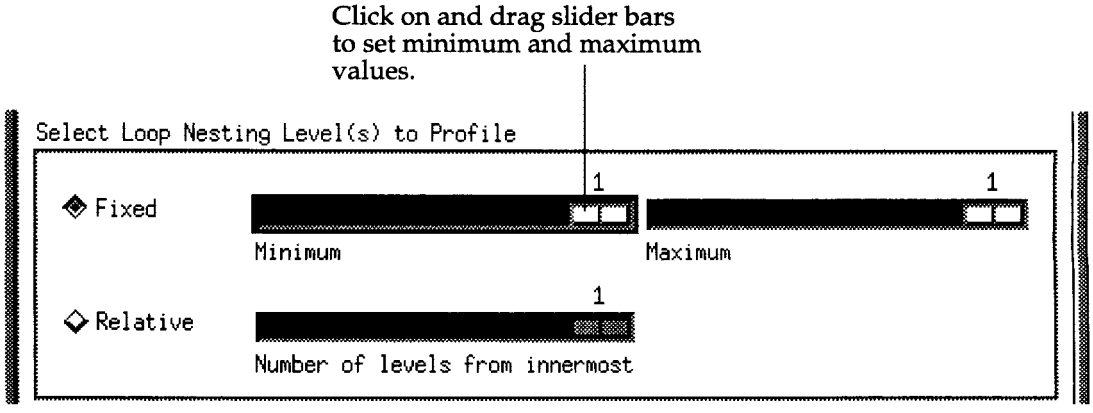
The first time you profile loop regions in your program, use the default setting for loop nesting levels (shown in the following figure). The default setting specifies a fixed loop nesting level range with a minimum of 0 and a maximum of 0 (after optimization). This means that all loops with a nesting level of 0 after optimization (outermost loops) are selected for profiling. This will minimize profiling intrusion.



Loop nesting level range default settings—Selects all loops at nesting level 0 only (outermost loops) for profiling.

Specifying a fixed loop nesting level range

On subsequent runs of your program, you can select different sections or "slices" of the loops within your program for profiling. When specifying a fixed ranged of loop nesting levels, you will generally want to set the minimum loop nesting loop level equal to the maximum loop nesting level, as shown in the following example:



Sample loop nesting level range with minimum and maximum nesting levels set to 1 selects only loops at nesting level 1 (after optimization) for profiling.

Specifying the number of relative loop nesting levels

Instead of choosing a fixed range of loop nesting levels for profiling, you can specify the number of loop nesting levels to profile relative to the innermost loop of each loop nest in your program.

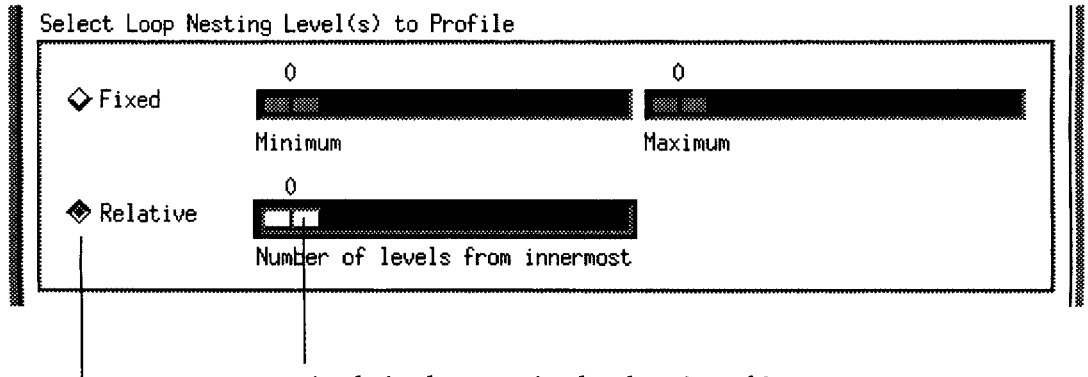
- A relative setting of 0 means that only the loops at the innermost (deepest) level of each loop nest are selected for profiling.
- A relative setting of 1 means that only the loops at the two innermost nesting levels of each loop nest are selected for profiling.

  For example, if the innermost nesting level of a loop nest is 4, the loops at nesting levels 3 and 4 of that loop nest will be selected for profiling.
- A maximum setting (setting the slider bar as far to the right as it will go) is equivalent to selecting all loops at all loop nesting levels.

When a relative loop nesting level is specified, loops that are not part of a loop nest are also selected for profiling.

To specify a relative setting for loop nesting levels:

1. Click the Relative toggle button in the Select Loop Nesting Level(s) to Profile panel.
2. Click and drag the slider bars to select the number of loop nesting levels to profile relative to the innermost loops in your program, as shown in the following figure:



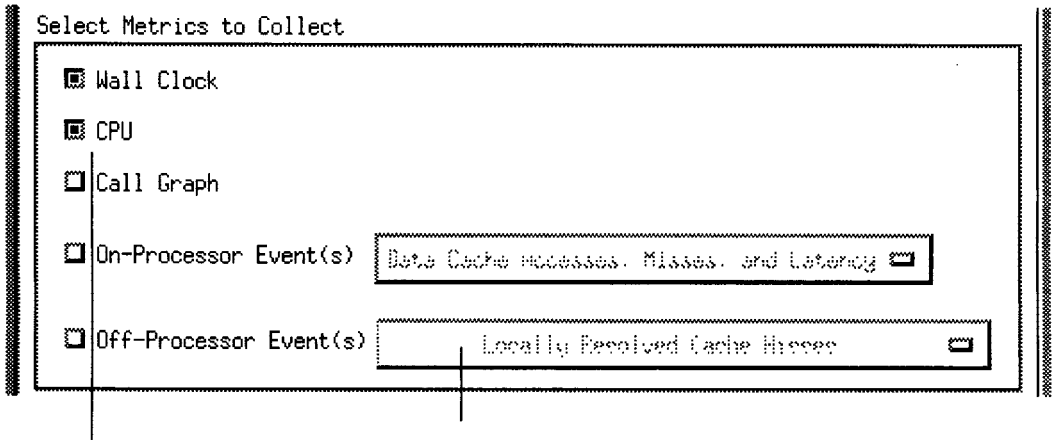
Selecting metrics to collect

Once you have specified the regions to profile, you can specify the profiling metrics you want to collect at these regions by clicking the toggle buttons in the Select Metrics to Collect section of the Profile Selection dialog.

CXpa collects these metrics at the regions of your program that are selected for profiling. You can choose to collect:

- Wall clock time (default).
- CPU time (default).
- Call Graph (if you select Call Graph, make sure that all routine regions are selected for profiling).
- Events.

By default, wall clock time and CPU time metrics are selected for collection, as shown in the following figure:



By default, wall clock time and CPU time metrics are selected.

Event selection option menus are disabled when events are not selected for collection.

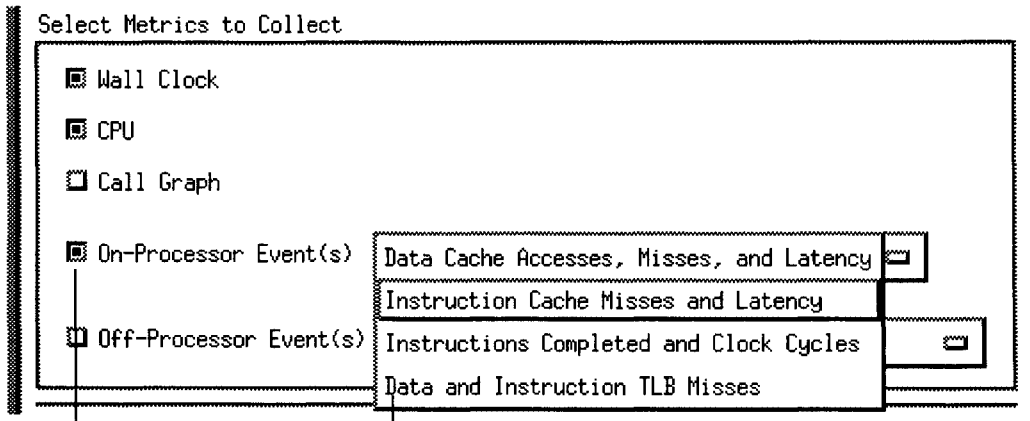
To specify the type of metrics to collect during profiling, perform the following steps:

1. Specify the metrics you want to collect by clicking the toggle buttons in the Select Metrics to Collect section of the Profile Selection dialog.

   If you choose to collect events, you must specify the type of event or events you want to collect as described below in step 2. Otherwise, continue with step 3.

2. If you have chosen On-Processor or Off-Processor Event(s) as one of the metrics in the Select Metrics to Collect section of the Profile Selection dialog, the Event(s) option menus are now available for you to select an event type or types.

   Click and hold down the left mouse button on the Event(s) option menu to display a list of available event types (shown in the following figure). While holding down the left mouse button, position the mouse cursor over the desired event type, and then release the mouse button.



Event collection is enabled.

Events(s) option menu now displays a list of hardware events that can be collected on your system. These vary according to machine architecture.

The number and type of events you can select vary according to machine architecture:

- Refer to the "Introducing metrics" online help topic or section in this book for a discussion of available event metrics for SPP1000, SPP1200, and SPP1600 Series systems.
- Refer to the "Selecting Metrics in X window mode" online help topic or section in this book for more information about selecting events.

Click on the following hyperlinks for a discussion of available event metrics for SPP Series systems or for information about selecting events.

3. Press OK to apply the changes and close the Profile Selection dialog or press Apply to apply the changes without closing the dialog.

Select Regions panel

Allows you to select the types of source code regions you want to profile and specify a set of routines that contain these regions to profile during a specific run of your program.

Label	Meaning
Routines	Selects routine regions in specified routines for profiling.
Loops (all)	Selecs all loop regions (including parallel loops) in specified routines for profiling.
Loops (parallel only)	Selects only parallel loops in specified routines. These are parallel loops created by Convex compilers at optimization level `-O3`.
Basic blocks	Selects basic blocks for profiling in specified routines.
All/None buttons	Selects/deselects all routines in your program that contain the indicated type of source code region (routines, all loops, parallel loops only, or basic blocks).
Name	Lists names of routines in your program that contain regions that can be selected for profiling. These are listed in alphabetical order.
Search	Allows you to search for a particular routine. Expressions with no wildcards will search for literal matches. Available wildcards include question marks (?) to match a single character and asterisks (*) to match multiple characters. When you press **RETURN**, CXpa executes the search, and, if a match is found, scrolls the list so that the first matching routine name is at the top.

Select Loop Nesting Level(s) panel

Allows you to specify either fixed range of loop nesting levels or a number of loop nesting levels relative to the innermost (deepest) loop in each nest. This setting applies to all loop nests in your program and is only active when loop regions are selected for profiling.

Fixed	Click and drag the slider bars for each field to specify a range of loop nesting levels to profile by setting maximum and minimum values.
Relative	Click and drag the slider bar to specify the number of loop nesting levels from the innermost loop to profile.

Select Metrics panel

Allows you to choose metrics to collect for the regions of your program selected for profiling.

Wall clock	Enable/disable collection of wall clock time.
CPU	Enable/disable collection of CPU time.
Call Graph	Enable/disable collection of dynamic call graph information. Make sure that all routines in your program are selected for profiling if this option is enabled.

On-Processor Event Counter(s) (SPP1200 and SPP1600 Series only)

Off-Processor Event Counter(s) (SPP1000 and SPP1600 Series only)

Displays an option menu where you can select the type of hardware event to collect. The number and types of events you can select differ among SPP1000, SPP 1200, and SPP1600 Series systems.

Refer to the "Introducing Metrics" and "Selecting metrics in X window mode" online help topics or sections in this book for descriptions of on-processor and off-processor hardware event metrics available on each architecture.

Buttons

Name	Action
OK	Applies any changes you have made and closes this dialog.
Apply	Applies any changes you have made without closing the dialog.
Cancel	Closes this dialog without making any changes.
Help	Displays a help page for this dialog.

Context

To open the Profile Selection dialog, press the Profile Selection button in the Executable Manager window.

Related Windows

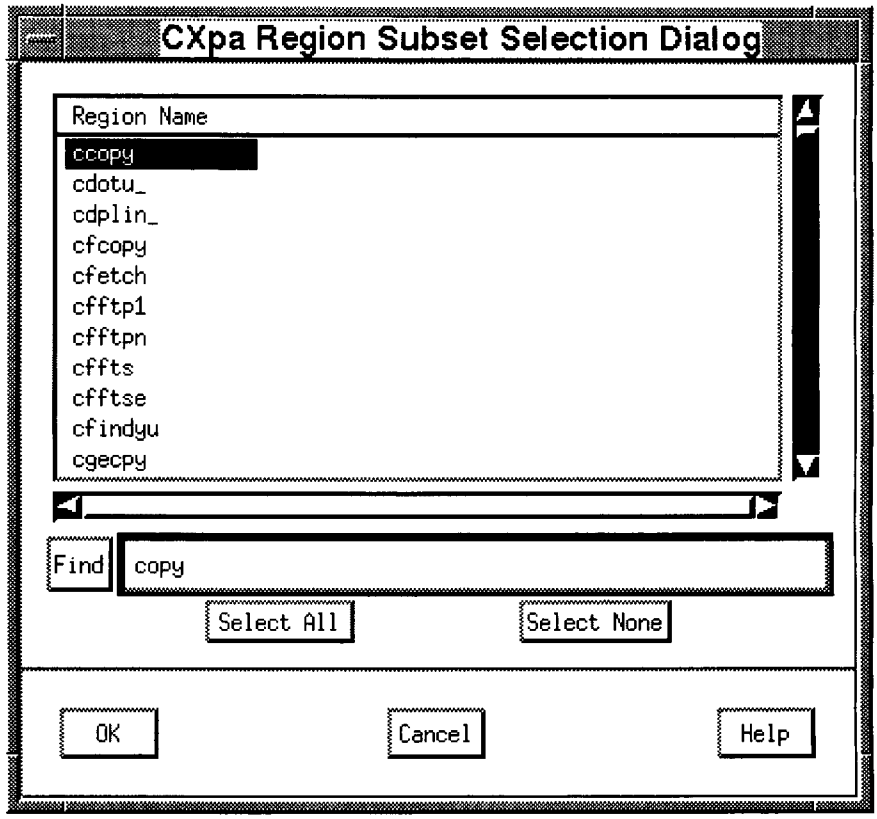
Analysis Report window

Executable Manager window

Related Topics

Introducing metrics
Introducing source code regions
Profiling strategy
Selecting metrics in X window mode
Selecting regions in X window mode
Using pre-instrumented executables

Region Subset Selection dialog



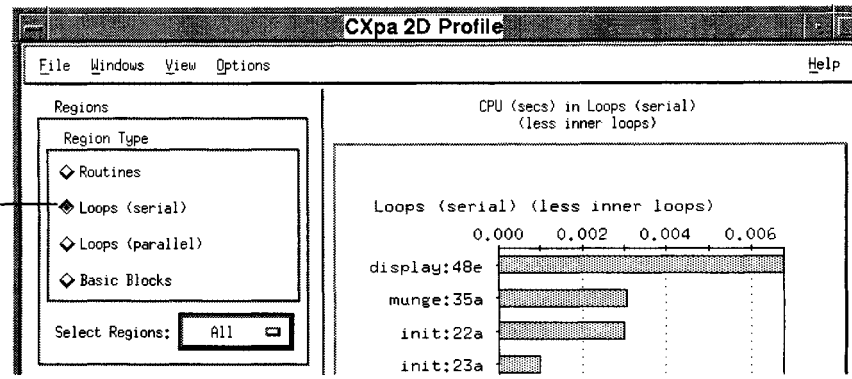
Description

The Region Subset Selection dialog allows you to create a customized report, 2D profile graph, or 3D profile graph by specifying a subset of routines that contain regions of the currently selected region type (routine, serial loop, parallel loop, or basic block) for analysis.

To create a customized profile graph or report:

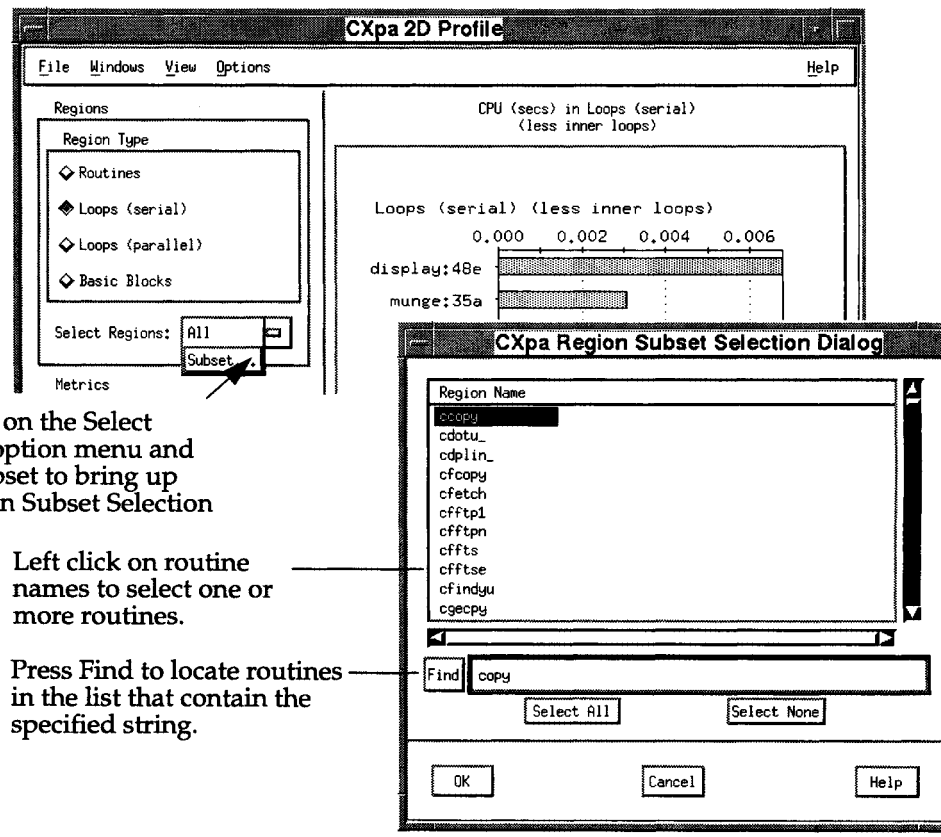
1. In the 2D Profile, 3D Profile, or Analysis Report window, make sure you have selected the region type for which you want to customize a profile. You can select only one.

Region Subset Selection dialog



Select a region type.

2. Select the Subset item from the Select Region options menu to bring up a Region Subset Selection dialog with a scrolled list of routines containing profiled regions of the selected region type.



Left click on the Select Regions option menu and select Subset to bring up the Region Subset Selection dialog.

Left click on routine names to select one or more routines.

Press Find to locate routines in the list that contain the specified string.

3. Select the routines that you want to include in the graph or report by clicking on them with the mouse. Selected routines are highlighted in reverse video. You can select multiple routines.

   If the program contains a large number of routines, you can specify a string in the Find field to search for, then press Find to locate the first routine name containing that string. CXpa scrolls the routine list so that the matching routine name is placed at the top of the list.

   Press Find again to locate the next routine that contains the specified string and scroll the list so that it is placed at the top of the list, and so on. The search will wrap to the beginning of the list. Be sure to click on routine names to select them after executing the search.

4. Press OK to display the new graph or report.

   If you press OK without selecting any routines, CXpa displays an Info dialog displaying the message "`INFO A70: No regions selected for a customized 2D or 3D profile.`" Close the Info dialog, then either select at least one routine or press Cancel to dismiss the Region Subset Selection dialog.

Fields

Heading	Meaning
Region name	Contains a scrolled list of routines in your program that contain regions of the currently selected type. Left click with the mouse on one or more routines in the list to select or deselect them for graphing or inclusion in text reports.

Buttons

Name	Action
Find	Searches the list of routine names for occurrences of the string specified in the text entry field opposite the Find button. If a match is found, the routine list scrolls so that the first matching routine name is placed at the top of the list (or, if it is near the end of the list, it is visible in the list). Press Find again to locate the next routine that contains the specified string and scroll the list so that it is placed at the top of the list, and so on. The search will wrap to the beginning of the list.
Select all	Selects all routines in the list. Selected routines are highlighted.
Select none	Deselects all routines in the list.

Region Subset Selection dialog

OK	Accepts the changes you have made, closes the dialog, and applies the changes to the graph.
Cancel	Does not apply any of the changes you have made and closes the dialog.
Help	Displays a help page for this dialog.

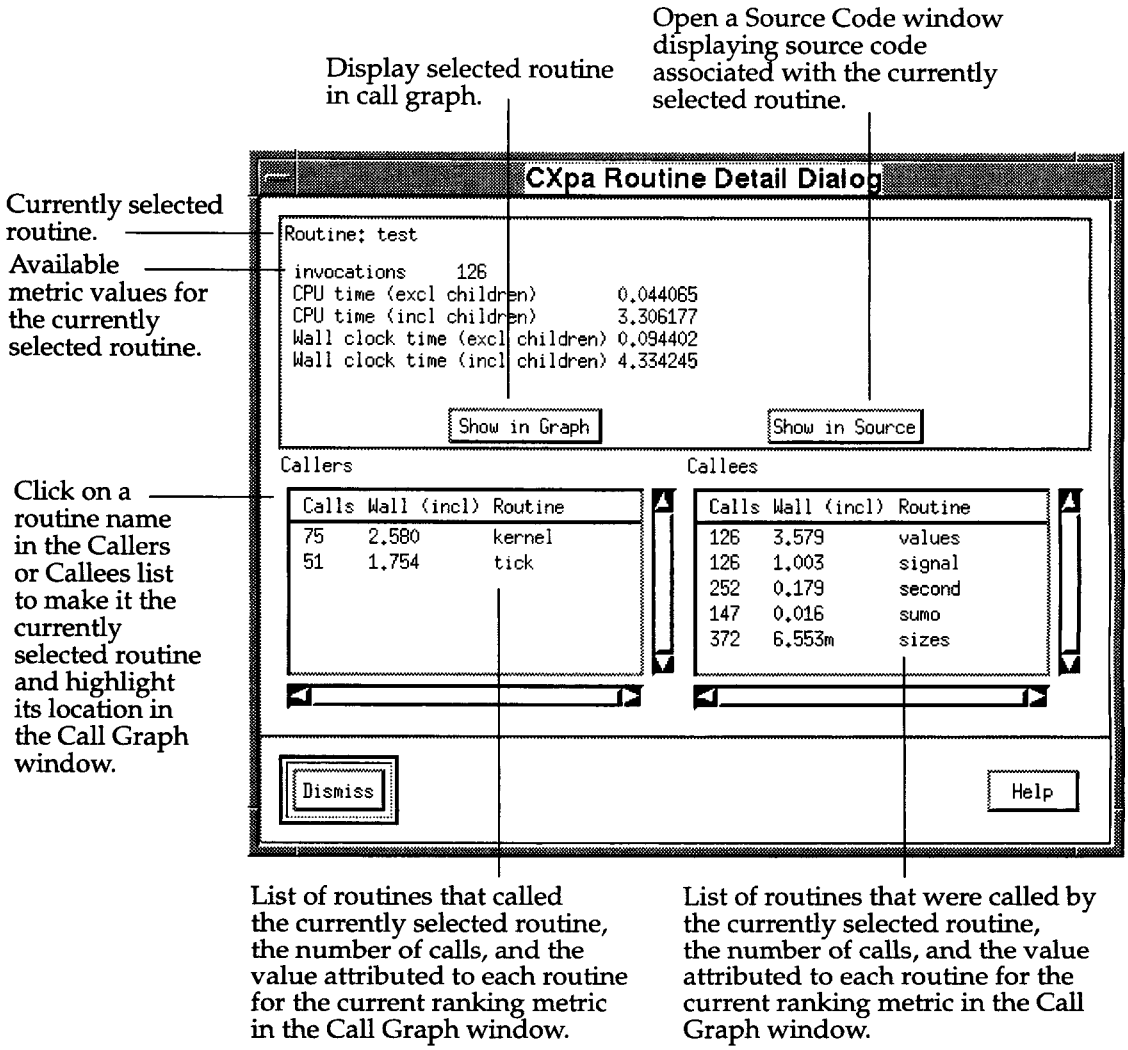
Context

To open a Region Subset Selection dialog, select Subset from the Select Regions option menu in the Regions panel in the 2D Profile, 3D Profile, or Analysis Report window.

Related Windows

2D Profile window
3D Profile window
Analysis Control window
Analysis Report window
Executable Manager window
Profile Selection dialog

Routine Detail dialog



Description

From the Routine Detail dialog you can:

- View inclusive and exclusive CPU time and wall clock time metrics collected for the routine currently selected in the Call Graph window.

- View a list of routines that were called by the currently selected routine (Callees).

  The list of callees is sorted by the value of the ranking metric that is currently selected in the Call Graph window; the routine that contributed the highest percentage of that metric to the total for the selected routine is listed first. Call counts and the value for the current ranking metric for each routine are also displayed.

- View a list of routines that called the currently selected routine (Callers).

  Call counts and the amount of the total value of the current ranking metric that is attributed to each calling routine are also displayed.

- Click on the name of any routine in the Callers or Callees list to make it the currently selected routine. Its location is highlighted in the Call Graph window, and the Routine Detail dialog updates to reflect the new selection.

  If the selected routine is in a collapsed node (one indicated by an asterisk (*) in the Call Graph window), the asterisk representing its node is highlighted. To expand the node so that the selected routine is showing in the Call Graph window, press the Show in Graph button.

- Press the Show in Source button to view source code associated with the routine currently selected in the Call Graph window.

Only one Routine Detail dialog is displayed per Call Graph window. As you select new routines to display by clicking on them in the Call Graph window or by using the Find Routine dialog, the display of information in the Routine Detail dialog updates to reflect the current choice.

Fields

Heading	Meaning
Routine	Displays the name of the currently selected routine, total number of invocations, and the available metric values for that routine.
Callers	Lists profiled routines in your program that called the currently selected routine (parent routines). The list is sorted by call counts. The number of calls and the value of the current ranking metric attributed to each routine are also displayed.

Callees	Lists profiled routines in your program that were called by the currently selected routine (child routines). The list of callees is sorted by the value of the ranking metric that is currently selected in the Call Graph window. The routine that contributed the highest percentage of that metric to the total is listed first. The number of calls and the value of the current ranking metric attributed to each routine is also displayed.

Buttons

Name	Action
Show in Graph	Highlights the routine in the Call Graph window and, if necessary, scrolls the window so that the currently selected routine is showing. If the selected routine is in a node that is currently collapsed, its node is expanded until the routine is displayed.
Show in Source	Opens a Source Code window displaying source code associated with the currently selected routine.
Dismiss	Close the dialog.
Help	Displays a help page for this dialog.

Context

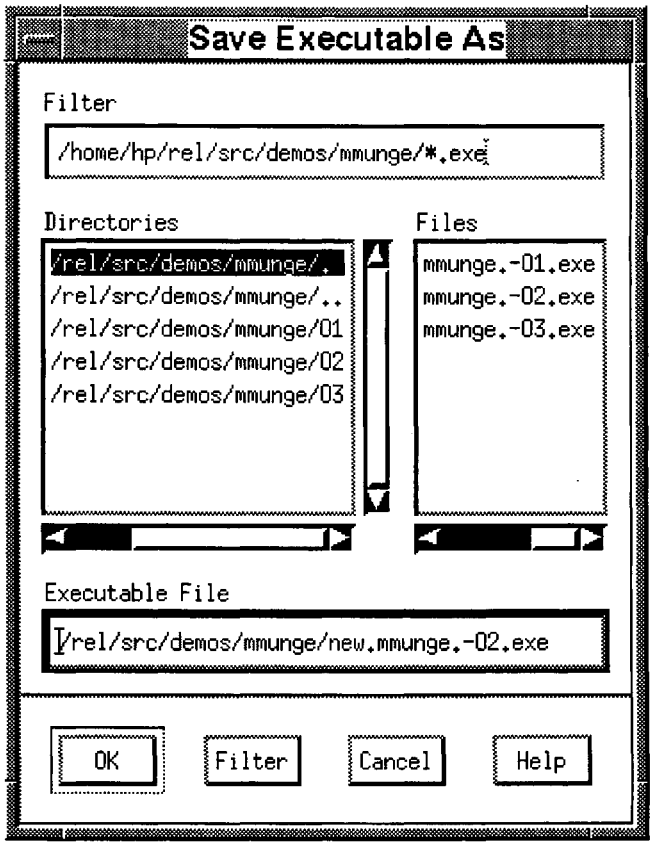
To open a Routine Detail dialog, click on the name of a routine in the Call Graph window.

Related Windows

Call Graph window
Find Routine dialog
Thread Selection dialog

Routine Detail dialog

Save Executable As dialog



Description

Use the Save Executable As dialog to save an executable file and its current profile selection settings (instrumentation) to a new executable file. This is referred to as *pre-instrumenting* an executable. Use pre-instrumented executables to:

- Profile with CXpa in environments that do not support CXpa's controlling a child process.
- Profile applications in conjunction with tools such as PVM (parallel virtual machine) that replicate processes or with applications where a driver program or script starts the process.

Refer to the "Profiling message-passing applications with CXpa" online help topic or section of this book for information about using pre-instrumented executables when profiling PVM applications with CXpa.

- Maintain separate copies of an executable with different regions and metrics selected for profiling. This makes it easier to generate multiple performance data files (PDFs) for comparison and analysis.
- Profile applications run with the `mpa` utility. Refer to the "CXpa and the `mpa` utility" online help topic or section of this book for more information.

The new executable file is an exact copy of the executable being profiled, except that it contains the current source code region and metric selections. All source code correlation is maintained. The size and permissions of the executable do not change, but the time stamp on the executable does.

You can then run the new executable file outside the control of CXpa and collect profiling data in a PDF file for later analysis. You can also profile the new executable in the usual way (that is, by invoking CXpa with the name of the executable and running it under CXpa).

Refer to the "Using pre-instrumented executables" online help topic or section of this book for information about using pre-instrumented executables.

Fields

Heading	Meaning
Filter	Displays a search pattern (usually a path and a search pattern containing wildcards) that is applied to the Files and Directories lists when you press the Filter button.
Directories	Lists all subdirectories in the directory specified in the Filter field. Click once on a directory name in this list to insert it into the path in the Filter field. Double-click on a directory name in this list to insert the directory name into the path in the Filter field, search for files that match the filter search pattern, and display them in the Files list.
Files	Lists all files and/or subdirectories in the that match the pattern in the Filter field. Click on the name of a file in this list to insert it into the Selection field.

Executable File	Contains the full path name of the file to save the current executable to.

Buttons

Name	Action
OK	Saves the executable file and its current profile selection settings (instrumentation) to the filename specified in the Executable File field.
Filter	Searches the directory in the Filter field for files that match the filter search pattern and displays them in the Files list.
Cancel	Closes the dialog without saving the executable.
Help	Displays a help page for this dialog.

Context

To open a Save Executable As dialog, select Save As from the File menu in the Executable Manager window.

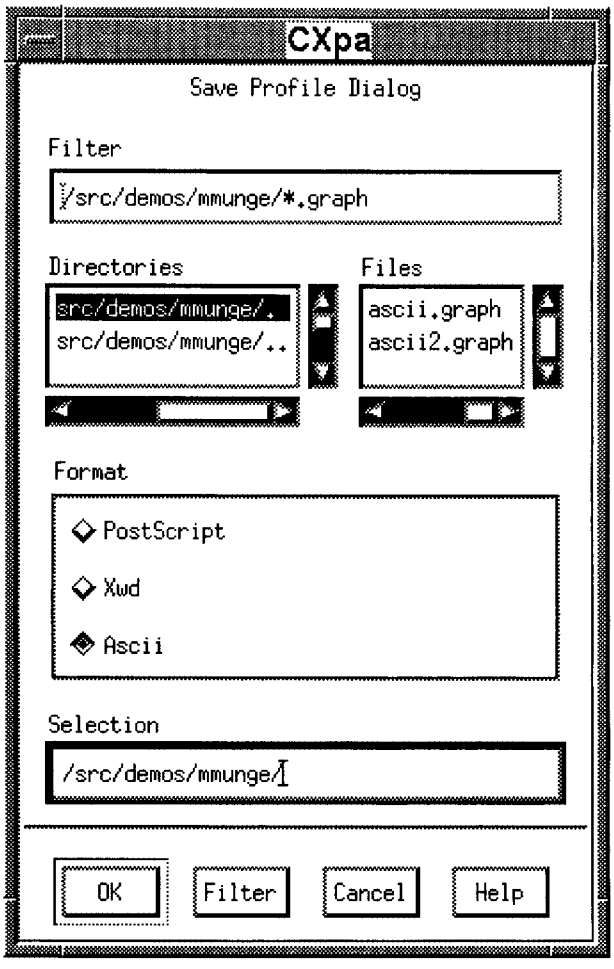
Related Concepts

CXpa and the `mpa` utility
Profiling message-passing applications with CXpa
Using pre-instrumented executables

Related Windows

Executable Manager window Profile Selection dialog

Save Profile dialog



Description

The Save Profile dialog allows you to save the graph in the 2D Profile or 3D Profile windows to a PostScript, ASCII, or xwd file. Only the area of the graph that is visible in the window is saved to the file. These files are immediately available for use by other utilities that accept these formats, as shown in the following table:

File format	Can be used with shell command	Can be imported to
PostScript	`lpr`	Document publishing or word processing applications
xwd	`xwud, xpr`	Document publishing or word processing applications
ASCII	`lpr`	Spreadsheet or graphic applications

Use one of the following methods to specify the name of a file to save 2D or 3D profile graphs to:

- Double-click on a file name in the Files list.
- Highlight a file name in the Files list and press OK.
- Type the full path name of the file in the Selection field and press OK or **RETURN**.

Fields

Heading	Meaning
Filter	Displays a search pattern (usually a path and a search pattern containing wildcards) that is applied to the Files and Directories lists when you press the Filter button.
Directories	Lists all subdirectories in the directory specified in the Filter field. Click once on a directory name in this list to insert it into the path in the Filter field. Double-click on a directory name in this list to insert the directory name into the path in the Filter field, search for files that match the filter search pattern, and display them in the Files list.
Files	Lists all files and/or subdirectories in the directory that match the pattern in the Filter field. Click on the name of a file in this list to insert it into the Selection field.

Format	Select a format type—ASCII, PostScript, or xwd.
Selection	Contains the file name to save the profile to.

Buttons

Name	Action
OK	Saves the profile graph in the selected format to the file specified in the Selection field.
Filter	Searches the directory in the Filter field for files that match the filter search pattern and displays them in the Files list.
Cancel	Closes this dialog without making any changes.
Help	Displays a help page for this dialog.

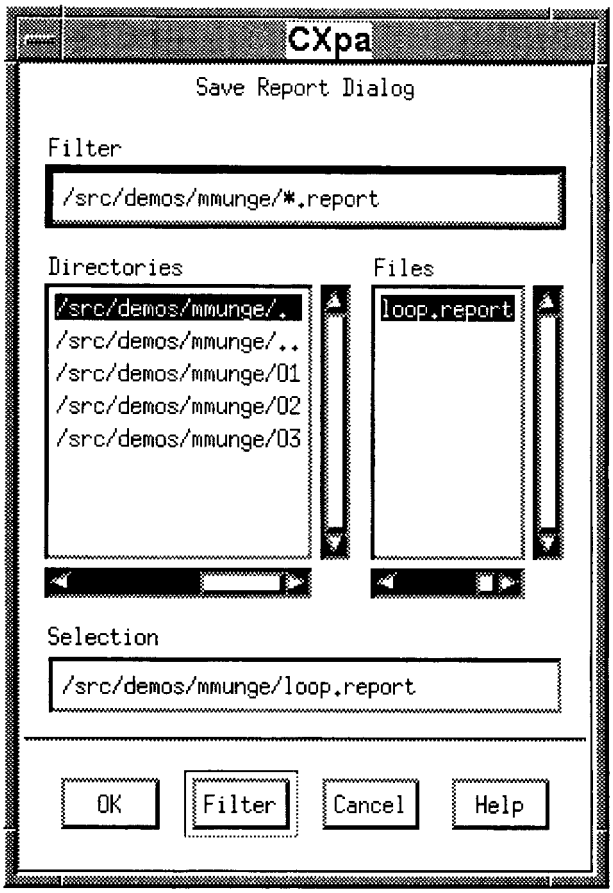
Context

To open a Save Profile dialog, select Save Profile from the File menu in the 2D Profile or 3D Profile windows.

Related Windows

2D Profile window
Filter Profile dialog
3D Profile window
Region Subset Selection dialog

Save Report dialog



Description

The Save Report dialog allows you to save the report in the Analysis Report window to an ASCII file. Use one of the following methods to specify the name of a file to save the report to:

- Double-click on a file name in the Files list.
- Highlight a file name in the Files list and press OK.
- Type the full path name of the file in the Selection field and press OK or **RETURN**.

Save Report dialog

Fields

Heading	Meaning
Filter	Displays a search pattern (usually a path and a search pattern containing wildcards) that is applied to the Files and Directories lists when you press the Filter button.
Directories	Lists all subdirectories in the directory specified in the Filter field. Click once on a directory name in this list to insert it into the path in the Filter field. Double-click on a directory name in this list to insert the directory name into the path in the Filter field, search for files that match the filter search pattern, and display them in the Files list.
Files	Lists all files and/or subdirectories in the directory that match the pattern in the Filter field. Click on the name of a file in this list to insert it into the Selection field.
Selection	Contains the file name to save the report to.

Buttons

Name	Action
OK	Saves the report to the file specified in the Selection field.
Filter	Searches the directory in the Filter field for files that match the filter search pattern and displays them in the Files list.
Cancel	Closes this dialog without making any changes.
Help	Displays a help page for this dialog.

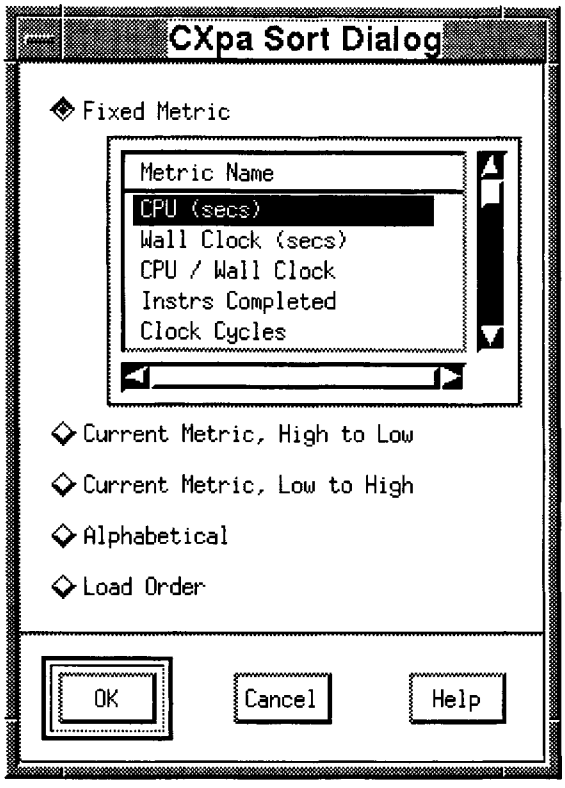
Context

To open a Save Report dialog, select Save Report from the File menu in the Analysis Report window.

Related Windows

Analysis Report window
Filter Report dialog
Region Subset Selection dialog

Sort dialog



Description

The Sort dialog allows you to sort the regions in the 2D and 3D profile graphs using one of the following methods:

- **Fixed metric**—When you select Fixed Metric as the sort order, the regions in the associated 2D or 3D Profile window are always sorted from highest to lowest, by the value for the metric you choose from the Metric Name list. The list contains the metrics collected for the run of the program that generated the current PDF file.

  As different metrics are selected for graphing in the corresponding 2D or 3D Profile window, the sort order of the regions displayed on the Regions axis remains constant and is based on the value of the fixed metric, from highest to lowest.

- **Current Metric, High to Low**—Sorts regions by the data values for the metric currently selected in the corresponding 2D or 3D Profile window, from highest to lowest. This is the default.
- **Current Metric, Low to High**—Sorts regions by the data values for the metric currently selected in the corresponding 2D or 3D Profile window, from lowest to highest.
- **Alphabetical**—Sorts regions alphabetically, by routine name.
- **Load Order**—Sorts regions in the order that the routines containing them were given to the link editor.

Order

Lists the sorting choices.

Fixed metric	Sorts regions in the associated 2D or 3D Profile graph from highest to lowest, by the data values for the metric that is selected from the Metric Name list.
Current metric, High to Low	Sorts regions in the associated 2D or 3D Profile graph from highest to lowest, by the data values for the currently selected metric in the 2D or 3D Profile window.
Current metric, Low to High	Sorts the regions in the associated 2D or 3D profile graph from lowest to highest, by the data values for the currently selected metric in the 2D or 3D Profile window. This is the default.
Alphabetical	Sorts the regions in the associated 2D or 3D profile graph alphabetically, by routine name.
Load order	Sorts the regions in the associated 2D or 3D profile graph in the order that the routines containing them were given to the link editor.

Buttons

Name	Action
OK	Sorts the regions in the graph in the chosen order and closes this dialog.
Apply	Sorts the regions in the graph in the chosen order without closing the dialog.

Cancel	Closes this dialog without making any changes.
Help	Displays a help page for this dialog.

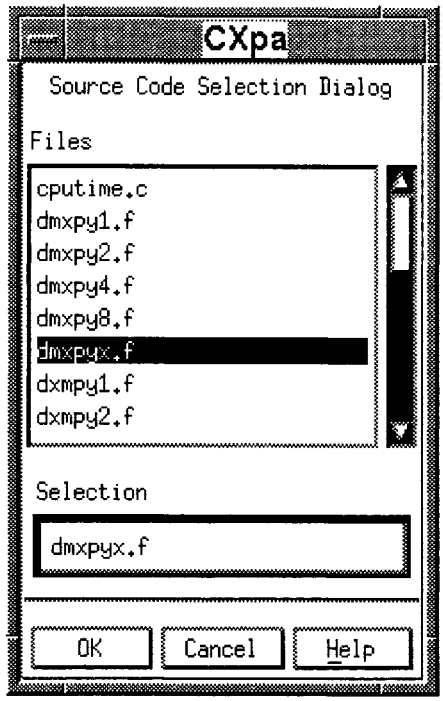
Context

To open a Sort dialog, select Sort from the View menu in the 2D or 3D Profile windows.

Related Windows

2D Profile window
3D Profile window
Region Subset Selection dialog
Zoom dialog

Source Code Selection dialog



Description

The Source Code Selection dialog allows you to select a different source file to display in the Source Code window.

Use the following procedure to change the source file displayed in the Source Code window:

1. Click on the name of the source file that you want to display. The selected file name is highlighted and displayed in the Selection field.
2. Select OK. The dialog closes, and the new source file is displayed in the Source Code window.

If CXpa cannot find the source file, change the search path by selecting Source Search Path from the Options menu to open a Source Search Path dialog.

Source Code Selection dialog

NOTE: You cannot enter a full path name in the Selection field. To change paths:

1. **Add the desired directory path in the Source Search Path dialog and click the OK button.**
2. **Type the file name in the selection field of the Source Code Selection dialog.**

Fields

Heading	Meaning
Files	Lists all the source files used to create the executable file.
Selection	Lists the file selected for display in the Source Code window.

Buttons

Name	Action
OK	Accepts the file name in the selection field as the new source file to display and closes this dialog.
Cancel	Closes this dialog without making any changes.
Help	Displays a help page for this dialog.

Context

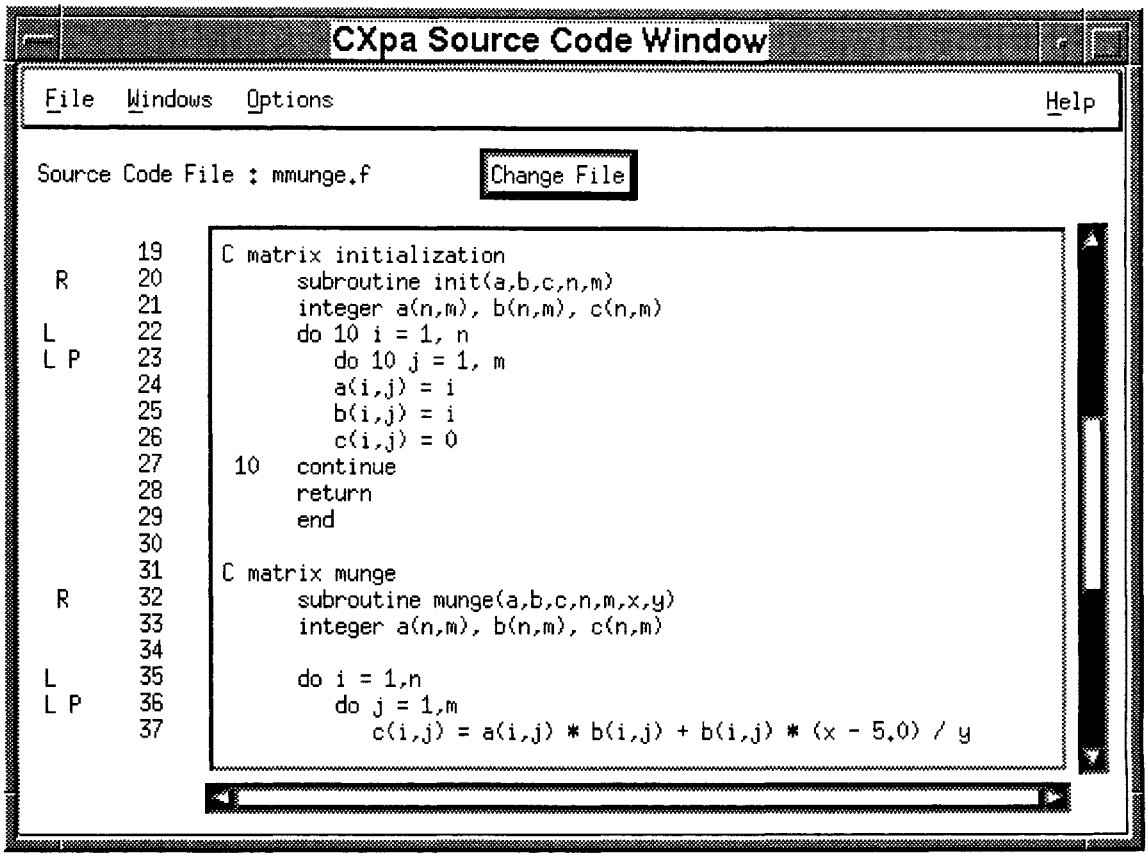
To open a Source Code Selection dialog, press the Change File button on the Source Code window.

Related Windows

Source Search Path dialog

Source Code window

Source Code window



Description

The Source Code window displays the source code for your program. By default, the Source Code window displays the file that contains your main routine. You can open multiple Source Code windows displaying different files in your program or use the Change File button to display a different source file in the current window.

Source Code window

Annotations

To the left of the line numbers, CXpa displays annotations that identify source code regions that can be profiled. Uppercase letters indicate source code regions currently selected for profiling. Lowercase letters indicate source code regions that are not selected for profiling.

- `R, r`—Indicates routine regions.
- `L, l`—Indicates loop regions.
- `P, p`—Indicates parallel loop regions.
- `B, b`—Indicates basic block regions.

The `=>` symbol to the right of a line number indicates the beginning of a section of code that corresponds to a bar in the 2D Profile or 3D Profile window that you clicked to display source code.

Changing source files

Use the following procedure to select a different source file to display:

1. Press the Change File button. The Source Code Selection dialog opens.
2. Click on the name of the source file that you want to display. The selected file name is highlighted and displayed in the Selection field.
3. Select OK. The dialog closes, and the new source file appears in the Source Code window.

   If CXpa cannot find the source file, change the search path by selecting Search Path from the Options menu to open a Source Search Path dialog.

Menus

Name	Meaning
File	Contains an item to close the window.
Windows	Contains items for opening additional CXpa windows that display 2D and 3D profile graphs, call graphs, performance reports, or source files.
Options	Contains an item for changing the search path CXpa uses to locate source code files (Source Search Path).
Help	Contains items for invoking the online help system.

Buttons

Name	Meaning
Change File	Displays a Source Code Selection dialog where you can choose another source file to display in the Source Code window.

Context

Use one of the following methods to open a Source Code window:

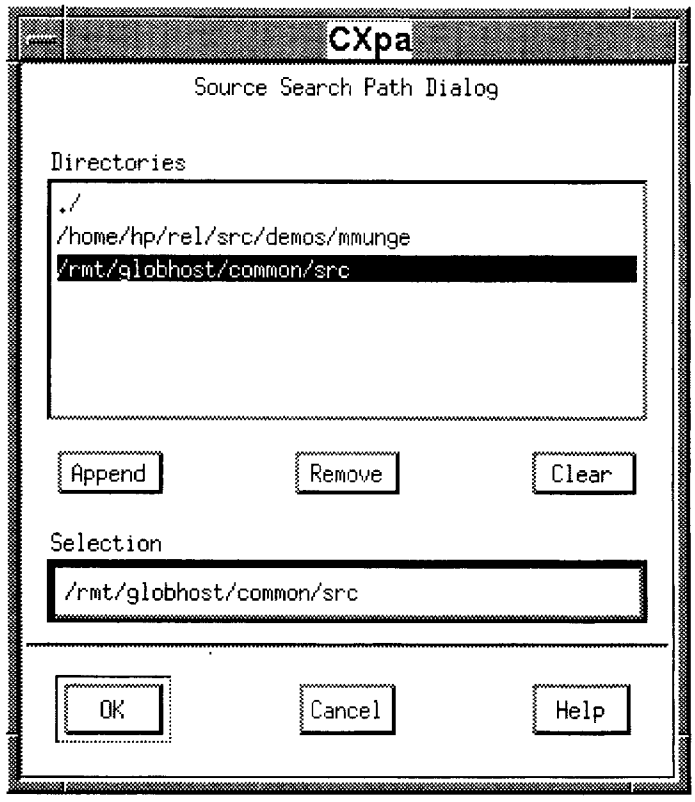
- Select Source Code from the Windows menu in any CXpa window.
- Click on a bar in the graph of the 2D or 3D Profile windows.
- Press the Show in Source button on the Routine Detail dialog.
- Invoke CXpa with the name of a PDF file only (without specifying an executable), if you have set the X application resource `Cxpa*defaultWindow` to `Source` or specified `-windows Source` when invoking CXpa from the command line.

Related Windows

2D Profile window
Analysis Control window
Call Graph window
Routine Detail dialog
Source Code Selection dialog
3D Profile window
Analysis Report window
Executable Manager window
Source Search Path dialog

Source Code window

Source Search Path dialog



Description

The Source Search Path dialog allows you to change CXpa's search path. CXpa uses its search path to find source files when you list a source file (by clicking on graphs in the 2D or 3D Profile windows or by using the Source Code window). CXpa uses the location of the source files embedded in the executable by the compiler to look for source files, so you will need to modify the search path if you have moved the source files after compiling them.

Adding a directory to CXpa's search path

Perform the following steps to add a directory to CXpa's search path:

1. Enter a directory path name in the Selection field.

2. Press the Append button. The path name appears in the Directories list.
3. Press the OK button to apply this change and close the dialog.

Removing a directory from CXpa's search path

Perform the following steps to remove a directory from CXpa's search path:

1. Highlight the path name to remove in the Directories list.
2. Press the Remove button.
3. Press the OK button to apply this change and close the dialog.

Fields

Heading	Meaning
Directories	Lists the directories in CXpa's search path.
Selection	Allows you to enter a directory name to add to or delete from CXpa's search path.

Buttons

Name	Action
Append	Adds the directory in the Selection field to the Directories list.
Remove	Removes a highlighted directory from the Directories list.
Clear	Removes all the directories from the list.
OK	Accepts the directories in the Directories list as CXpa's search path and closes this dialog.
Cancel	Closes this dialog without changing CXpa's search path.
Help	Displays a help page for this dialog.

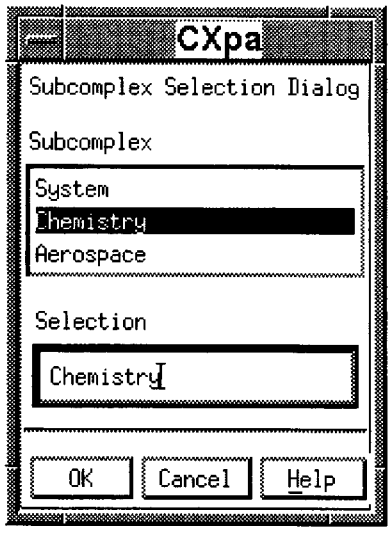
Context

To open a Source Search Path dialog, select Source Search Path from the Options menu in the Source Code, Executable Manager, or Analysis Control windows.

Related Windows

Analysis Control window
Call Graph window
Executable Manager window
Source Code Selection dialog
Source Code window

Subcomplex Selection dialog



Description

The Subcomplex Selection dialog allows you to select the name of the subcomplex on which you want to execute your program. When you start CXpa, it queries the system for the number of subcomplexes configured and only makes this dialog available if there is more than one.

A *subcomplex* is a collection of processors and memory from one or more nodes of an SPP Series system (which define the boundary within which all threads belonging to a process execute).

The default value is the subcomplex from which you invoked CXpa. You only need to use this dialog if you want to run your program on a different subcomplex. You must have the appropriate permissions to run the process on the specified subcomplex.

Subcomplex Selection dialog

The names of all subcomplexes on your system are displayed in the Subcomplex field. Perform the following steps to select a different subcomplex:

1. Click on the name of the subcomplex you want to select. Your selection is displayed in the Selection field. You can also type in the name of the subcomplex you want to select in this field
2. Press OK to select the new subcomplex and close the dialog.

For more information on subcomplexes on SPP Series systems, refer to the scm(1) and scm(4) man pages or the *SPP-UX System Administration Guide* (DSW-853) or contact the system administrator at your site.

Fields

Field	Meaning
Subcomplex	Lists the names of all subcomplexes on your system.
Selection	When you first invoke the Subcomplex Selection dialog, this field contains the name of the subcomplex from which you invoked CXpa. Otherwise, it displays the currently selected subcomplex (the subcomplex your process is set to run on).

Buttons

Name	Action
OK	Selects the subcomplex displayed in the Selection field and closes the dialog.
Cancel	Closes this dialog without applying the changes.
Help	Displays a help page for this dialog.

Context

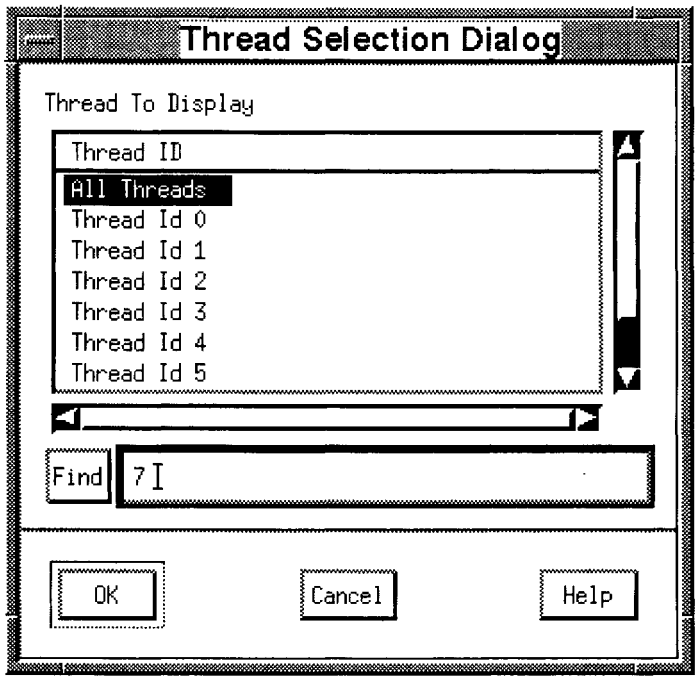
To open a Subcomplex Selection dialog, press the Subcomplex Selection button on the Executable Manager window. The Subcomplex Selection button is not available if only one subcomplex is configured on your system.

CXpa queries the system for available subcomplexes at start-up, so if a subcomplex is added during a CXpa session, it will not be visible to CXpa during that session.

Related Windows

Executable Manager window Info Session dialog

Thread Selection dialog



Description

Use the Thread Selection dialog to select the thread ID number of the thread whose data you wish to display in the Call Graph window. When the Thread Selection dialog is first opened, it displays a list of kernel thread ID numbers for the threads allocated for use by your program. The default selection is All Threads.

To select a thread ID:

1. Click on the thread ID number of the thread whose call graph data you wish to display. The selected thread ID is highlighted. You can select one thread or all threads.

   If the program contains a large number of threads, you can specify a string containing the thread ID number in the Find field to search for, then press Find to locate that thread. CXpa scrolls the thread ID list so that the first thread ID containing the specified string is placed at the top of the list (or, if it is near the end of the list, is visible in the list).

Press Find again to locate the next thread ID that contains the specified string and scroll the list so that it is placed at the top of the list, and so on. The search will wrap to the beginning of the list. Be sure to click on the thread ID number to select it after executing the search.

2. Press OK to close the dialog and update the Call Graph window so that it displays information for the specified thread.

Fields

Heading	Meaning
Thread to Display	Contains a scrolled list of thread ID numbers for the threads allocated for use by your program. Left click with the mouse on a thread ID number in the list to select it. The currently selected thread is highlighted.

Buttons

Name	Action
Find	Searches the list of thread ID numbers for occurrences of the string specified in the text entry field opposite the Find button. If a match is found, the thread ID list scrolls so that the first matching routine name is placed at the top of the list (or, if it is near the end of the list, is visible in the list). Press Find again to locate the next thread ID that contains the specified string and scroll the list so that it is placed at the top of the list, and so on. The search will wrap to the beginning of the list
OK	Updates the Call Graph window so that it only displays information for the selected thread.
Cancel	Closes the dialog.
Help	Displays a help page for this dialog.

Context

To open a Thread Selection dialog, select Thread from the View menu in the Call Graph window.

Related Windows

Call Graph window

Routine Detail dialog

X defaults

Description

Default X resource settings (Xdefaults) for the X Window System interface of CXpa are specified in the file /opt/cxpa/newconfig/X11/app-defaults/Cxpa.

To modify these resource settings, copy the default specifications into the file that contains your own X resource specifications (usually .Xdefaults or .Xresources). Then, modify the specifications to suit your needs.

After modifying the resource specifications, you must enter the following command in your xterm window:

```
% xrdb -merge ~/resource_file
```

resource_file is the name of the file that contains your resource specifications (usually .Xdefaults or .Xresources).

NOTE: If any of these resource specifications conflict with the settings used by your window manager, the window manager may override your CXpa resource specifications.

The Xdefaults in the /opt/cxpa/newconfig/X11/app-defaults/Cxpa file are organized into the following categories:

- Generic resources
- 2D profile graph resources
- Session behavior resources

CXpa also supports standard X/Motif general resource specifications. Refer to your X Window System documentation for more information.

Generic application resources—These resources define basic properties for all CXpa windows:

```
Cxpa*font: <font>
Cxpa*fontList: <font>
```

NOTE: Displaying a 2D profile with a large font specified in an application X resource can result in an incorrectly sized initial 2D profile display. This can also occur when no data is collected for the selected metric. To work around the problem, resize the 2D Profile window manually, then click the "Show All" button, or specify a smaller, fixed font.

```
Cxpa*background: <color>
Cxpa*foreground: <color>
```

2D and 3D Profile graph resources—The following resources define the fonts used to display axis labels and titles in 2D Profile window graphs:

```
Cxpa*xrtAxisFont: <font>
Cxpa*xrtHeaderFont: <font>
```

The following resources specify the font size scaling factor for axis labels and titles in 3D Profile window graphs. The larger the number, the larger the font, relative to the size of the graph. As the 3D graph is enlarged, the axis and title fonts are enlarged proportionately. The default font size scaling factor is `80`.

```
Cxpa*xrt3dAxisStrokeSize: <size>
Cxpa*xrt3dAxisTItleStrokeSize: <size>
```

Session behavior resources—These resources define:

- Foreground and background colors for graphs, reports, and source code displayed in CXpa analysis windows (2D and 3D Profile, Call Graph, Analysis Report, and Source Code windows).
- Auto-positioning behavior for xterms CXpa creates.
- Automatic window creation behavior for graph, source code, and report windows.

```
Cxpa*analysisBackgroundColor: <color>
Cxpa*analysisForegroundColor: <color>
```

The above resources define foreground and background colors for graphs, reports, and source code displayed in the 2D and 3D Profile, Call Graph, Analysis Report, and Source Code windows. The default foreground color is `white`; the default background color is `black`. The `*foreground`, `*background`, `-bg`, and `-fg` X resource settings do not affect the background and foreground colors for graphs and reports in analysis windows. These must be set explicitly with the resources listed above.

```
Cxpa*autoPosition: <Boolean>
```

By default, auto-positioning is enabled (`True`). Set this resource to `False` if you are running a virtual window manager (such as `tvtwm`) and you find that CXpa positions xterms that it creates (such as the process interface window) in unexpected locations (that is, not in the current virtual root window).

```
Cxpa*defaultWindow: <windows>
```

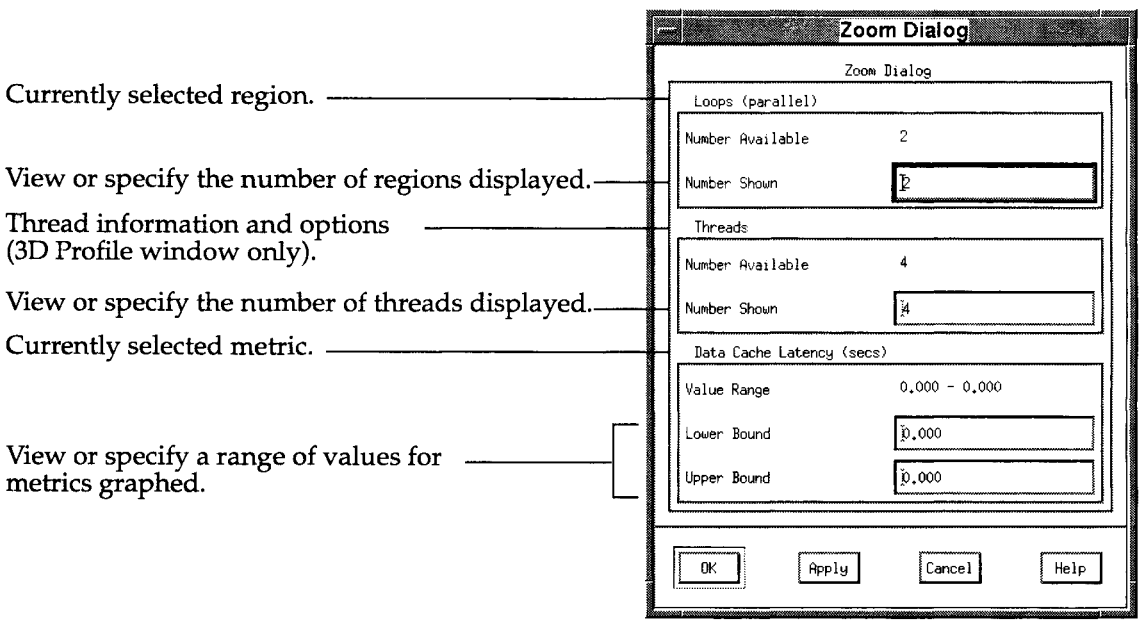
Use this resource to specify the window or windows that are created automatically when you invoke CXpa in analysis mode (without specifying an executable). You can specify multiple windows. Separate each value with a space. The default is `None`. Valid values for *<windows>* are as follows:

- `2DProfile`—Automatically create a 2D Profile window.
- `3DProfile`—Automatically create a 3D Profile window.
- `All`—Automatically create a 2D Profile window, 3D profile window, Analysis Report window, and Source Code window in analysis mode.
- `Callgraph`—Automatically creates a Call Graph window in analysis mode.
- `None`—Disable automatic creation of windows in analysis mode (this is the default).
- `Report`—Automatically create an Analysis Report window.
- `Source`—Automatically create a Source Code window.

Related Windows

2D Profile window
3D Profile window
Analysis Control window
Analysis Report window
Call Graph window
Executable Manager window
Source Code window

Zoom dialog



Description

Use the Zoom dialog to view or specify the range of metric values graphed, the number of regions displayed, or the number of threads displayed along a given axis in a 2D or 3D graph. This is especially useful in cases where there are a large number of data items to graph and you want to focus on a subset of the data.

Labels in the Zoom dialog indicated the currently selected region level and metric type and are updated as different metrics and regions are selected in the associated 2D or 3D Profile window.

2D graph zoom options

The following zoom options are available for the 3D graph:

- To change the number of source code regions displayed in the current window, enter a new value in the Number Shown field for currently selected metric.

- To specify a different range or limit the range of metric values graphed along the Metric (horizontal) axis, enter a new value in the Upper- and/or Lower-bound fields for the currently selected metric.

3D graph zoom options

The following zoom options are available for the 3D graph:

- To change the number of source code regions graphed along the Region axis, enter a new value in the Number Shown field for the currently selected region.
- To change the number of threads graphed, enter a new value in the Number Shown field in the Threads panel of the dialog.
- To specify a different range or limit the range of data values (metrics) graphed, enter a new value in the Upper- and/or Lower-bound fields for the currently selected metric.

Fields

Field	Description/Valid values
Value Range	Displays the range of data values (metrics) that can be shown in the graph.
Lower Bound	Sets the lower-bound of the range for the specified axis. This value must be less than the value specified in the Upper Bound field but can be smaller than the minimum data value.
Upper Bound	Sets the upper-bound range for a given axis. This value must be greater than the value specified in the Lower Bound field but can be larger than the maximum data value.
Available	Displays number of available data items (regions or threads) displayed in the graph.
Number Shown	Shows the number of items (regions or threads) currently displayed. Valid values are integers from one to the number available. Values larger than the number available are ignored.

Buttons

Name	Action
OK	Updates the graph display according to the selected values and closes this dialog.
Apply	Updates the graph display according to the selected values, but does not close the dialog.

Cancel	Closes this dialog without making any changes.
Help	Displays a help page for this dialog.

Context

To open a Zoom dialog, select Zoom from the View menu in the 2D Profile or 3D Profile window.

Related Windows

2D Profile window
Filter Profile dialog
3D Profile window
Region Subset Selection dialog

Commands

6

This chapter contains a reference page for each CXpa command. Commands can be:

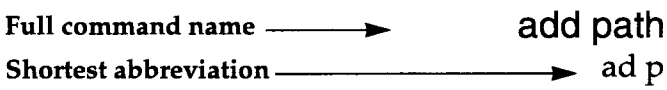
- Entered in line mode (when you invoke CXpa with the `-nw` option) at the `(CXpa)` command prompt
- Used in CXpa script files
- Executed in batch mode

You can abbreviate CXpa commands. For example, the command `analyze cpu loop` can be abbreviated to `an c 1`. The shortest unique abbreviation for each command is shown in the upper right corner of the first reference page for each command, immediately below the command name.

Each reference page displays its command name and shortest abbreviation at the top, followed by a one-line description. The rest of the page is divided into the following sections:

- **Syntax**—Lists the format rules for the command and its parameters.
- **Description**—Explains the purpose and functionality of the command.
- **Examples**—Shows one or more examples illustrating the use of the command.
- **Related Commands or Topics**—Lists CXpa commands or topics related to the command being described.

The heading at the top of each command description contains the following lines of information:



add path

ad p

Add directories to CXpa's search path for source files.

Syntax

add path *<directory-list>*

Parameter	Meaning
<directory-list>	Specifies one or more directories, separated by a space, to add to CXpa's search path.

Description

The `add path` command appends the specified list of directories to CXpa's search path. CXpa uses its search path to locate source files. By default, the search path contains the:

- Location of the original source files when the program was compiled.
- Location of the executable and/or PDF.
- Current working directory.

CXpa uses the location of the source files embedded in the executable by the compiler to look for source files, so you will need to use the `add path` command to modify the search path if you have moved the source files after compiling them.

Use the `info` command to list CXpa's current search paths. Use the `path` command to replace CXpa's current search path set.

You may find it convenient to place the `add path` command in CXpa's initialization file, .cxpainit, to automatically set CXpa's search path each time you invoke CXpa.

Examples

The following examples show typical uses of the `add path` command.

```
(CXpa) add path c_progs
(CXpa) info

(Skipping command output not relevant to this example.)

Current Search Path(s) : /mnt/user/progs/
                         /mnt/user/progs/c_progs
```

The above example of the `add path` command appends the relative path of `c_progs` to CXpa's search path.

```
1.(CXpa) list selectable SUB2
             File prog.f not found in search path.
2.(CXpa) info

(Skipping command output not relevant to this example.)

     Current Search Path(s) : /mnt/dev_tree/wrk

3.(CXpa) add path /mnt/dev_tree/progs
4.(CXpa) list selectable SUB2
       R  1 SUBROUTINE SUB2(MATRIX, VAR3)
      L P 5 DO I=1,5
      L   6    DO J=1,5
```

The above example shows a scenario for using the `add path` command when CXpa cannot find a source file you are trying to list. The line numbers are for reference only.

1. When the `list selectable SUB2` command is issued, CXpa cannot find the file that contains the routine `SUB2`.
2. The `info` command displays CXpa's current search path at the bottom of the `info` command's output.
3. The `add path` command adds /mnt/dev_tree/progs to CXpa's search path.
4. Now that CXpa's search path has been modified, CXpa finds the needed source file when the `list selectable SUB2` command is issued.

Related Commands

`info` `list`
`list selectable` `path`

analyze
an

Display performance reports for profiled source code regions.

Syntax

`analyze` [*<metric-list>*] [*<region-type>*] [*<routine-list>*] [*<i/o_redirection>*]

Parameter	Meaning

When parameters are used with this command, they must be specified in the order shown in the syntax statement above.

<metric-list>

Restricts the output of this command to the specified metrics. If no metrics are specified, all available metrics are displayed.

When used, this parameter should precede any other parameter. Separate multiple metrics with a space. Valid values for SPP Series systems are as follows:

```
call_graph
counts
cpu
wall_clock
events
```

<region-type>

Specifies the type of source code region for which you want to display reports. Valid values are as follows:

`routine`
`loop` (all loops)
`pregion` (parallel loops only)
`block` (basic blocks only)

If you do not specify a region, reports are displayed for all profiled regions. You can only specify one region type.

<routine-list>

For the selected source code region, specifies one or more routines. Separate multiple routines with a space. If you do not specify a *region-type* with the *routine-list* parameter, routine-level analysis reports are displayed.

<i/o_redirection>	Redirects this command's standard output or error to the specified file when you include one of the redirection operators (<, >, >>, >&, >>&).

Description

Use the `analyze` command to create and display textual performance reports. When you execute the `analyze` command without specifying any parameters, all available reports and metrics are displayed for all profiled regions in your program.

CXpa displays reports in line mode using the pager specified with your `PAGER` environment variable. If the `PAGER` environment variable is not set, CXpa uses the `more` command to page output. You can also redirect output to a file using redirection operators.

The `analyze` command generates the reports from the data in the performance data file (PDF), so a PDF must exist before you can display a performance report. CXpa creates a PDF when you select region types with a `select` command and execute the program with the `run` command. If you have not specified a PDF name in this profiling session, CXpa uses the default file name *<executable>*.pdf.

When you invoke CXpa with the name of a PDF file only, you can use the `analyze` command to look at reports from multiple PDFs or PDFs created in previous CXpa sessions (including PDFs created on different architectures). Then, use the `set pdf` command to change the name of PDF being analyzed.

NOTE: If you invoked CXpa with the name of an executable, you can only analyze PDFs that were created during the current CXpa session and generated from the executable you are currently profiling.

To generate reports for a specific source code region level, use the `analyze` command followed by a *region-type* parameter: `analyze block`, `analyze routine`, `analyze loop`, or `analyze pregion`.

You can use the *metric-list* and *routine-list* parameters to display reports for a subset of metrics and/or routines, respectively.

To view intermediate profiling results, press **CTRL-c** to pause the program and then use the `analyze` command.

Reports

The `analyze` command can display reports for the following source code regions under the listed conditions:

- **Routine reports**—Use the `analyze` or `analyze routine` command to display routine reports. Source files must be compiled with `-cxpa` or `-cxpar` or instrumented for profiling with `cxoi`, and routine regions selected for profiling with the `select all` or `select routine` commands.

- **Dynamic Call Graph report**—Use the `analyze` or `analyze call_graph` command to display a dynamic call graph report. Source files must be compiled with a Convex compiler using the `-cxpa` option or instrumented for routine-level profiling with `cxoi`, and all routines in the program should be selected for profiling with the `select routine all` command.
- **Loop reports**—Use the `analyze` or `analyze loop` command to display loop reports (including summary information for profiled parallel loops). Source files must be compiled with `-cxpa` at optimization level `-O1` or higher, and loop regions must be selected for profiling with the `select all` or `select loop` commands.
- **Parallel Region reports**—Use the `analyze` or `analyze pregion` command to display reports for parallel loops only. Parallel loops are created by Convex compilers at optimization level `-O3`. Source files must be compiled with a Convex compiler with the `-cxpa` option at optimization level `-O3`, and parallel loops must be selected for profiling with the `select all`, `select loop all`, or `select pregion` commands.
- **Basic Block report**—Use the `analyze block` command to display a basic block report. Source files must be compiled with a Convex compiler using the `-cxpab` option, and block regions must be selected for profiling with the `select all` or `select block` commands.

For a detailed description of CXpa reports and the metrics displayed in each report, refer to the "Introducing metrics," "Reports," "Dynamic Call Graph report," "Loop reports," "Parallel Region reports," "Routine reports," "Report fields," and "Basic Block report" online help topics or sections of this book.

Examples

The examples in this section show how to use the `analyze` command.

```
1.(CXpa) select routine all
2.(CXpa) collect cpu wall_clock events
3.(CXpa) set events local_misses
4.(CXpa) run
   (Program runs to completion, and any output is displayed.)
5.(CXpa) analyze
   (Performance reports are displayed.)
```

The above scenario shows how you would normally use the `analyze` command in conjunction with other CXpa commands to generate performance analysis reports. The line numbers are for reference only.

1. The `select routine all` command tells CXpa to select all routine regions in your program for profiling.
2. The `collect cpu wall_clock events` command tells CXpa which metrics to collect. In this case, CPU time, wall clock time, and events will be collected (iteration/execution counts are always collected). You must then use the `set events` command to specify the type of event to collect.
3. The `set events local_misses` command tells CXpa to collect the number of times that a memory reference had to be satisfied from memory on the processor's node due to a miss in the processor's data cache. The `local_misses` parameter is only available on SPP1000 and SPP1600 Series systems.
4. The `run` command executes the program and initiates profile data collection. Profile data collection ends when the program runs to completion.
5. The `analyze` command calculates and displays all possible performance reports from data collected and stored in the PDF file.

The following examples show how to use the `analyze` command after regions and metrics have been selected for profiling and profiling data has been collected and stored in a PDF.

```
(CXpa) analyze events loop sub2
```

The above command creates and displays loop performance analysis reports for event metrics collected at all profiled loop regions executed in subroutine `sub2`. The order of the parameters is significant. The *metric-list* parameter (in this case, `events`) must be specified first, and the routine specifier `sub2` must follow the `loop` *region-type* parameter.

```
(CXpa) analyze loop > report_output
```

The above command creates loop performance analysis reports containing all metrics collected for all profiled loop regions in the program and redirects the output to a file named report_output. Any existing data in the file report_output is overwritten.

```
(CXpa) analyze events cpu
```

The above command creates and displays performance reports containing events and CPU time metrics collected for all profiled regions in the program.

```
(CXpa) analyze loop init display
```

The above command creates and displays loop performance reports containing all collected metrics for the profiled loop regions executed in subroutines `init` and `display`.

```
(CXpa) analyze counts
```

The above command creates and displays iteration/execution counts reports only for all profiled regions in the program.

```
(CXpa) analyze call_graph
```

The above command creates and displays a dynamic call graph report for all profiled routines in the program.

Related Commands

`deselect`
`rerun`
`run`
`select`
`set pdf`

Related Topics

Basic Block report
Dynamic Call Graph report
Introducing metrics
Introducing source code regions
Loop reports
Report fields
Reports
Routine reports
Parallel Region reports

collect

col

Specify the metrics that you want to collect while profiling your program.

Syntax

```
collect [call_graph] [counts] [cpu] [wall_clock]
[events]
```

Parameter	Meaning

Specify one or more of the following parameters with the collect command. Separate multiple parameters with a space.

call_graph	Collects dynamic call graph information for all profiled routine regions.
counts	By default, iteration/execution counts are always collected. To restrict metric collection to iteration/execution counts, specify the `counts` parameter only with the `collect` command (for example, `collect counts`).
cpu	Collects CPU time and iteration/execution counts.
wall_clock	Collects wall clock time.
events	Collects events metrics that you can configure with the `set events` command.

Description

The `collect` command tells CXpa which metrics to collect at the regions of your program that have been selected for profiling. Each use of this command replaces the values previously set.

NOTE: Unless you have selected source code regions to profile with the `select` command, no region-level analysis will be possible.

NOTE: If you specify event collection with the `events` parameter of the `collect` command, you must use the `set events` command to specify the type of event collected. Refer to the "`set events`" online help topic or command reference page in this book for more information.

Examples

The examples in this section show various ways to use the `collect` command, assuming your program is compiled appropriately for the regions selected for profiling.

```
1.(CXpa) select routine all
2.(CXpa) collect cpu wall_clock events
3.(CXpa) set events data_cache
4.(CXpa) run
   (Program runs to completion, and any output is displayed.)
5.(CXpa) analyze
   (Performance reports are displayed.)
```

The above scenario shows how you would normally use the `collect` command in conjunction with other CXpa commands to specify the metrics you want to collect. The line numbers are for reference only.

1. The `select routine all` command tells CXpa to select all available routines in your program for profiling.
2. The `collect cpu wall_clock events` command tells CXpa which metrics to collect. In this case, CPU time, wall clock time, and events will be collected (by default, iteration/execution counts are also collected). You must then use the `set events` command to specify the type of event to collect.
3. The `set events data_cache` command configures on-processor event counters to collect data cache misses, accesses, and latency. The `data_cache` parameter is available on SPP1200 and SPP1600 Series systems only.
4. The `run` command executes the program and initiates profile data collection. Profile data collection ends when the program runs to completion.
5. The `analyze` command calculates and displays all possible performance reports from data collected and stored in the PDF file.

```
(CXpa) select loop all
(CXpa) collect wall_clock cpu
```

The above commands select all loops in your program for profiling and enable CXpa to collect wall clock time and CPU time for loops.

Related Commands

`analyze`	`run`
`select`	`set events`
`set pdf`	`set visibility`

Related Topics

Introducing metrics	Selecting metrics in line mode

continue

con

Continue profiling a paused program.

Syntax

```
continue
```

Description

The `continue` command resumes the profiling of a paused program.

When you continue profiling, the selected program resumes execution, and CXpa resumes profile data collection.

Examples

The following example shows a likely scenario in which you would use the `continue` command. The line numbers are for reference only.

```
1.(CXpa) run
2.(CXpa) CTRL-c
   (Pressing CTRL-c pauses program execution.)
3.(CXpa) analyze
   (Intermediate performance reports are displayed.)
4.(CXpa) continue
   (Program runs to completion, and data collection ends.)
5.(CXpa) analyze
   (Complete performance reports are displayed.)
```

The following lines explain the example above by number:

1. The `run` command runs the program and initiates profile data collection.
2. Pressing **CTRL-c** pauses program execution.
3. The `analyze` command displays the performance information that has been collected to this point.
4. The `continue` command resumes the program execution and data collection.
5. When the program has run to completion, CXpa is finished collecting profile data. The `analyze` command is used again to display the final profile results of this run.

Related Commands `run` `stop`

cxpa

Invoke the Convex performance analyzer.

Syntax

cxpa [*<executable>*] [**-help**] [**-nap**] [**-nw**] [**-nx**]
[[**-path** *<dir>*] ...] [[**-pdf**] *<filename>*] [**-pid**][**-tm** *<architecture>*]
[**-stack** *<bytes>*] [**-w**] [**-x** *<cmdfile>*] [*<X-Toolkit-options>*]
[**-e** *<executable>* [*<arguments ...>*]]

Parameter	Meaning
<executable>	Specify the name of the executable you wish to profile. The default is `a.out`.
-e *<executable>* [*<arguments ...>*]	Supply command-line arguments to the program you are profiling. This must be the last option on the command line. This option is useful for batch execution; for example: **cxpa -x** *<cmdfile>* **-e a.out** *<args-list>*
-help	Display the CXpa usage message, which lists and describes command line options.
-nap	Disables auto-positioning of xterms in X window mode. You can use this option if you are running a virtual window manager (such as `tvtwm`) and you find that CXpa positions xterms that it creates (such as the process interface window) in unexpected locations (that is, not in the current virtual root window). You can also fix the problem by setting the X application resource `Cxpa*autoPosition:` to `False` (the default setting is `True`).
-nw	Invoke CXpa in line mode. Do not bring up the X window version.
-nx	Do not execute the CXpa commands in .cxpainit, the CXpa start-up command file.

-path *<dir>*
Append the specified directory to the end of CXpa's search path. CXpa uses its search path when it looks for a source file. Any number of directories can be specified by repeating the `-path` option several times. The list of directories is initialized to the current working directory and the directory where the executable or PDF is located.

-pdf *<filename>*
Invoke CXpa with the specified performance data file. CXpa uses the PDF to store profiling data and to generate the performance reports. The default PDF name is *<executable>*.pdf.

-pid
Adds the process identification number (of the process you are profiling) to the name of the PDF that CXpa creates during a profiling session.

-stack *<bytes>*
Specify the size of the profiling stack in bytes. The default is 10240 bytes. If CXpa aborts because the profiling stack is too small, use this option to increase its size.

-tm *<architecture>*
When pre-instrumenting an executable on an architecture that is different from the architecture the executable will be run on to generate profiling data, you must specify this option when you invoke CXpa. This ensures that the correct timing routines are called to collect appropriate hardware metrics for the target system. Valid values for *<architecture>* are as follows:

`spp1000`—Exemplar SPP1000 Series
`spp1200`—Exemplar SPP1200 Series
`spp1600`—Exemplar SPP1600 Series

-w
Suppress warning messages issued by CXpa.

-win *<windows>*
Specify the window or windows that are created automatically when you invoke CXpa in analysis mode (without specifying an executable). The default is `None`.

Valid values for *<windows>* are as follows:

```
2DProfile
3DProfile
All
Callgraph
None
Report
Source
```

You can specify multiple values. Separate multiple values on the command line with a space.

-x *<cmdfile>* — Execute the CXpa commands in the specified file. After CXpa has executed the commands in the file, the profiling session is terminated.

<X_Toolkit_options> — Specifies X Toolkit options. For more information about these options, refer to your X Window System's documentation.

Description

CXpa is an interactive performance analyzer for C and Fortran that enables you to profile optimized programs compiled using Convex compilers with a profiling option (`-cxpa`, `-cxpar`, or `-cxpab`) or instrumented with the `cxoi` utility. CXpa can run under X windows or with CRT terminals.

CXpa enables you to collect profiling data for four types of source code regions: routines, serial loops, parallel loops, and basic blocks. You can select any of these regions for profiling, provided they exist. The data collected for the selected regions can be viewed and analyzed using reports and 2D or 3D profile graphs.

CXpa stores the performance information collected for a specific run of your program in a performance data file, called a PDF. By default, CXpa appends .pdf to the name of the executable file to form the name of the PDF file (for example, a.out.pdf).

PDFs are platform-independent; the data stored in a PDF created on one platform can be viewed and analyzed on a different platform. For example, you can collect performance data for a large program in batch mode running on an SPP1600 Series computer, then move the PDF file to a different subcomplex or to an SPP1200 system to interactively view and analyze the data.

Preparing programs for profiling with CXpa

To compile a program for profiling, use one of the following profiling options of the Convex compilers (`/usr/convex/bin/fc`, `/usr/convex/bin/cc`):

- `-cxpa`—Used for profiling routines, loops, and parallel regions (this option is recommended for most profiling).
- `-cxpar`—Used for profiling routines only.
- `-cxpab`—Used for profiling basic blocks only.
- `-cxpalib`—Used for linking your program with system libraries that are instrumented for CXpa (assuming they are installed on your system).
- `-cxpamon=`*<dir>*

  Specifies an alternate directory for CXpa data collection routines (cxpamon.o). The default value for *<dir>* is /usr/lib.

When compiling, you should only use one profiling instrumentation option (that is, `-cxpa`, `-cxpar`, or `-cxpab`) per source file.

The Convex object file instrumentor (`/usr/convex/bin/cxoi`, a separate utility shipped with CXpa) enables you to instrument object and archive library files produced by any PA-RISC targeting compiler for routine-level profiling with CXpa. This includes executables compiled with Hewlett-Packard Fortran, C, and C++ compilers.

Refer to the `cxoi` man page or to the "Profiling HP PA-RISC Object Files and Libraries" online help topic or section of this book for more information.

Using the X windows version of CXpa

To use CXpa in X window mode, follow these steps:

1. Prepare your program for profiling with CXpa, either by compiling it with a CXpa compiler option or by instrumenting it with `cxoi`, as discussed in the previous section.
2. Set your `DISPLAY` environment variable. For example, using C shell syntax:

   `% setenv DISPLAY` *display_name*`:0.0`

   Using Bourne shell (sh) syntax:

   `$` **`DISPLAY=`***display_name*`:0.0; export DISPLAY`

3. Invoke CXpa with the name of your executable. The following command invokes CXpa in X window mode:

   ```
   % cxpa a.out &
   ```

   The Executable Manager window appears. CXpa is a licensed product. If you do not obtain a license at start-up, contact the site administrator for your system for assistance.

4. Enter any arguments to the program you are profiling in the Program Arguments field in the Executable Manager window.

5. Choose the source code regions you want to profile by pressing the Profile Selection button to open the Profile Selection dialog. Click the toggle buttons on the upper half of the dialog to select/deselect region types.

6. If you wish to change the default set of metrics that CXpa collects, click the toggle buttons in the lower half of the Profile Selection dialog to select/deselect the metrics you want to collect. These metrics are only collected at the regions of your program selected for profiling in Step 5 above.

7. Run your program by pressing the Start button.

8. Create and view a performance report or graph by selecting one of the options from the lower-right option menu.

Using the line mode version of CXpa

Line mode allows you to use CXpa interactively without the graphical user interface. Line mode is designed primarily for use on windowless terminals (for example, VT-100s), but you can also use it on X terminals. Performance data is displayed in textual reports.

To use CXpa in line mode:

1. Prepare your program for profiling with CXpa, either by compiling it with a CXpa compiler option or by instrumenting it with `cxoi`.

2. Invoke CXpa with the name of your executable. The `-nw` option invokes CXpa in line mode.

   ```
   % cxpa -nw a.out
   ```

   CXpa is a licensed product. If you do not obtain a license at start-up, contact the site administrator for your system for assistance.

3. Choose the source code regions you want to profiling using the `select` command. For example, to select all routine regions, enter:

   ```
   (CXpa) select routine all
   ```

By default, CXpa collects wall clock time and CPU time, which are the recommended set of metrics to collect the first time a program is profiled with CXpa. To select a different set of metrics to collect, use the `collect` command.

The metrics you select are only collected at the regions of your program that you selected for profiling with the `select` command.

4. Run your program:

   `(CXpa)` **`run arg1 arg2 < input_file`**

5. Create and view performance reports by using the `analyze` commands. For example:

   `(CXpa)` **`analyze`**

Using the CXPA environment variable to specify options

You can specify CXpa command line options in the CXpa environment variable (`CXPA`). This frees you from having to enter frequently used options repeatedly from the command line.

To use this environment variable in C shell (csh), use the following syntax:

`%` **`setenv CXPA`** *'-option -option ...'*

To use this option in Bourne shell (sh), use the following syntax:

`$` **`CXPA=`***'-option -option ...'*`;` **`export CXPA`**

For example,

```
% setenv CXPA '-nw -pid -w'
```

forces CXpa to start in line mode (`-nw`). The `-pid` option tells CXpa to add the process ID number of the process you are profiling to the name of the PDF file it creates when you run your program. The `-w` option suppresses warning messages issued by CXpa.

Examples

The following examples show various ways to invoke CXpa.

```
% cxpa -nw
```

The above command invokes CXpa in line mode with the default executable (a.out) and default PDF (a.out.pdf) if they exist. If neither exist, CXpa starts, but only allows you to analyze existing PDFs. You can specify a PDF with the `set pdf` command.

```
% cxpa prog.out
```

The above command invokes CXpa in X window mode, and the Executable Manager window appears. The file name is treated as an executable file. This begins a profiling session using the specified executable file, and the default performance data file (PDF) named prog.out.pdf.

```
% cxpa -pdf my.pdf
```

The above command invokes CXpa in analysis mode, and the Analysis Control window appears. The `-pdf` option (which is optional if the filename ends in .pdf) specifies the file name (my.pdf) as the performance data file (PDF). CXpa uses the PDF to store the performance data and to generate performance reports.

In X window mode, when you invoke CXpa with the name of a PDF file only, and no executable a.out exists in the current directory, the Analysis Control window appears. From this window, you can analyze multiple PDFs created from different executables, but you cannot execute your program or gather more performance data without specifying an executable at the CXpa invocation line.

```
% cxpa -nw prog.out
```

The above command invokes CXpa with the executable `prog.out`. Using the `-nw` ("no windows") option invokes CXpa in line mode.

```
% cxpa -nx a.out
```

The above command invokes CXpa but inhibits it from processing any initialization files.

```
% cxpa -x cmdfile my.out >& output_file < input_file
```

The above command invokes CXpa in batch mode (which is not an interactive mode). The `-x` option tells CXpa to execute the CXpa commands in the file cmdfile. Program output and messages are redirected to the file output_file, and input for the executable `my.out` is read from the file input_file (unless they are redirected in the command file).

```
% /usr/convex/bin/fc -03 test.f -cxpa -cxpalib
```

The above command line builds an executable file called `a.out` that is instrumented for loops, routines, parallel loops (if created by the compiler), and system libraries in a single step. The `-03` compiler option enables parallel optimizations.

```
% /usr/convex/bin/fc -02 -cxpa test.f -c
% /usr/convex/bin/fc file.f test.o -cxpalib
```

The first command in the above example creates an object file, test.o, with routines and loops instrumented for CXpa. The second command creates an executable, a.out, with instrumented libraries. The regions in test.o are instrumented for CXpa; the regions in file.o are not instrumented.

If you use the `-cxpalib` option, be aware that:

- The program you are profiling may execute much more slowly.
- The amount of profiling data will be significantly increased.

Related Commands

`analyze`
`collect`
`continue`
`deselect`
`merge`
`quit`
`run`
`select`
`set events`
`set visibility`

Related Windows

2D Profile window
3D Profile window
Analysis Control window
Analysis Report window
Call Graph window
Executable Manager window
Profile Selection dialog

Related Topics

Analyzing PDFs only
Compiling
Introducing metrics
Introducing source code regions
Learning CXpa quickly
Performance data files (PDFs)
Profiling HP PA-RISC object files and libraries
Profiling message-passing applications with CXpa
Reports
Using pre-instrumented executables

deselect

d

Deselect source code regions for profiling.

Syntax

deselect [*<region-type>*] [**all** | **in** *<routine-list>* | **at** *<line-number-list>*]

Parameter	Meaning

<region-type>	Specifies the type of region to deselect. Valid values are as follows:
	`routine`
	`loop`
	`pregion`
	`block`

all	Deselects the specified *<region-type>* in all routines in your program. If you do not specify a region type, all regions are deselected.
in *<routine-list>*	Specifies the names of one or more routines whose region types you want to deselect. Separate routine names with a space. If two routines have the same name, prefix them with a file name followed by a colon: *<file-name>* : *<routine-name>*.
at *<line-number-list>*	Deselects all region types at *<line-number-list>*. *<line-number-list>* specifies one or more line numbers of the region type that you want to deselect. Separate line numbers with a space. To deselect a region type in another source file, prefix the line number with a file name followed by a colon: *<file-name>* : *<line-number>*.

Description

The `deselect` command deselects source code regions for profiling in one or more routines or at one or more line numbers. The `deselect` command has no effect on regions that are already deselected.

When you invoke CXpa in line mode, all source code regions in your program are deselected for profiling until you select one or more of them with the `select` command. CXpa ignores deselected regions when you profile a program.

CXpa places collection instructions in your program's executable when you compile your program with one of the following CXpa options:

- `-cxpa`—Inserts routine, loop, and parallel region collection instructions into your program.
- `-cxpar`—Inserts routine collection instructions only.
- `-cxpab`—Inserts basic block collection instructions only.

For example, `deselect all` only deselects basic block collection instructions if you compiled your program with `-cxpab`.

Use the `list selectable` command to list source code regions that can be selected or deselected for profiling.

Examples

The following examples show various ways to use the `deselect` command.

```
(CXpa) deselect loop in init matrix_mult sub3
```

The above command deselects all loop regions for profiling in the routines `init`, `matrix_mult`, and `sub3`.

```
(CXpa) deselect at 14
```

The above command deselects all regions at line 14 in the current source file.

```
(CXpa) deselect pregion all
```

The above command deselects parallel regions for profiling in all routines in your program.

```
(CXpa) deselect loop in sub2
Routine sub2 has no instrumented loop entries.
```

In the above example, the loop regions in subroutine `sub2` could not be deselected because the source file containing `sub2` was not compiled with the `-cxpa` option.

Related Commands

`list selectable` `run` `select`

help
h

Display help information.

Syntax

help [*<string>*]

Parameter	Meaning
<string>	A character string used to search for help topics. All topic titles that contain the string are listed. If only one match is found, the help text for that topic is automatically displayed. If you enter the `help` command without specifying a search string, CXpa displays the text for the `help` command. The string can contain white space without being enclosed in quotes.

Description

The `help` command displays help information on specified commands, CXpa error, warning, and informational messages, and other topics. CXpa searches the help topic titles for the string you specify.

The output of the `help` command is sent to the pager specified in your `PAGER` environment variable. If you have not specified a pager with the `PAGER` environment variable, CXpa uses the `more` command to page output.

To display an ASCII text version of the release notice for the version of CXpa currently installed on your system, enter `help release`.

Examples

The following examples show how to use the `help` command.

```
(CXpa) help continue
```

The above command displays help information for the `continue` command.

```
(CXpa) help A19
A19
       Message     PDF <filename> is empty or corrupt.
       Type        ERROR
      Explanation Regenerate the PDF or try a different PDF.
```

The above command displays help information for CXpa error message number A19.

```
(CXpa) help pdf
Searching the topic titles found the following matches for
      'PDF':

   set pdf
   Analyzing PDFs only
   Setting the PDF
   Info PDF dialog
   New PDF dialog
   Open PDF dialog

(CXpa) help set pdf

                                                    set pdf
                                                    set p

          Specify the name of the performance data file (PDF).

Syntax      set pdf <filename>

(Skipping lines of output.)
```

In the above example, the command `help pdf` is ambiguous; CXpa displays all help topic titles that match the string `pdf`. The command `help set pdf` displays the help text for the `set pdf` command.

```
(CXpa) help index list
Index

      Enter 'help <topic_name> to view its  help page.

Windows                                  Using CXpa

About_CXpa_dialog                        Overview_of_CXpa

Analysis_Control_window                  CXpa_limitations
```

(...lines of output omitted)

```
(CXpa) help commands

Commands

      Enter 'help <command_name>' to view the help page
      for that command.

add path

    Add the specified list of directories to CXpa's search path
       for source files.

analyze

     Display performance analysis reports for profiled source
       code regions.
```

(...lines of output omitted)

As shown in the above example, you can view lists of online help topics by entering the following commands:

- `help using list`
- `help index`
- `help commands`
- `help windows`
- `help reports list`

Related Commands

`info`

info

i

Display information about your CXpa session.

Syntax

```
info
```

Description

The `info` command lists the following information in three categories:

Executable information

- **Current executable**—Name of the executable that you are profiling.
- **Current Process State**—Current state of the process you are profiling. The states include `running`, `paused`, `terminated`, `exited`, and `not started`.
- **Process ID**—Executable's process ID (PID).
- **Created on**—Date that the current executable was created.
- **Instrumentation Version**—Version of the CXpa profiling routines linked into your program.

PDF information

- **Current PDF**—Name of the current performance data file (PDF).
- **Created on**—Date and time that the PDF was created.
- **PDF Format**—Format version number of the PDF.
- **Created by CXpa Version**—Version number of CXpa that created the PDF.
- **Process State**—Process state recorded in the PDF.
- **Executable Profiled**—Name of the executable you are profiling.
- **Executable Created on**—Date that the executable that produced the current PDF file was created.
- **Instrumentation Version**—Version of the CXpa profiling routines linked into your executable when the PDF was created.
- **Visibility Setting**—Indicates whether process-level data or thread-level data will be displayed in CXpa text reports, and displays the current loop nesting level setting.

File and directory information

- **Current List File**—The name of the source file CXpa currently displays with the `list` or `list selectable` commands.
- **Current Working Directory**—Current directory.
- **Current Search Path(s)**—Search path that CXpa uses to find source files.
- **Current Subcomplex**—Subcomplex that your process is currently set to run on.
- **Available Subcomplex(s)** —Lists subcomplexes available on your system. Use the `set subcomplex` command to specify a different subcomplex to run your program on.

Examples

The following example shows the output of the `info` command.

```
(CXpa) info
       Current Executable : /src/demos/mmunge/mmunge.-O3.exe
    Current Process State : Not started
                Process ID : Not started
                Created on : Fri Jul 12 10:24:18 1996
  Instrumentation Version : 3.3
            Current PDF : /src/demos/mmunge/mmunge.-O3.exe.pdf
                Created on : Fri June 28 15:54:15 1996
                PDF Format : 478
  Created by CXpa Version : 3.5
              Process State : exited
     Executable Profiled : /src/demos/mmunge/mmunge.-O3.exe
       Executable Created on : Fri June 28 10:24:18 1996
  Instrumentation Version : 3.5
       Current Visibility : Process, Loop levels 0 to 0
        Current List File : mmunge.f
Current Working Directory : /src/demos/mmunge
   Current Search Path(s) : ./
                           /src/demos/mmunge
       Current Subcomplex : System
  Available Subcomplex(s) : System, Chemistry
```

Related Commands

`version` `set visibility`

list
1

List lines of text from a source file.

Syntax

`list` [*<routine>* | [*<filename>*] [`:`] {*<first-line>* [*<last-line>*] | *<routine>*}]

Parameter	Meaning
<routine>	Specifies the name of a routine to display.
<filename>	Specifies the name of a source file to display.
<first-line>	Specifies a source code line number as the first line to display.
<last-line>	Specifies a source code line number as the last line to display.

Description

The `list` command lists lines of text from the source files that were compiled to form the current executable. Lines containing source code regions that can be selected or deselected for profiling are prefaced with one or more of the following letters: `r` for routines, `l` for loops, `p` for parallel regions, and `b` for basic blocks. Lowercase letters indicate regions that are currently deselected, while uppercase letters indicate regions that are currently selected for profiling.

When you execute the `list` command without parameters, CXpa lists the current source file. The current source file is either the last source file specified in a CXpa command or the source file that contains the program's main entry point.

When you use the `list` command, CXpa uses the directories in its search path to find the needed source file. If a source file has been moved after compiling, use the `add path` command to add the new directory to CXpa's search path.

The following list describes each permutation of the `list` command:

- `list`—List the current source file. Press the **SPACEBAR** to page forward.
- `list` *<routine>*—List the routine specified.
- `list` *<filename>*—List the specified source file. This source file must be one of the files compiled to form the current executable.

- `list` *<first-line>* [*<last-line>*]—List parts of the current source file by specifying the first and possibly the last line to display.
- `list` *<filename>*:*<first-line>* [*<last-line>*]—List parts of the specified file by specifying the first and possibly the last line to display.
- `list` *<filename>*:*<routine>*—List the routine specified. The file name allows you to choose between routines with the same names that are in different files.

Examples

The following examples show various ways to use the `list` command.

```
(CXpa) list
 R 1 PROGRAM GENERIC
   2 INTEGER VAR, VAR3, VAR4, COUNT
   3
   4 VAR = 126
   5 VAR4 = VAR * 16
     .
     .
     .
```

The above command lists the current source file. The uppercase `R` at line 1 indicates the routine region starting at line 1 is selected for profiling.

```
(CXpa) list sub2
 r    1 SUBROUTINE SUB2(MATRIX, VAR3)
      2 INTEGER MATRIX(5,5), VAR3, VAR5
      3
      4 PRINT *,'ENTERING SUB2'
 l p  5 DO I=1,5
 l    6 DO J=1,5
      7 MATRIX(I,J) = (I + J) - VAR3
      8 ENDDO
      9 ENDDO
     10 VAR5 = 38
     11 PRINT *,'LEAVING SUB2'
     12 PRINT *
     13 VAR5 = 12
     14 END
```

The above command lists the routine named `sub2` in the current source file. The lowercase letters `r`, `l`, and `p` indicate routine, loop, and parallel regions that are deselected for profiling.

```
(CXpa) list subs.f:8 30
   8
 L 9 DO 88 COUNT = 1,10,1
  10
  11 IF (COUNT .LT. 5) THEN
  12 VAR = VAR + 3
  13 CALL SUB1(VAR, VAR3)
  14 ELSE
  15 VAR = VAR + 32
  16 CALL SUB1(VAR, VAR3)
  17 ENDIF
  18
  19 VAR3 = VAR3 - 1
  20
  21 88 CONTINUE
  22
  23 CALL SUB4
  24
  25 IF (VAR .EQ. 2000) THEN
  26 CALL SUB5
  27 END IF
  28
  29 END
  30
```

The above command lists lines 8 through 30 in the file named subs.f. The uppercase `L` indicates that the loop region beginning at line 9 is selected for profiling.

```
(CXpa) list matrix_mult.c
```

The above command lists the source file named matrix_mult.c.

```
(CXpa) list 20 55
```

The above command lists lines 20 through 55 of the current source file.

```
(CXpa) list 85
```

The above command lists the current source file starting at line 85.

Related Commands

`add path`	`info`
`list selectable`	`path`

list selectable

ls

List source code regions available for profiling in a source file.

Syntax

`list selectable` [*<routine>* | [*<filename>*] [**:**] {*<first-line>* [*<last-line>*] | *<routine>*}]

Parameter	Meaning
<routine>	Specifies the name of a routine to display.
<filename>	Specifies the name of a file to display.
<first-line>	Specifies a source code line number as the first line to display.
<last-line>	Specifies a source code line number as the last line to display.

Description

The `list selectable` command lists only lines of source code that contain source code regions that can be selected for profiling in the source files that were compiled to form the current executable.

Source code regions that can be selected or deselected for profiling are prefaced with one or more of the following letters: `r` for routines, `l` for loops, `p` for parallel regions, and `b` for basic blocks. Lowercase letters indicate regions that are currently deselected, while uppercase letters indicate regions that are currently selected for profiling (refer to the "Selecting regions in line mode" online help topic or section in this book for more information).

When you use the `list selectable` command without parameters, CXpa lists the lines of source code in the current source file that contain selectable source code regions. The current source file is either the last source file specified or the source file that corresponds to the first object file given to the linker to form the current executable.

When you execute the `list selectable` command, CXpa uses the directories in its search path to find the needed source file. If a source file has been moved after compiling, use the `add path` command to add the needed directory to CXpa's search path.

The following list describes each permutation of the `list selectable` command:

- `list selectable`—List lines selectable regions in the current source file.
- `list selectable` *<routine>*—List the lines containing selectable regions in the routine specified.
- `list selectable` *<filename>*—List lines of source code containing selectable regions in the file specified.
- `list selectable` *<first-line>* [*<last-line>*]—List the lines of source code containing selectable regions in the range specified.
- `list selectable` *<filename>*`:`*<first-line>* [*<last-line>*]—List the lines containing selectable regions in the specified source file in the range specified.
- `list selectable` *<filename>*`:`*<routine>*—List selectable regions in the routine specified. Specifying the file name allows you to distinguish between two routines with the same name that are in different files.

If you enter the `list selectable` command and get no output, it is because there were no selectable source code regions in the range you specified.

Examples

The following examples show various ways to use the `list selectable` command.

```
(CXpa) list selectable
  r    1 PROGRAM GENERIC
 L     9 DO 88 COUNT = 1,10,1
```

The above command lists the regions that can be selected for profiling in the current source file. The annotations show that the routine region at line 1 is currently selected for profiling and the loop region at line 9 is deselected.

```
(CXpa) list selectable sub2
  r   1 SUBROUTINE SUB2(MATRIX, VAR3)
L p   6 DO I=1,5
L     7 DO J=1,5
L     9 DO K=1,30
```

The above command lists the regions that can be selected for profiling in the routine named `sub2`. The annotations show that the loop regions at lines 6, 7, and 9 in `sub2` are currently selected for profiling and the routine region at line 1 is deselected.

```
(CXpa) list selectable prog.f:68 99
  r  68 SUBROUTINE SUB4
L    76 DO I = 1,100,2
L    79 DO WHILE (K .LT. 10)
L p  82 DO J = 1,20,1
  r  99 SUBROUTINE SUB5
```

The above command lists the regions available for profiling in lines 68 through 99 in the file named prog.f. The annotations indicate that the loop regions are currently selected for profiling, and the routine regions are currently deselected.

```
(CXpa) list selectable subs.f
```

The above command lists the regions that can be selected for profiling in the file named subs.f. In this case, no regions are available for profiling.

```
(CXpa) list selectable 20 55
 R 33 SUBROUTINE SUB1(VAR, VAR3)
 R 51 SUBROUTINE SUB3(MATRIX)
```

The above command lists the regions that can be profiled on lines 20 through 55 of the current source file.

```
(CXpa) list selectable 51
 R 51 SUBROUTINE SUB3(MATRIX)
 L 56 DO I=1,5
```

The above command lists the regions that can be profiled in the current source file starting at line 51. Both of these regions are currently selected for profiling, as indicated by the uppercase `R` and `L` annotations.

Related Commands

`add path`	`info path`
`list`	

merge
m

Combines profiling data from multiple PDF files generated from the same executable into a single PDF file for analysis.

Syntax

merge <*filename*>.pdf

Parameter	Meaning
<*filename*>.pdf	Specifies the name of the PDF file in which the merged profiling data will be stored.

Description

The merge command combines the profiling data from multiple PDF files generated from the same executable into a single PDF file.

This feature is useful when profiling message-passing applications with CXpa. Refer to the "Profiling message-passing applications with CXpa" online help topic or section of this book for more information.

The PDF files must be generated from the same executable, and the region and metric selections must be identical. CXpa uses the executable associated with the first PDF file specified on the command line when CXpa was invoked. If an invalid PDF is specified, an error message is displayed, and CXpa continues to merge the data from valid PDF files.

When you execute the merge command, CXpa merges all PDF files specified from the command line when you invoke CXpa plus all PDF files specified during the current session with the set pdf command.

To analyze the merged data in line mode, execute the set pdf command, specifying the name of the new PDF file.

Examples

The following example shows how to use the merge command.

```
% /usr/convex/bin/cxpa a.out.*.pdf -nw

                        CONVEX Performance Analyzer

Type 'help' for help.
Selecting profile a.out.20703.pdf...
Selecting profile a.out.20704.pdf...
Selecting profile a.out.20705.pdf...
```

```
Selecting profile a.out.20706.pdf...
Selecting profile a.out.20707.pdf...
Selecting profile a.out.20708.pdf...
Selecting profile a.out.20709.pdf...
Selecting profile a.out.20710.pdf...
Selecting profile a.out.20711.pdf...
(CXpa) merge a.out.summary.pdf
Using PDF a.out.20703.pdf as base of merge
a.out.20704.pdf                    used (1 thread added)
a.out.20705.pdf                    used (1 thread added)
a.out.20706.pdf                    used (1 thread added)
a.out.20707.pdf                    used (1 thread added)
a.out.20708.pdf                    used (1 thread added)
a.out.20709.pdf                    used (1 thread added)
a.out.20710.pdf                    used (1 thread added)
a.out.20711.pdf                    used (1 thread added)
(CXpa) set pdf a.out.summary.pdf
(CXpa) analyze
```

In the above example, the command

```
% /usr/convex/bin/cxpa a.out.*.pdf -nw
```

invokes CXpa from the shell in line mode with multiple PDF files. CXpa displays the names of the PDF files specified. The `merge` command specifies that the merged data will be stored in the file a.out.summary.pdf.

The output of the `merge` command indicates that the PDF file a.out.20703.pdf was specified first, and additional PDF files specified must match the base information in that PDF in order to be merged (the base information includes name of the executable file that generated the PDF, along with other information that ensures the PDF files to be merged are compatible). The name of each PDF file used to create the merged PDF is also displayed.

The `set pdf` command opens the new PDF file, a.out.summary.pdf, and makes it the current PDF file. The analyze command then uses the data in a.out.summary.pdf to generate reports.

Related Commands

`cxpa` `save executable`

Related Concepts

Profiling message-passing applications with CXpa
Using pre-instrumented executables

path

p

Set CXpa's search path for source files.

Syntax

path *<directory-list>*

Parameter	Meaning
<directory-list>	Specifies one or more directories, separated by a space, as CXpa's search path.

Description

The `path` command replaces CXpa's current search path with the one specified in *<directory-list>*.

By setting CXpa's search path, you tell CXpa where to look for source files. When you compile your source code with CXpa options, CXpa embeds the location of the source files in the executable so that CXpa can find these files. If they are moved after compiling, then CXpa cannot find them.

You can append one or more directories to CXpa's current search path with the `add path` command. You can display CXpa's current search path with the `info` command.

Examples

The following example shows how to use the `path` command.

```
(CXpa) path /usr/data /usr/data/input /usr/data/output
(CXpa) info
```

(Skipping lines of command output not relevant to this example.)

```
Current Search Path(s) : /usr/data
                         /usr/data/input
                         /usr/data/output
```

The `path` command in the above example sets CXpa's search path to the specified directories. The `info` command shows CXpa's search path.

Related Commands

`add path`
`info`
`list`
`list selectable`

quit

q

Exit CXpa.

Syntax

```
quit
```

Description

The `quit` command exits you from CXpa. If you issue the `quit` command during an active profiling session, CXpa notifies you and asks if you still wish to quit. If so, the performance data file (PDF) is closed, and the program you were profiling is terminated.

Examples

This section shows examples of the `quit` command.

```
(CXpa) quit
%
```

The `quit` command exits CXpa and returns you to your shell prompt.

```
(CXpa) quit
Program is paused, quit anyway? ([y]/n)?
```

In the above example, CXpa informs you that you have paused a process and asks if you still wish to quit. The default is yes (`[y]`). Press **RETURN** to accept the default and quit CXpa, or type `n` to cancel the quit operation.

Related Commands

`continue` `stop`

rerun

re

Run and profile your program again using the arguments specified in the last `run` command.

Syntax

`rerun` [*<i/o_redirection>*]

Parameter	Meaning
<i/o_redirection>	Redirects the program's standard input, output, or error from or to the specified file when you include one of the redirection operators (<, >, >>, >&, >>&).

Description

The `rerun` command executes the current executable with the arguments that you specified in the last `run` command.

NOTE: If you use a preexisting PDF, the performance data in the PDF will be overwritten with new data when you execute the `run` or `rerun` command. Use the `set pdf` command to specify a new name for the PDF to avoid overwriting an existing PDF.

NOTE: The `rerun` command does not retain file redirection specified with the `run` command.

While your program is running, you can type **CTRL-c** to pause profiling. Once paused, you can use the `analyze`, `stop`, or `continue` commands.

Examples

The following examples show how the `rerun` command works.

```
(CXpa) run 8 5
The arguments are 8 and 5.
(CXpa) rerun
The arguments are 8 and 5.
```

The above example shows that the `rerun` command uses the arguments specified in the last `run` command.

```
(CXpa) rerun < /usr/data/input
```

The above command runs your program using the arguments from the last `run` command and redirects standard input from the file /usr/data/input.

```
(CXpa) rerun > /usr/data/output
```

The above command runs your program, using the arguments from the last `run` command and redirects standard output to the file /usr/data/output.

```
(CXpa) rerun >& /usr/data/output
```

The `>&` in the above command tells CXpa to redirect standard output and standard error to the file /usr/data/output.

Related Commands

`continue` `run` `stop`

run

ru

Run and profile your program with the specified arguments.

Syntax

run [*<argument>* ...] [*<i/o_redirection>*]

Parameter	Meaning
<argument>	Specifies any number of command line arguments to the program you are profiling. Separate multiple arguments with spaces.
<i/o_redirection>	Redirects the program's standard input, output, or error from or to the specified file when you include one of the redirection operators (<, >, >>, >&, >>&).

Description

The `run` command starts profile data collection and executes the current executable. You specify this executable when you invoke CXpa.

As your program runs, CXpa collects metrics at the regions you selected for profiling with the `select` command. CXpa writes the data it collects to the performance data file (PDF). The default PDF name is *<executable>*.pdf. Use the `set pdf` command to specify another PDF name.

NOTE: If you use a preexisting PDF, the performance data in the PDF will be overwritten with new data when you execute the `run` or `rerun` command. Use the `set pdf` command to specify a new name for the PDF to avoid overwriting an existing PDF.

While your program is running, you can type **CTRL-c** to pause profiling. Once paused, you can use the `analyze`, `stop`, or `continue` commands.

Examples

The examples in this section show various ways to use the `run` command.

```
1.(CXpa) select routine all
2.(CXpa) collect wall_clock cpu
3.(CXpa) run
4.(CXpa) CTRL-c
   (Program execution is paused.)
5.(CXpa) stop
Process 24144 terminated with signal: SIGKILL.
```

The above scenario shows how the `run` command can be used. The line numbers are for reference only.

1. The `select routine all` command selects all routines in your program for profiling.
2. The `collect wall_clock cpu` command tells CXpa to collect wall clock time and CPU time metrics.
3. The `run` command begins program execution and data collection.
4. Program execution is paused by pressing **CTRL-c**.
5. The `stop` command terminates program execution.

```
(CXpa) run
(Program runs to completion, and any output is displayed.)
```

The command in the above example executes the current executable. No arguments are passed to the program. The program's output follows the `run` command.

```
(CXpa) run 18 364
```

The above command executes the program you are profiling and supplies 18 and 364 as arguments to the program.

```
(CXpa) run < /usr/data/input
```

The above command executes the program you are profiling and redirects standard input from the file /usr/data/input.

```
(CXpa) run > /usr/data/output
```

The above command executes the program you are profiling and redirects standard output to the file /usr/data/output.

```
(CXpa) run >& /usr/data/output
```

The `>&` in the above command tells CXpa to redirect standard output and standard error to the file /usr/data/output.

```
(CXpa) run > /usr/data/output >& /usr/data/errors
```

The above example redirects standard output and standard error to different files.

Related Commands

`continue` `rerun` `stop`

save executable

sa e

Save profile selection settings (instrumentation) to the current executable file or to a copy of the current executable.

Syntax

`save executable` [*<filename>*]

Parameter	Meaning
<filename>	An optional parameter that specifies the name of the new executable. The new file is an exact copy of the executable being profiled, except that it contains profiling instrumentation. If you enter the `save executable` command without specifying a file name, the profile selection settings are saved in the current executable.

Description

Use the `save executable` command to write profile selection settings (instrumentation) to the current executable file or to a copy of the current executable. This is referred to as *pre-instrumenting* an executable. Use pre-instrumented executables to:

- Profile with CXpa in environments that do not support CXpa controlling a child process.
- Profile applications in conjunction with tools such as PVM (parallel virtual machine) that replicate processes or with applications where another driver program or script starts the process.

  Refer to the "Profiling PVM applications with CXpa" online help topic or section of this book for information about using pre-instrumented executables when profiling PVM applications with CXpa.

  For example, you can use CXpa command files to pre-instrument executables, then run the instrumented executables in batch mode (using shell scripts) to generate multiple PDF files.
- Maintain separate copies of an executable with different regions and metrics selected for profiling. This makes it easier to generate multiple PDF files for comparison and analysis.

- Profile applications run with the `mpa` utility. Refer to the "CXpa and the `mpa` utility" online help topic or section of this book for more information.

You can then run the resulting executable file outside the control of CXpa and collect profiling data in a .pdf file for later analysis. You can also profile the new executable in the normal way (that is by invoking CXpa with the name of the executable and running it under CXpa).

When you enter the `save executable` command without specifying a file name, CXpa writes the instrumentation to the executable currently being profiled, without changing its name.

To write the instrumentation to a copy of the current executable, specify a file name with the `save executable` command. The resulting file is an exact copy of the executable being profiled, except that it contains the current source code region and metric selections (instrumentation). All source code correlation is maintained. The size and permissions of the executable do not change, but the time stamp on the executable does.

Refer to the "Using pre-instrumented executables" online help topic or section of this book for information about using pre-instrumented executables.

Examples

The following examples demonstrate how to use the `save executable` command.

```
% /usr/convex/bin/cxpa -nw a.out

       CONVEX Performance Analyzer


Type 'help' for help.
Reading executable a.out...
Selecting profile a.out.pdf...

(CXpa) select routine all
(CXpa) collect cpu wall_clock events
(CXpa) set events data_cache
(CXpa) save executable
(CXpa) instrumenting, enter <CTRL+C> to abort.
...10%...20%...30%...40%...50%...60%...70%...80%...90%..100%
(CXpa) instrumentation finished.
(CXpa) quit
```

In the previous example:

- The first command invokes CXpa from the shell with an executable file, `a.out`. The `-nw` (no windows) option specifies that CXpa's line mode (tty) interface will be used.
- The `select` routine all, `collect cpu wall_clock events`, and `set events data_cache` commands specify the regions and metrics selected for profiling.
- The `save executable` command writes the information directly to the executable file named `a.out`.
- The `quit` command exits CXpa.

When the instrumented executable `a.out` is run from the shell, it will generate a PDF file named a.out.pdf, which can then be analyzed with CXpa.

```
% /usr/convex/bin/cxpa -nw a.out

       CONVEX Performance Analyzer


Type 'help' for help.
Reading executable a.out...
Selecting profile a.out.pdf...

(CXpa) select routine all
(CXpa) collect cpu wall_clock
(CXpa) save executable new.a.out
(CXpa) instrumenting, enter <CTRL+C> to abort.
...10%...20%...30%...40%...50%...60%...70%...80%...90%..100%
(CXpa) instrumentation finished.
(CXpa) quit
```

In the above example:

- The first command invokes CXpa from the shell with an executable file, `a.out`. The `-nw` (no windows) option specifies that CXpa's line mode (tty) interface will be used.
- The `select routine all` and `collect cpu wall_clock events` commands specify the regions and metrics selected for profiling.
- The `save executable new.a.out` command writes the information to a copy of the a.out executable named `new.a.out`.
- The `quit` command exits CXpa.

When the instrumented executable `new.a.out` is run from the shell, it will generate a PDF file named new.a.out.pdf, which can then be analyzed with CXpa.

Related Concepts

CXpa and the `mpa` utility
Using pre-instrumented executables

Related Commands

`analyze`
`collect`
`merge`
`run`
`select`
`set events`
`set visibility`

select

sel

Select source code regions in your program for profiling.

Syntax

select [*<region-type>*] [**all** | **in** *<routine-list>* | **at** *<line-number-list>*]

Parameter	Meaning
<region-type>	Specifies the type of region to select. Valid values are as follows: `routine` `loop`—loops `pregion`—parallel loops only `block`—basic blocks
all	Selects the specified *<region-type>* in all routines in your program. If you do not specify a region type, all available regions are selected.
in *<routine-list>*	Specifies the names of one or more routines whose regions you want to select. Separate routine names with a space. If two routines have the same name, prefix them with a file name followed by a colon: *<file-name>* : *<routine-name>*.
at *<line-number-list>*	Selects regions at *<line-number-list>*. *<line-number-list>* specifies one or more line numbers that contain regions you want to select. Separate line numbers with a space. To select a region that is not in the current source file, prefix the line number with a file name followed by a colon: *<file-name>* : *<line-number>*.

Description

The `select` command to select source code regions for profiling in all routines, in specific routines, or at specific lines in source files.

You do not have to recompile your program to select or deselect regions for profiling.

When you invoke CXpa in line mode, all regions in your program are initially deselected for profiling, so you must select one or more of them with the `select` command. When you run your program CXpa collects metrics only at the regions selected for profiling.

NOTE: The loop nesting level setting affects the number of loops selected for profiling. The default loop nesting level setting only selects loops at nesting level 0 (outermost loops) for profiling. Refer to the "Profile Selection dialog" or "`set visibility`" command online help topics or sections of this book for more information about loop nesting levels.

Selecting specific regions to profile provides greater control over profiling and can shorten profiling time.

Refer to the "Profiling strategy" section of this book for more information selecting regions and metrics and a step-by-step profiling strategy.

Select all routine regions the first time you profile your program with the `select routine all` command. This provides a complete picture of your program's performance.

After you have identified the routines whose performance you want to improve, you may want to select only those specific routines for profiling. With fewer source code regions selected, less time is spent in the timing routines CXpa uses to collect performance data.

Selecting code regions for profiling does increase wall-clock time. Profiling time increases with the number of regions selected for profiling. In general, selecting loop regions for profiling increases execution time more than selecting routine regions.

Depending on the option(s) with which you compiled your source code, four types of source code regions can be selected for profiling:

- **Routine**—Routine regions are only available for profiling if your source code is compiled with a Convex compiler using the `-cxpa` or `-cxpar` option or has been instrumented for routine-level profiling with the `cxoi` utility.
- **Loop**—Loop regions are only available for profiling if your source code contains loops and is compiled with a Convex compiler using the `-cxpa` option at optimization level `-O1` or higher.
- **Parallel region**—Parallel regions (parallel loops) are only available for profiling if your source code contains loops and is compiled with a Convex compiler using the `-cxpa` option at optimization level `-O3` (at optimization levels below `-O3`, the compiler does not parallelize loops).
- **Basic block**—Basic block regions are only available for profiling if your source code is compiled with a Convex compiler using the `-cxpab` option.

To list source code regions that can be selected for profiling, use the `list selectable` command.

Examples

The examples in this section show several ways to use the `select` command.

```
(CXpa) select routine all
```

The above command selects all routines in your program for profiling.

```
(CXpa) select pregion in sub2
```

In the above example, all parallel loops at the currently specified loop nesting level in routine `sub2` are selected for profiling.

```
(CXpa) select pregion at 9
```

The above command selects all parallel loops at the currently specified nesting level at line 9 in the current source file.

```
(CXpa) select loop in sub2 init display
```

The above command selects all loops in routines `sub2`, `init`, and `display` for profiling.

```
(CXpa) select at 82
(CXpa) list selectable sub4
      r       68   SUBROUTINE SUB4
     l        76   DO I = 1,100,2
     l        79      DO WHILE (K .LT. 10)
     L P      82         DO J = 1,20,1
```

In the above example, the `select at 82` command selects all source code regions at line 82 of the current source file for profiling.

The `list selectable sub4` command lists the regions that can be selected for profiling in the routine named `sub4`. The letters to the left of the line numbers in the `list selectable` output represent available regions for collection. The uppercase `L` and `P` indicate that line 82 *contains* loop and parallel loop regions that are selected for profiling.

Related Commands

```
deselect                    list selectable
run                         set pdf
set visibility
```

Related Topics

Profiling strategy

set events

set e

Specify the type of events to collect at source code regions selected for profiling.

Syntax

set events <*event*(s)> [**read_only**] [**write_only**]

Parameter	Meaning
<*event(s)*>	Specifies the type of event or events to collect. The type and number of events that can be collected per program run differ according to machine architecture:

- On SPP1000 systems, you can collect one type of off-processor event per program run.
- On SPP1200 systems, you can collect one set of on-processor events per program run.
- On SPP1600 systems, you can collect one type of off-processor events and one set of on-processor events per program run.

SPP1000 and SPP1600 Series off-processor events

Off-processor events on SPP1000 and SPP1600 Series systems are monitored by event counters on the Convex CPU agent chip. Valid off-processor events parameters are as follows:

local_misses— Configures SPP1000 and SP1600 off-processor event counters to collect the number of times that data not found in the processor cache was found in local memory (memory allocated to that processor's hypernode). Requests for memory on the same hypernode use the hypernode crossbar.

remote_misses—Configures SPP1000 and SPP1600 Series off-processor event counters to collect the number of times that data not found in the processor cache was found in remote memory (memory allocated to a different hypernode). Requests for memory on other hypernodes use the CTI rings.

local_and_remote_misses—Configures SPP1000 and SPP1600 Series off-processor event counters to collect the number of times that data not found in the processor cache was found in local and remote memory, combined.

You can use one or both of the following parameters of the `set events` command to specify whether the type of off-processor event you have selected is collected during read operations only, write operations only, or both:

read_only

The `read_only` parameter can only be specified for off-processor events (`local_and_remote_misses`, `remote_misses`, or `local_misses`). This option specifies that CXpa should collect these events during read operations. A *read miss* is a data cache miss caused by a load. By default, the off-processor event counters on SPP1000 and SPP1600 Series systems collect all events caused by reads or writes.

write_only

The `write_only` parameter can only be specified for off-processor events (`local_and_remote_misses`, `remote_misses`, or `local_misses`). This option specifies that CXpa should collect these events during write operations. A *write miss* is a data cache miss caused by a store or a data cache miss caused by a load and clear. By default, the off-processor event counters on SPP 1000 systems collect all events caused by reads or writes.

SPP1200 and SPP1600 Series on-processor events

SPP1200 and SPP1600 Series systems use HP PA-RISC 7200 processors which have on-processor event counters. These can be configured to collect one of the following sets of events per program run using the parameters listed below:

data_cache—Configures SPP1200 and SPP1600 Series on-processor event counters to collect total data cache access counts, miss counts, and latency.

instruction_cache—Configures SPP1200 and SPP1600 Series on-processor event counters to collect total instruction cache miss counts and latency.

instruction_counts—Configures SPP1200 and SPP1600 Series on-processor event counters to collect completed instruction counts and CPU clock cycles.

`tlb_misses`—Configures SPP1200 and SPP1600 Series on-processor event counters to collect data and instruction TLB (translation lookaside buffer) misses.

Description

The `set events` command specifies the collection of events at the source code regions of your program you have selected for profiling. Each use of this command replaces the values previously set. For more information about events metrics on SPP1000, SPP1200, and SPP1600 architectures, refer to the "Introducing metrics" and "Selecting metrics in line mode" online help topics or sections in this book.

NOTE: Unless you have selected source code regions to profile with the `select` command and specified event collection with the `events` parameter of the `collect` command, the `set events` command will not cause any events to be collected.

Examples

The following examples show various ways to use the `set events` command.

```
1. (CXpa) select routine all
2. (CXpa) collect cpu wall_clock events
3. (CXpa) set events local_misses
```

The above sequence of commands shows how to use the `set events` command in combination with the `select` and `collect` commands to select regions for profiling and metrics to collect. The line numbers are for reference only.

1. The `select routine all` command selects all routines in your program for profiling.
2. The `collect` command specifies data collection for CPU time, wall clock time, and events. You must define the types of events to collect with the `set events` command.
3. The `local_misses` parameter of the `set events` command is only valid for SPP1000 and SPP1600 Series machines. The `set events local_misses` command specifies that you want to collect the number of times that data not found in the processor cache was found in memory allocated on the processor's hypernode.

```
(CXpa) set events remote_misses write_only
```

Remote misses can only be collected on multinode SPP1000 and SPP1600 Series machines. The above command tells CXpa to collect the number of times that data not found in the processor cache was found in remote memory (memory allocated to a different hypernode) for the profiled regions of your program. The `write_only` parameter specifies that remote misses will only be collected during write operations.

```
(CXpa) set events instruction_counts remote_misses
```

The above example is specific to SPP1200 and SPP1600 Series systems. The `instruction_counts` parameter configures the on-processor event counters to collect completed instruction counts and clock cycles, while the `remote_misses` parameter configures the off-processor event counters to monitor the number of data cache misses that were resolved remotely.

Related Commands

`collect`
`deselect`
`list selectable`
`run`
`select`
`set visibility`

Related Topics

Introducing metrics
Selecting metrics in line mode

set pdf

set p

Specify the name of the performance data file (PDF).

Syntax

set pdf *<filename>*

Parameter	Meaning
<filename>	Specifies the name of a PDF. The file name you specify should end in .pdf.

Description

The `set pdf` command sets the name of the performance data file (PDF) to be written to and/or read from during a CXpa session.

The PDF is a binary file that contains the performance data for a single run of your program. The data in a PDF is used to calculate the performance reports that appear when you use one of the `analyze` commands. If you do not set the PDF name, CXpa uses the default PDF name of *<executable>*.pdf.

Using the `set pdf` command, you can change the name of the PDF. You may want to do this for two reasons:

- **To prevent CXpa from overwriting an existing PDF**—If you have invoked CXpa with the name of an executable file, when you use CXpa's `run` or `rerun` command, CXpa overwrites all of the data in the PDF. If you do not want this to occur, you must change the name of the PDF between runs of your program with the `set pdf` command.
- **To analyze a different PDF**—If you have invoked CXpa without an executable or with the name of a PDF only, you can use the `set pdf` command to select a PDF created in a previous CXpa session. You can then display performance reports for that PDF with the `analyze` command.

NOTE: If you invoke CXpa with an executable, you can only analyze a PDF created during the current CXpa session. To analyze a PDF created with a different executable or multiple PDF files, invoke CXpa without specifying an executable or with the name of a PDF file.

Examples

The following examples show how to use the `set pdf` command.

```
(CXpa) set pdf /usr/data/my.pdf
```

The previous command sets the name of the PDF to my.pdf. If a program is now run, performance data is collected in the file /usr/data/my.pdf. If a report is generated, CXpa analyzes the data in /usr/data/my.pdf.

```
(CXpa) set pdf ../profiles/prog1.pdf
```

The previous command sets the name of the PDF to prog1.pdf in the ../profiles directory.

Related Commands

`analyze`	`deselect`
`merge`	`run`
`select`	`set events`

Related Topics

Analyzing PDFs only

Performance data files (PDFs)

set subcomplex

set s

Specify the subcomplex you want to run your program on.

Syntax

`set subcomplex` *<subcomplex_name>*

Parameter	Meaning
<subcomplex_name>	Specifies the name of the subcomplex you want to run your program on. The default is the subcomplex from which you invoked CXpa.

Description

Use the `set subcomplex` command to specify the name of the subcomplex you want to run your program on. A *subcomplex* is a collection of processors and memory from one or more hypernodes of an Exemplar SPP Series system (the subcomplex defines the boundary within which all threads belonging to a process execute).

The default value is the subcomplex from which you invoked CXpa. You need only use this command if you want to run your program on a different subcomplex. You must have the appropriate permissions to run the process on the specified subcomplex.

For more information on subcomplexes on SPP Series systems, refer to the scm(1) and scm(4) man pages or the Convex *SPP-UX System Administration Guide* (DSW-853) or contact the system administrator at your site.

To list available subcomplexes on your system or to list the current subcomplex, use the CXpa `info` command.

CXpa queries the system for available subcomplexes at start-up, so if a subcomplex is added during a CXpa session, it will not be visible to CXpa during that session.

Examples

The following example shows how to use the `set subcomplex` command.

```
(CXpa) info

       Current Executable : /home/smith/a.out
   Current Process State : Finished

(Skipping lines of output not relevant to this example)

       Current Subcomplex : System
  Available Subcomplex(s) : Chemistry, System
(CXpa) set subcomplex Chemistry
```

The last two lines in the output of the `info` command in the above example lists the current subcomplex (subcomplex your process is set to run on) and available subcomplexes on your SPP system. The `set subcomplex Chemistry` command specifies that the process will now run on the Chemistry subcomplex, assuming you have the appropriate permissions for that subcomplex.

Related Commands

`info`

set visibility

set v

Set filters (visibility) for profile data collection and/or analysis.

Syntax

```
set visibility
   {loop_levels <min> <max>] |
   loop_levels innermost <num_levels>} |
   {process | threads}
```

Parameter	Meaning
Loop nesting level filters	
`loop_levels` *<min>* *<max>*	Specifies a fixed range of loop nesting levels to profile. *<min>* and *<max>* are positive integers specifying the minimum and maximum loop nesting levels to profile, respectively. Separate the *<min>* and *<max>* values with a space.
`loop_levels innermost` *<num_levels>*	Specifies the number of loop nesting levels to profile relative to each loop nest's innermost level. *<num_levels>* must be a positive integer.

The default loop nesting level is `loop_levels 0 0`.

Process/thread filters	
`process`	Enables you to display process-level performance data in reports.
`threads`	Enables you to display performance data for individual threads in reports.

The default setting is `process`.

Description

The `set visibility` command allows you to set the following filters for profile data collection and/or analysis:

- Loop nesting levels
- Process or thread visibility in CXpa reports

To view the current settings for any these filters, use the `info` command. These settings are explained in more detail in the sections that follow.

Loop nesting level filters

When loop regions are selected for profiling, only loops at nesting level 0 (after optimization) are selected by default. This default setting minimizes profiling intrusion for loop regions.

The `loop_levels` parameter of the `set visibility` command allows you to specify either a fixed range of loop nesting levels to profile or a number of nesting levels relative to each loop nest's innermost level. Loop nesting level settings apply to all loop regions selected for profiling.

CXpa automatically determines the number of loop nesting levels in your program and sets the maximum loop nesting levels and the maximum number of levels from the innermost loop appropriately. These nesting levels correspond to the loops that are created by the compiler, and may not correspond directly to your original source code due to optimizations performed.

Specifying a fixed loop nesting level range

The first time you profile loop regions in your program, use the default setting for loop nesting levels. On subsequent runs of your program, you can select different sections or "slices" of the loops within your program for profiling by specifying a minimum and maximum loop nesting level. When specifying a fixed ranged of loop nesting levels, you will generally want to set the minimum loop nesting loop level equal to the maximum loop nesting level. For example, the command

```
(CXpa) set visibility loop_levels 1 1
```

selects only loops at nesting level 1 (after optimization) for profiling.

Specifying relative loop nesting levels

Instead of choosing a fixed range of loop nesting levels for profiling, you can specify the number of loop nesting levels to profile relative to the innermost loop of each loop nest in your program.

- A relative setting of 0 means that only the loops at the innermost (deepest) level of each loop nest are selected for profiling.
- A relative setting of 1 means that only the loops at the two innermost nesting levels of each loop nest are selected for profiling.

  For example, if the innermost nesting level of a loop nest is 4, the loops at nesting levels 3 and 4 of that loop nest will be selected for profiling.
- A maximum setting (setting the slider bar as far to the right as it will go) is equivalent to selecting all loops at all loop nesting levels.

When a relative loop nesting level is specified, loops that are not part of a loop nest are also selected for profiling. When specifying a relative loop nesting level setting, you must use the `innermost` keyword with the `loop_levels` parameter of the `set visibility` command. For example:

```
(CXpa) set visibility loop_levels innermost 1
```

Process/thread filters

By default, performance data in reports (except for parallel region reports) is displayed for processes; by setting visibility for threads you can display performance data for on a thread-by-thread basis.

Examples

The following examples show how to use the `set visibility` command.

```
(CXpa) select loop in sub1 sub2 sub3
(CXpa) set visibility loop_levels 1 1
```

The above two commands illustrate how to use the `loop_levels` parameter of the `set visibility` command to specify a fixed loop nesting level range.

The `select loop` command selects all loops in routines `sub1`, `sub2`, and `sub3` for profiling. The `set visibility loop_levels 1 1` command further specifies that only loops at nesting level 1 (after optimization) in the specified routines are selected for profiling.

```
(CXpa) set visibility loop_levels innermost
```

The above command specifies a relative loop nesting level setting of 0, and only the innermost loop of each loop nest will be selected for profiling. (If you do not specify a number of levels with the `innermost` keyword, CXpa assumes a default value of 0). This setting also selects any loops that are not part of a loop nest.

```
(CXpa) set visibility loop_levels innermost 1
```

The above command specifies a relative loop nesting level setting. Only the two innermost loops of each loop nest will be selected for profiling.

```
(CXpa) set visibility thread
```

The above command enables you to display performance data on a thread-by-thread basis in CXpa reports.

Related Commands

`analyze`	`deselect`
`info`	`select`
`set events`	`set pdf`

Related topics

Profiling strategy

Reports

source

SO

Execute a CXpa command file.

Syntax

source *<filename>*

Parameter	Meaning
<filename>	Specifies the name of a CXpa command file.

Description

The `source` command executes the CXpa commands in a specified CXpa command file. Sourcing a command file is useful when you find that you are repeating a series of commands during a profiling session.

A CXpa command file is a text file containing a list of CXpa commands. Each command must be on a separate line. Comment lines are denoted with the pound sign (#).

In line mode, CXpa exits and returns you to the shell prompt when it encounters a `quit` command; otherwise, CXpa returns you to the CXpa prompt when it reaches the end of the command file.

In batch mode, CXpa exits when it encounters either a `quit` command or the end of the file.

If CXpa encounters an error in a command file, CXpa stops executing the command file, displays an error message, and returns the CXpa prompt.

Examples

The following examples show how to use the `source` command and CXpa command files.

```
(CXpa) source my_cmd_file
```

The above command executes the CXpa commands in the file named my_cmd_file.

```
# This is a comment line.
select loop in sub4
run
analyze loop > sub4.report
quit
```

The above example shows the format of a CXpa command file.

Related Commands

`analyze` `quit`
`run` `select`

Related Topics

Using batch mode

stop

st

Stop profiling a paused program.

Syntax

```
stop
```

Description

The `stop` command stops data collection, saves the collected data, and terminates the process being profiled. Before you can use the `stop` command, you must pause the program first by pressing **CTRL-c**. Then enter the `stop` command.

When you stop or pause profiling, you can use the `analyze` command to view profile data that was collected up until your program was stopped.

When you display performance reports for a stopped program, the information in the reports is incomplete and only reflects the partial execution of your program.

Examples

The following example shows a likely scenario in which you would use the `stop` command. The line numbers are for reference only.

```
1.(CXpa) run
   (Program output is displayed.)
2.(CXpa) CTRL-c
   (Pressing CTRL-c pauses profiling.)
3.(CXpa) stop
4.(CXpa) analyze
   (Incomplete performance reports are displayed.)
```

The following lines explain the previous example by number:

1. The `run` command runs the program and initiates profile data collection.
2. **CTRL-c** pauses profiling.
3. The `stop` command stops the profiling of your program.
4. The `analyze` command displays the collected profile data.

Related Commands

`analyze` `continue` `run`

version

V

Display version and release information for CXpa.

Syntax

version

Description

The `version` command lists:

- CXpa's version number
- The release date of this version of CXpa
- The product number
- Copyright information

Examples

The output of the `version` command is shown in the following example.

```
(CXpa) version
Convex Performance Analyzer

Version : 3.5
Product # : 710-018415-002
Release Date : 6/20/96

Copyright (c) 1989-1996 Hewlett-Packard Company
All rights reserved.

Report problems by running the "contact" program
which will send electronic mail to the
HP-Convex Technical Assistance Center.
```

Related Commands

`info`

Messages 7

This chapter contains reference pages that explain CXpa messages. The messages are listed in order by identification number (ID). Each explanation contains the following sections:

- **Message** — The exact text of the message. Variable parameters are enclosed in angle brackets (<>) and are shown in italic type. For example, *<collection type>* is a variable that represents a type of source code region.
- **Type** — The message type, which can be one of the following:
  - `INFO` — A condition that is normal or expected processing under the given circumstances.
  - `WARNING` — A condition that might not be normal or expected, but is not severe enough to cause an error. CXpa continues to process your command after issuing the warning.
  - `ERROR`—A condition that prevents completion of the current CXpa command.
  - `FATAL`—A condition that prevents further execution of the process being profiled. Both the process and the CXpa session are terminated.
- **Explanation**—A more detailed explanation of the message, including possible actions to correct the situation.

To display online help for CXpa messages:

- In X window mode, enter the message number in the Search field in the CXpa Help window.
- In line mode, enter the command `help` *<message_number>* at the CXpa prompt.

ID		Description
A1	Message	*<filename>* has been stripped of all symbolic information, unusable.
	Type	ERROR
	Explanation	Quit CXpa, recompile executable source code with one of the CXpa options, and then reinvoke CXpa with the new executable file.
A2	Message	Missing or unmatched *<token>*.
	Type	ERROR
	Explanation	Correct the quotation marks and re-execute the command.
A3	Message	Command syntax error - *<expecting or missing>* *<token>*.
	Type	ERROR
	Explanation	For more information about this command, refer to the online help system or the reference manual.
A4	Message	Command *'<string>'* is ambiguous. Could refer to: *<keyword list>*
	Type	ERROR
	Explanation	Complete your command further so that it can be uniquely recognized.
A5	Message	Command line too complex.
	Type	ERROR
	Explanation	Try to simplify and re-execute the command.
A6	Message	Cannot open input file *<filename>*.
	Type	ERROR
	Explanation	Check to make sure the file exists and the permissions are set so that you can access it.
A7	Message	Cannot open output file *<filename>*.
	Type	ERROR
	Explanation	Check directory and file permissions to see if you are allowed write access.
A8	Message	Cannot have more than one redirection to/from *<filename>*.
	Type	ERROR
	Explanation	Re-execute the command (in line/batch mode) or GUI action (in X window mode) and redirect it to/from another file.
A9	Message	Cannot redirect to *<filename>*.
	Type	ERROR
	Explanation	Re-execute the command (in line/batch mode) or GUI action (in X window mode) and redirect it to/from another file.

ID		Description
A10	Message	Cannot start a new process while another process is still running.
	Type	ERROR
	Explanation	Wait until the current process completes or use the "stop" command (in line/batch mode) or the Abort button (in X window mode) to stop it.
A11	Message	Cannot access PDF *<filename>*.
	Type	ERROR
	Explanation	Check directory and file permissions to see if you have read/write access.
A12	Message	Cannot open file *<filename>*. *<errno description>*
	Type	ERROR
	Explanation	Check directory and file permissions to see if you have write access.
A13	Message	Cannot read from PDF. *<errno description>*.
	Type	ERROR
	Explanation	Check directory and file permissions to see if you have read access.
A14	Message	Cannot read from PDF.
	Type	ERROR
	Explanation	PDF may be corrupt.
A15	Message	Cannot write to PDF. *<errno description>*.
	Type	ERROR
	Explanation	Check directory and file permissions to see if you have write access.
A16	Message	Cannot write to PDF.
	Type	ERROR
	Explanation	PDF may be corrupt.
A17	Message	Obsolete
	Type	ERROR
	Explanation	None.
A18	Message	Executable required before using this command.
	Type	ERROR
	Explanation	Quit CXpa and invoke it with the name of an executable file. Then re-execute this command (in line/batch mode) or GUI action (in X window mode).
A19	Message	PDF *<filename>* is empty or corrupt.
	Type	ERROR
	Explanation	Regenerate the PDF again or try a different PDF.

ID		Description
A20	Message	Cannot create PDF <*filename*>.
	Type	ERROR
	Explanation	Check directory and file permissions to see if you have write access.
A21	Message	PDF <*filename*> cannot be analyzed with this executable.
	Type	ERROR
	Explanation	PDF and this executable are incompatible. Invoke CXpa in analysis mode with the PDF file only or regenerate PDF with this executable.
A22	Message	PDF incompatible with this version of CXpa; regenerate PDF.
	Type	ERROR
	Explanation	PDF can no longer be analyzed; regenerate PDF.
A23	Message	Cannot read name of executable file from PDF.
	Type	ERROR
	Explanation	PDF may be corrupt.
A24	Message	Obsolete
	Type	ERROR
	Explanation	None.
A25	Message	Source file <*filename*> has changed since the PDF was created.
	Type	INFO
	Explanation	Line numbers reported in the Source Window may be incorrect. Regenerate the PDF to correct any line number inaccuracies.
A26	Message	Obsolete
	Type	ERROR
	Explanation	None.
A27	Message	Source file must be specified with this command.
	Type	ERROR
	Explanation	Re-execute this command with an existing source file (in line/batch mode) or use the Windows menu option, Source Code, to select a source file (in X window mode).
A28	Message	File <*filename*> is not an executable file.
	Type	ERROR
	Explanation	Check the directory and file permissions to see if you are allowed to execute it.

ID		Description
A29	Message	Error in command file <*filename*>.
	Type	ERROR
	Explanation	Edit the command file to correct any errors, then re-execute it.
A30	Message	PDF contains incomplete data.
	Type	ERROR
	Explanation	Regenerate the PDF or select a different PDF.
A31	Message	PDF contains no data.
	Type	INFO
	Explanation	The PDF was created with no regions or metrics selected. Select the desired regions and metrics and regenerate the PDF.
A32	Message	PDF, <*filename*>, has the same name as the executable file.
	Type	ERROR
	Explanation	PDF and executable files must be unique. Choose a different filename for the PDF using the "set pdf" command (in line/batch mode) or the File menu option, New PDF (in X windows mode).
A33	Message	Executable has been modified since start-up, please restart CXpa.
	Type	ERROR
	Explanation	The executable (<*filename*>) has been modified since product invocation. Please quit and restart CXpa to read in the new executable.
A34	Message	Error reading from file <*filename*>.
	Type	ERROR
	Explanation	An error occurred reading from file <*filename*>. Check to make sure the file exists and you have permissions to read it.
A35	Message	Error writing to <*filename*>
	Type	ERROR
	Explanation	An error occurred writing to file <*filename*>. Check file and directory permissions and make sure there is disk space available.
A36	Message	Maximum number of threads reached.
	Type	ERROR
	Explanation	You have reached an internal limit on the number of threads a PDF can store.
A37	Message	PDF file is incompatible with the merge command; regenerate PDF.
	Type	ERROR
	Explanation	The merge command requires PDF files from this version of CXpa. PDF files generated from prior versions cannot be merged.

ID		Description
A38	Message	Cannot read source file <*filename*>.
	Type	ERROR
	Explanation	Source file is empty or you do not have permission to read the file.
A39	Message	PDF required before using this command.
	Type	ERROR
	Explanation	Choose a PDF with the "set pdf" command and re-execute the command (in line/batch mode) or choose a PDF with the File menu option, New PDF, and re-execute the GUI action (in X window mode).
A40	Message	Obsolete.
	Type	ERROR
	Explanation	None.
A41	Message	Obsolete.
	Type	ERROR
	Explanation	None.
A42	Message	Obsolete.
	Type	ERROR
	Explanation	None.
A43	Message	Obsolete.
	Type	ERROR
	Explanation	None.
A44	Message	Obsolete.
	Type	ERROR
	Explanation	None.
A45	Message	Directory <*filename*> does not exist.
	Type	ERROR
	Explanation	Re-execute the command (in line/batch mode) or GUI action (in X window mode) with a different directory name.
A46	Message	Obsolete.
	Type	ERROR
	Explanation	None.
A47	Message	Terminating with signal <*signal identifier*>. <*errno description*>
	Type	FATAL
	Explanation	CXpa has received a fatal signal and is terminating. There is no recovery from this condition.

ID		Description
A48	Message	No regions selected for profiling. No region-level analysis will be possible.
	Type	INFO
	Explanation	To obtain region-level metrics use the "select" and "collect" commands (in line/batch mode) or the Region Selection dialog (in X window mode).
A49	Message	Obsolete.
	Type	ERROR
	Explanation	None.
A50	Message	Obsolete
	Type	ERROR
	Explanation	None.
A51	Message	Obsolete
	Type	FATAL
	Explanation	None.
A52	Message	Obsolete
	Type	ERROR
	Explanation	None.
A53	Message	Obsolete
	Type	ERROR
	Explanation	None.
A54	Message	Obsolete
	Type	ERROR
	Explanation	None.
A55	Message	Obsolete
	Type	ERROR
	Explanation	None.
A56	Message	Obsolete
	Type	ERROR
	Explanation	None.
A57	Message	No profilable source code regions could be found. Recompile with current compiler with a CXpa option.
	Type	ERROR
	Explanation	Your executable contains no sources files compiled for profiling with CXpa. Recompile source file(s) and relink with one of the CXpa options to generate a new executable file.

ID		Description
A58	Message	Profiling routines incompatible or missing. Relink with current compiler or linker with a CXpa option.
	Type	ERROR
	Explanation	The profiling routines contained in your executable file are no longer compatible with the current version of CXpa or it was not compiled and linked for profiling with CXpa. Relink with one of the CXpa options to generate a new executable file.
A59	Message	No active PDF selected.
	Type	ERROR
	Explanation	Cannot create a new window until you select an active PDF. Select a PDF from the Active PDF list.
A60	Message	No loop, parallel, or block source code regions are available in *<filename>*.
	Type	INFO
	Explanation	The indicated PDF does not contain any profiling data for loop, parallel, or block source code regions. Only routine-level analysis is available for this PDF.
A61	Message	No *<metric level>* data to graph for *<metric region>* source code regions.
	Type	INFO
	Explanation	There was no data to graph for the source code region you specified. Try graphing a different metric or a different region.
A62	Message	PDF *<filename>* is already in the Analysis Control list; cannot add again.
	Type	ERROR
	Explanation	You can select this PDF from the list to create multiple windows.
A63	Message	Obsolete.
	Type	ERROR
	Explanation	None.
A64	Message	Obsolete.
	Type	ERROR
	Explanation	None.
A65	Message	Cannot save *<graph type>* to *<type identifier>* file. *<errno description>*.
	Type	ERROR
	Explanation	CXpa could not save the graph in the format you requested. Try saving it in a different format.

ID		Description
A66	Message	Exceeded maximum nesting level for CXpa command files.
	Type	ERROR
	Explanation	The command files you were executing contained more than 20 nesting levels. Redefine some of the command files to reduce the level of nesting.
A67	Message	No subcomplexes are available at this time.
	Type	ERROR
	Explanation	If needed, contact your system administrator for assistance in creating a new subcomplex.
A68	Message	Subcomplexes are not available on this architecture.
	Type	ERROR
	Explanation	None.
A69	Message	Could not access subcomplex <*filename*>.
	Type	ERROR
	Explanation	Verify that the specified subcomplex exists by using the "info" command (in line/batch mode) or Info Session dialog (in X window mode). If you are still unable to set the subcomplex, please contact your system administrator for assistance.
A70	Message	No regions selected for a customized 2D or 3D profile.
	Type	INFO
	Explanation	Bring up the Profile Customization dialog by pressing the Customize button and select one or more Profile Regions.
T1	Message	<*string*>.
	Type	ERROR
	Explanation	Product test message.
C1	Message	Cannot open executable file <*filename*>.
	Type	ERROR
	Explanation	The indicated executable file could not be opened. Check to make sure the file exists and that you have permission to access it. If the file does exist, it might contain data that has been corrupted. Try recompiling the file with the appropriate compiler option For CXdb with Convex compilers, use -cxdb; with HP compilers, use -g. For CXpa with Convex compilers, use one of: -cxpa, -cxpar, -cxpab; with HP compilers, use cxoi (refer to the cxoi man page for further information). Do not strip the executable of symbolic information with the -s compiler option or with the strip utility.

ID		Description
C2	Message	Obsolete.
	Type	ERROR
	Explanation	None.
C3	Message	Cannot find <*string*> for <*filename*>.
	Type	ERROR
	Explanation	The table containing the symbolic debugging or profiling information exists, but does not contain data in a format compatible with the current version of CXdb or CXpa. Try recompiling the file with the appropriate compiler option For CXdb with Convex compilers, use -cxdb; with HP compilers, use -g. For CXpa with Convex compilers, use one of: -cxpa, -cxpar, -cxpab; with HP compilers, use cxoi (refer to the cxoi man page for further information). Do not strip the executable of symbolic information with the -s compiler option or with the strip utility.
C4	Message	Corrupt <*string*> for <*filename*> encountered.
	Type	ERROR
	Explanation	The table containing the symbolic debugging or profiling information exists, but does not contain data in a format compatible with the current version of CXdb or CXpa. Try recompiling the file with the appropriate compiler option For CXdb with Convex compilers, use -cxdb; with HP compilers, use -g. For CXpa with Convex compilers, use one of: -cxpa, -cxpar, -cxpab; with HP compilers, use cxoi (refer to the cxoi man page for further information). Do not strip the executable of symbolic information with the -s compiler option or with the strip utility.
C5	Message	Pathname <*filename*> is not a valid directory.
	Type	ERROR
	Explanation	The pathname you specified is not a directory. Try a different pathname.
C6	Message	Symbolic debugging or profiling information format incompatible with this version of CXdb or CXpa.
	Type	WARNING
	Explanation	The format of the symbolic information generated by the compiler is incompatible with this version of CXdb or CXpa. Try recompiling the file with the appropriate compiler option For CXdb with Convex compilers, use -cxdb; with HP compilers, use -g. For CXpa with Convex compilers, use one of: -cxpa, -cxpar, -cxpab; with HP compilers, use cxoi (refer to the cxoi man page for further information). Do not strip the executable of symbolic information with the -s compiler option or with the strip utility.

ID		Description
C7	Message	Cannot find source file for <*filename*> in search path.
	Type	WARNING
	Explanation	Could not find the source file associated with your executable file. If you have moved the source file since compiling it, use the "add path" command to specify the new location of this file.
C8	Message	Obsolete.
	Type	ERROR
	Explanation	None.
C9	Message	Obsolete.
	Type	ERROR
	Explanation	None.
C10	Message	Ambiguous file name <*filename*>. Use a qualified pathname.
	Type	ERROR
	Explanation	The specified source file name is ambiguous. Use a path name to qualify the source file name.
C11	Message	Source file <*filename*> is out of date. Last modified <*date*>; compiled <*date*>.
	Type	WARNING
	Explanation	The specified source file has been modified since the executable was last compiled. This is only a warning; the specified version of your source file will be used.
C12	Message	Obsolete.
	Type	ERROR
	Explanation	None.
C13	Message	Cannot find file <*filename*> within current search path.
	Type	ERROR
	Explanation	Could not find the specified file in your current search path. Use the "add path" command to add directories to the search path.
C14	Message	Obsolete.
	Type	ERROR
	Explanation	None.

ID		Description
C15	Message	Symbolic data file <*filename*> is out of date. Last compiled <*date*>; data file created <*date*>.
	Type	ERROR
	Explanation	The indicated symbolic data file is out of date with the executable file. Try relinking the executable file to include the correct version of the data file. Use the "add path" command to add directories to the search path.
C16	Message	Obsolete.
	Type	ERROR
	Explanation	None.
C17	Message	Cannot read line <*count*> from file <*filename*>.
	Type	ERROR
	Explanation	Could not read from the indicated source file. If you have modified this file since its last compilation, try recompiling the file.
C18	Message	Obsolete.
	Type	ERROR
	Explanation	None.
C19	Message	File <*filename*> is not a valid object file. <*errno description*>
	Type	ERROR
	Explanation	The specified file is not a valid object file, for the reason indicated. Try a different object file name.
C20	Message	Routine <*routine identifier*> was not compiled for or rejected for profiling.
	Type	ERROR
	Explanation	Recompile the source file containing the routine with one of the CXpa compiler options. Refer to the CXpa limitations section online help topic or the CXpa Reference.
C21	Message	Cannot <*operation*> alternate entries to routine <*routine identifier*>.
	Type	ERROR
	Explanation	Re-execute the command (in line/batch mode) or GUI action (in X window mode) using the main entry point to the routine.
C22	Message	Routine <*routine identifier*> is not unique, qualify using filename:routine.
	Type	ERROR
	Explanation	Re-execute the command (in line/batch mode) or GUI action (in X window mode) qualifying the routine with a filename. Use the format filename:routine.

ID		Description
C23	Message	Cannot <*operation*> <*collection type*> in routine <*routine identifier*>.
	Type	ERROR
	Explanation	Re-execute the command with a different routine name. Use the "list selectable" command (in line/batch mode) or the Region Selection dialog (in X window mode) to view the available source regions and their state of selection.
C24	Message	Line <*count*> in file <*filename*> was not compiled for or rejected for <*collection type*> profiling.
	Type	ERROR
	Explanation	Recompile the source file containing the line with one of the CXpa compiler options. Refer to the CXpa limitations section online help topic or the CXpa Reference.
C25	Message	No <*collection type*> to <*operation*> at line <*count*> in file <*filename*>.
	Type	ERROR
	Explanation	Re-execute the command with a different line number. Use the "list selectable" command (in line/batch mode) or the Region Selection dialog (in X window mode) to view the available source regions and their state of selection.
C26	Message	Cannot find routine <*routine identifier*>.
	Type	ERROR
	Explanation	Check to see if the source file containing this routine is within the search path(s) or re-execute the command (in line/batch mode) or GUI action (in X window mode) with a different routine name.
C27	Message	Cannot find file <*filename*>.
	Type	ERROR
	Explanation	Check that the file exists and that you specified its name correctly. If it is a source file, try using the "add path" command (in line/batch mode) or the Source Search Path dialog (in X window mode) to help CXpa locate the file.
D1	Message	Cannot read <*string*> from executable. <*string*> <*string*>
	Type	ERROR
	Explanation	A critical data structure could not be found in your current program. This prevents the backtrace command from working. You may either continue cautiously or try recompiling and relinking your application. For CXdb with Convex compilers, use -cxdb; with HP compilers, use -g. For CXpa with Convex compilers, use one of: -cxpa, -cxpar, -cxpab; with HP compilers, use cxoi (refer to the cxoi man page for further information). Do not strip the executable of symbolic information with the -s compiler option or with the strip utility.

ID		Description
D2	Message	Cannot read <*string*> from executable. <*string*> <*string*>
	Type	ERROR
	Explanation	The current executable file is corrupt and cannot be executed. Try recompiling your executable. For CXdb with Convex compilers, use -cxdb; with HP compilers, use -g. For CXpa with Convex compilers, use one of: -cxpa, -cxpar, -cxpab; with HP compilers, use cxoi (refer to the cxoi man page for further information). Do not strip the executable of symbolic information with the -s compiler option or with the strip utility.
D3	Message	Current executable is unreadable.
	Type	ERROR
	Explanation	The current executable cannot be read. No further work can continue on this executable. Try recompiling and relinking your application. For CXdb with Convex compilers, use -cxdb; with HP compilers, use -g. For CXpa with Convex compilers, use one of: -cxpa, -cxpar, -cxpab; with HP compilers, use cxoi (refer to the cxoi man page for further information). Do not strip the executable of symbolic information with the -s compiler option or with the strip utility.
D4	Message	File <*filename*> is not a core file.
	Type	ERROR
	Explanation	The given file is not recognized as a core file. A core file is a file created when your program aborts unexpectedly. No other file can be a core file. If this file was created by an unexpected abort, then it may have been corrupted. Recreate a new core file by running your program again and be sure that you have enough disk space.
D5	Message	Cannot find symbolic support in current executable.
	Type	WARNING
	Explanation	The current executable does not have any symbolic support. Both debugging and performance analysis may proceed; however, many important features will not work such as loop instrumentation, source code to program counter correlation, and printing user variables. If you want these features, recompile your program with the appropriate compiler option. For CXdb with Convex compilers, use -cxdb; with HP compilers, use -g. For CXpa with Convex compilers, use one of: -cxpa, -cxpar, -cxpab; with HP compilers, use cxoi (refer to the cxoi man page for further information). Do not strip the executable of symbolic information with the -s compiler option or with the strip utility.

ID		Description
D6	Message	Cannot read <*string*> from executable. <*string*> <*string*>.
	Type	ERROR
	Explanation	The current executable contains symbolic support; however, the specified table could not be read. Both debugging and performance analysis may proceed; however, many important features such as loop instrumentation, source code to program counter correlation, and printing user variables will not work correctly. If you want these features, recompile your program with the appropriate compiler option. For CXdb with Convex compilers, use -cxdb; with HP compilers, use -g. For CXpa with Convex compilers, use one of: -cxpa, -cxpar, -cxpab; with HP compilers, use cxoi (refer to the cxoi man page for further information). Do not strip the executable of symbolic information with the -s compiler option or with the strip utility.
D7	Message	Executable not properly linked. Relink with the Convex linker.
	Type	WARNING
	Explanation	The Convex linker generates table that are used by CXdb and CXpa to index the symbolic information in the executable. You must relink with the Convex linker to take advantage of symbolic information. Both debugging and performance analysis may proceed; however, many important features such as loop instrumentation, source code to program counter correlation, and printing user variables will not work correctly.
D8	Message	Executable has been preprocessed for exclusive use with xdb or DDE. Relink with the Convex linker.
	Type	WARNING
	Explanation	CXdb cannot read symbolic debugging information from an executable which has been preprocessed by the pxdb utility (the HP symbolic information preprocessor). Note that the DDE and xdb debuggers automatically invoke pxdb on executables that have not already been preprocessed, which overwrites the symbolic information in the executable. To correct this problem, relink the application with the Convex linker.
S1	Message	Cannot seek data in process memory. Errno: <*errno*>; address: <*address*>
	Type	ERROR
	Explanation	Operation could not be performed. There is no recovery.
S2	Message	Cannot read data from process memory. Errno <*errno*>; address <*address*>.
	Type	ERROR
	Explanation	Operation could not be performed. There is no recovery.

ID		Description
S3	Message	Partially read data from process memory
	Type	WARNING
	Explanation	Operation could not be performed. There is no recovery.
S4	Message	Cannot write data to process memory. Errno *<errno>*; address *<address>*.
	Type	ERROR
	Explanation	Operation could not be performed. There is no recovery.
S5	Message	Partially written data to process memory
	Type	WARNING
	Explanation	Operation could not be performed. There is no recovery.
S6	Message	Process is executing.
	Type	ERROR
	Explanation	Operation could not be performed. There is no recovery.
S7	Message	Process is not executing.
	Type	ERROR
	Explanation	Operation could not be performed. There is no recovery.
S8	Message	Process is not paused.
	Type	ERROR
	Explanation	Operation could not be performed. There is no recovery.
S9	Message	Process not detached.
	Type	ERROR
	Explanation	Operation could not be performed. There is no recovery.
S10	Message	Process is detached.
	Type	ERROR
	Explanation	Operation could not be performed. There is no recovery.
S11	Message	Process no longer exists.
	Type	ERROR
	Explanation	Operation could not be performed. There is no recovery.
S12	Message	Breakpoint already exists at address *<address>*.
	Type	ERROR
	Explanation	Operation could not be performed. There is no recovery.

ID		Description
S13	Message	Cannot access executable *<filename>*. *<errno description>*.
	Type	ERROR
	Explanation	Check the permissions on this file.
S14	Message	fork() system call failed. *<errno description>*.
	Type	ERROR
	Explanation	Operation could not be performed. There is no recovery.
S15	Message	exec() system call failed.
	Type	ERROR
	Explanation	Operation could not be performed. There is no recovery.
S16	Message	Process cannot be terminated. *<errno description>*.
	Type	ERROR
	Explanation	Operation could not be performed. There is no recovery.
S17	Message	Process cannot be attached to. *<errno description>*.
	Type	ERROR
	Explanation	Operation could not be performed. There is no recovery.
S18	Message	Process cannot be detached. *<errno description>*.
	Type	ERROR
	Explanation	Operation could not be performed. There is no recovery.
S19	Message	Process cannot be continued. *<errno description>*.
	Type	ERROR
	Explanation	Operation could not be performed. There is no recovery.
S20	Message	Process cannot be closed. *<errno description>*.
	Type	ERROR
	Explanation	Operation could not be performed. There is no recovery.

Glossary

A

ALL
Acronym for Convex Assembler, Loader, and Libraries.

B

bank conflict
An attempt to access a particular memory bank before a previous access to the bank is complete.

basic block
A linear sequence of machine instructions with a single entry and a single exit.

blocking factor, loop
Integer representing the stride of the outer strip of a pair of loops created by blocking.

C

cache
A small, high-speed buffer memory used in modern computer systems to hold temporarily those portions of the contents of the main memory that are, or are believed to be, currently in use. Cache memory is physically separate from main memory and can be accessed with substantially less latency. Convex SPP Series computers employ separate data and instruction cache memories.

cache, direct mapped

A form of cache memory which addresses encached data by a function of the data's virtual address. On SPP1000 Series computers, the cache address is identical to the least significant 20 bits of the data's virtual address. This means cache thrashing can occur when the virtual addresses of two data items are an exact multiple of 1 Mbyte (20 bits) apart. On SPP1200 Series computers, the main cache address is identical to the least significant 18 bits of the data's virtual address. Cache thrashing can therefore occur on SPP1200 machines when the virtual addresses of two data items are an exact multiple of 256 kbytes (18 bits) apart.

cache, fully associative

A form of cache memory that attempts to prevent encached data from being overwritten by storing an incoming element in a cache location that is determined using a hashing algorithm. The incoming element's virtual address is irrelevant. Unlike a direct mapped cache, a fully associative cache will never displace a cache line unless the cache is full.
SPP1200 Series machines use 2-kbyte, on-chip, fully associative assist caches to mitigate cache thrashing.

cache hit

A cache hit occurs if data to be loaded resides in the cache.

cache line

A chunk of contiguous data that is copied into a cache in one operation. On SPP Series computers, processor cache lines consist of 32 bytes of data. When a processor cache miss occurs and data must be fetched from outside the processor cache, the requested data is brought in as part of a 32-byte cache line. CTIcache lines consist of 64 bytes of data (two contiguous processor cache lines). When a CTIcache miss occurs, the requested data is brought into the CTIcache as part of a 64-byte cache line.

cache misses, data

Number of times requested data was not found in the processor's data cache.

cache misses, instruction

Number of times that referenced instructions were not found in the processor's instruction cache.

cache thrashing

Cache thrashing occurs when two or more data items that are frequently needed by the program map to the same cache address. In this case, each time one of the items is encached, it overwrites another needed item, causing constant cache misses and impairing data reuse.

chunk
A unit of work in a loop that has been parallelized by the compiler consisting of a number of loop iterations.

chunk count
Number of chunks (packets of loop iterations) assigned to execute on a particular thread in a parallel loop.

clock cycle
The duration of the square wave pulse sent throughout a computer system to synchronize operations. The clock cycle time for Convex SPP 1000 Series systems is ~10 nanoseconds.

clock cycles per instruction
A measure of the efficiency of instruction scheduling. CXpa calculates this metric during analysis if instruction counts and clock cycles are collected. On SPP 1200 systems, the maximum number of instructions that can be executed in a single clock cycle is 2. This means that the theoretical peak value for the clock cycles per instruction metric on this architecture is 0.5.

coherency (cache)
A term frequently applied to caches. If a data item is referenced by a particular processor on a multiprocessor system, the data is copied into that processor's cache and is updated there if the processor modifies the data. If another processor references the data while a copy is still in the first processor's cache, a mechanism is needed to ensure that the second processor does not use an outdated copy of the data from memory. The state that is achieved when both processors' caches always have the latest value for the data is called cache coherency. On SPP Series computers, an item of data may reside concurrently in several processors' caches.

compiler
Software that converts high-level language programs into machine code. Compilers for parallel systems improve performance of applications by automatically determining the best way to execute program procedures when several processors are available.

compiler parallel support library (CPSlib)
A library of thread management and synchronization routines that can be used to control parallelism on Exemplar systems. Using CPSlib requires you to manually control all aspects of parallelism, synchronization, and data partitioning.

concurrency factor, parallel
The ratio of CPU time to wall clock time. For parallel regions, this metric is an indicator of the speed-up achieved through parallelism. Values that approach *n*, where *n* is the number of processors used by your program, indicate good parallel concurrency.

CPU Agent
The gate array on Convex SPP Series systems that provides a high-speed interface between the pairs of PA-RISC processors in a functional block and the crossbar. Also called the Agent and the CPA.

CPU time
Time the CPU spent in the program (user CPU time), not including time waiting for I/O or running other programs. If a program can use multiple processors, the CPU time may be greater than the wall clock time.

CPU/wall clock
Ratio of CPU time to wall clock time. For serial regions, if the CPU/Wall clock ratio is high (approaches 1.0), the region is compute-bound. For parallel regions, this ratio corresponds to the concurrency factor, which is an indicator of the speed-up achieved through parallelization. Values that approach *n*, where *n* is the number of processors used by your program, indicate good parallel concurrency. For both parallel and serial regions, if the CPU/Wall clock ratio is low, this could indicate a performance bottleneck caused by I/O calls, system calls, or memory accesses.

crossbar
A switching device that connects the CPUs, banks of memory, and I/O controller on a single hypernode of a Convex SPP Series system. Because the crossbar is nonblocking, all ports can run at full bandwidth simultaneously unless there is contention for a particular port.

CTIcache
A partition of physical memory that exists on each hypernode and is used to store copies of global data fetched from other hypernodes.

CTI (Coherent Toroidal Interconnect) ring
The ring interconnect that connects all the hypernodes of a multihypernode Convex SPP Series system together in a ring topology. While the CTI ring is derived from the IEEE SCI standard, complete compatibility is sacrificed to provide lower latencies.

`cxoi` utility

The Convex object file instrumentor (`/usr/convex/bin/cxoi`, a separate utility shipped with CXpa) is used to instrument object and archive library files produced by any PA-RISC targeting compiler. This includes executables compiled with HP C, C++, or Fortran compilers. Only routines are exposed for profiling with this utility. The `cxoi` utility only *enables* selection of routine regions for profiling in object and archive library files; it does not automatically select these regions for profiling. Region selection is done using CXpa.

D

data cache

On Convex SPP1000 systems, a 1-Mbyte, write-back, direct-mapped cache memory with a 1-clock cycle access time. This cache holds prefetched and current data. On Convex SPP1200 systems, there are two data caches—a 256-kbyte off-chip, write-back, direct-mapped main cache and a 2-kbyte, fully associative, on-chip assist cache; the access time is also 1 clock cycle.

data cache hit

A data cache hit occurs if data to be loaded resides in the processor's data cache.

data cache hit rate

The percentage of total data cache accesses that were data cache hits. If the data cache hit rate is low, this indicates cache thrashing. CXpa uses the following formula to calculate the data cache hit rate:

$$data\_cache\_hit\_rate = \frac{total\_data\_cache\_accesses - data\_cache\_misses}{total\_data\_cache\_accesses} \times 100$$

data cache miss

A data cache miss occurs if data to be loaded does not reside in the processor's data cache.

DTLB misses, data TLB misses

Data translation lookaside buffer misses. This metric represents the number of times the address translation from virtual to physical memory for data to be referenced was not found in the translation lookaside buffer (TLB). The TLB is a cache of 120 virtual-to-physical memory address translations for the most recently referenced page table entries.

dynamic selection
The process by which the compiler chooses the appropriate clone of a code section (typically, a loop) at runtime, in order to achieve the lowest execution time.

E

event
Hardware events such as locally and/or remotely resolved cache misses during reads and/or writes; data and instruction cache accesses and misses; instruction counts and clock cycles, and data and instruction TLB (translation lookaside buffer) misses. Using CXpa, you can configure on-processor and off-processor hardware event counters on SPP Series systems to collect hardware event metrics. Hardware events that can be collected vary according to machine architecture.

event counts
The number of times an event, such as a data or instruction cache miss, occurred.

exclusive times and metrics
Exclusive times and metrics reported by CXpa do not include time spent in or metrics collected for called (child) routines.

G

globally shared memory (GSM)
A feature of some parallel systems that lets all processors transparently access any location in main system memory. This lets a single, scalable operating system control the resources of the system. The arrangement presents a familiar environment to developers and users. On SPP Series computers, globally shared memory is distributed among hypernodes, but any hypernode's memory is accessible from any processor on any hypernode. This type of memory is sometimes referred to as shared virtual memory or global virtual memory.

H

hypernode
In Exemplar SPP Series systems, a set of up to eight processors and physical memory organized as a symmetric multiprocessor (SMP) running a single image of the operating system microkernel. An SPP system consists of one or more hypernodes, with a high speed CTI ring connecting the hypernodes.

I

inclusive times and metrics
Inclusive times and metrics reported by CXpa include time spent in or metrics collected for called (child) routines.

instruction cache
On SPP1000 systems, a 1-Mbyte cache memory with a 1-clock cycle access time. This cache holds prefetched instructions and permits the simultaneous decoding of one instruction with the execution of a previous instruction. On SPP1200 systems, it is 256 kbytes in size with a 1-clock cycle access time.

instruction cache miss
An instruction cache miss occurs when a memory reference for an instruction cannot be resolved in the processor cache.

instrumenting, instrumentation
Before you can profile your program with CXpa, it must be prepared, or instrumented for profiling. When you compile your program with a CXpa profiling option or instrument your program with the `cxoi` utility, instructions are inserted into the executable file that enable CXpa to gather performance data during execution of your program. When you select regions and metrics for profiling, CXpa inserts calls to the timing and profile data collection routines for the selected regions and metrics.

ITLB misses, instruction TLB misses
Instruction translation lookaside buffer misses. This metric represents the number of times the address translation from virtual to physical memory for an instruction was not found in the translation lookaside buffer (TLB). The TLB is a cache of 120 virtual-to-physical memory address translations for the most recently referenced page table entries.

J

join
The synchronized termination of parallel execution by spawned tasks or threads.

L

latency time

As measured by CXpa, the amount of time spent accessing memory to locate data or instructions not found in the processor's data or instruction cache.

latency/counts
Average latency time per event for a code region. For example, if total data cache miss counts are collected, then the event latency/counts value computed by CXpa during analysis represents the average amount of time it took to resolve a data cache miss.

latency/CPU
Ratio of event latency to CPU time for a code region, expressed as a percentage. CXpa calculates this metric during analysis if data or instruction cache miss events, latency, and CPU time are collected. When this percentage is high, it means that the program spent the majority of its CPU time in the region "reaching" for data or instructions that were not encached rather than computing with encached data or instructions.

load
An instruction used to move the contents of a memory location into a register.

locality of reference
An attribute of a memory reference pattern that refers to the likelihood of an address of a memory reference being physically close, in terms of the number of clock cycles necessary to access it, to the CPU making the reference.

localization
Data localization. Optimizations designed to keep frequently used data in the processor data cache, thus eliminating the need for more costly CTIcache or main memory accesses.

locally resolved cache misses
Cache misses that are resolved by using the hypernode crossbar to access memory found on the same hypernode as the processor; the CTI rings are not used.

loop blocking
A loop transformation that strip-mines and interchanges a loop to provide optimal reuse of the encachable loop data.

loop distribution
The restructuring of a loop nest to create simple loop nests. Loop distribution creates two or more loops, called distributed parts, which can serve to make parallelization more efficient by increasing the opportunities for loop interchange and isolating code that must run serially from code that can be parallelized. It can also improve data localization and other optimizations.

loop interchange
The reordering of nested loops. Loop interchange is generally done to increase the granularity of the parallelizable loop(s) present or to allow more efficient access to loop data.

loop replication
The process of transforming one loop into more than one loop to facilitate an optimization. The optimizations that replicate loops are `IF-DO` and `if-for` optimizations, dynamic selection, loop unrolling, unroll and jam, and loop blocking.

loop strip mining
The transformation of a single loop into two nested loops. Conceptually, this is how parallel loops are created by default. A conceptual outer loop advances the initial value of the inner loop's induction variable by the parallel strip length. The parallel strip length is based on the trip count of the loop and the amount of code in the loop body. Strip mining is also used by the data localization optimization.

loop unrolling
A loop transformation performed by the compiler that involves increasing a loop's step value and replicating the loop body, with each replication appropriately offset from the induction variable so that all iterations are performed, given the new step. Unrolling can be total or partial.

Total unrolling involves eliminating the loop structure completely, replicating the loop body a number of times equal to the iteration count, and replacing the iteration variable with constants. Total unrolling is generally performed on loops with small iteration counts.

Partial unrolling is performed on loops with larger or unknown iteration counts. It retains the loop structure, but replicates the body a number of times equal to the unrolling factor, and adjusts references to the iteration variable accordingly.

M

memory bank conflict
An attempt to access a particular memory bank before a previous access to the bank is complete.

message passing
A type of programming in which program modules (often running on different processors or different hosts) communicate with each other by means of system library calls that package, transmit, and receive data. All message passing library calls must be explicitly coded by the programmer.

MIPS
Millions of instructions per second.

MIPS rate
CXpa uses the following formula to calculate the MIPS rate:

$$MIPS\_rate = \frac{Number\_of\_instructions\_completed}{Wall\_clock\_time\_in\_sec}$$

The theoretical peak MIPS rate for Hewlett-Packard PA-RISC 7100/7200 processors with a 10-ns clock cycle at a clock rate of 100 MHz is 200 MIPS.

N

NUMA
Nonuniform memory access. This term describes memory access times in systems such as the SPP Series, in which different types of memory result in nonuniform access times.

O

off-processor events
Off-processor events are monitored by event counters (when available) on the Convex CPU agent chip. On an SPP1000 and SPP1600 Series system, these event counters can be configured to monitor the number of data cache miss events that are resolved locally and/or remotely (remote miss events imply use of the CTI rings; local miss events do not use the CTI rings) and whether those events occurred due to reads (loads) or writes (stores).

on-processor events
On-processor events are monitored by event counters (when available) located on the HP PA-RISC processors used in SPP Series systems. These event counters monitor events from the processor's point of view only.

optimization
The refining of application software programs to minimize processing time. Optimization takes maximum advantage of a computer's hardware features and minimizes input/output traffic and idle processor time.

optimization level
The degree to which source code is optimized by the compiler. The Convex Fortran and C compilers have five levels of optimization, level `-no`, `-O0`, `-O1`, `-O2`, and `-O3`. The default level for Convex compilers is `-O2`.

oversubscription
In the context of parallel threads, a process attribute that permits the creation of more threads within a process than the number of processors available to the process.

P

parallel optimization
The transformation of source code into parallel code (parallelization) and restructuring of code to enhance parallel performance.

parallelization
The process of transforming serial code to a form of code that can run simultaneously on multiple CPUs while preserving semantics. At optimization level `-O3`, the Convex compilers automatically parallelize loops in your program and recognize compiler directives with which you can manually specify parallelization of both loops and tasks.

parallelization, loop
The process of splitting a loop into several smaller loops, each of which operates on a subset of the data of the original loop, and generating code to run these loops on separate processors in parallel.

PDF (performance data file)
A binary file CXpa creates that contains the performance data for a single run of your program. The data in a PDF is used to create 2D and 3D profile graphs and analysis reports.

pre-instrumented executable
You can write profile selection settings (instrumentation) to the current executable file or to a copy of the current executable. This is referred to as *pre-instrumenting* an executable. The resulting executable file can be run outside the control of CXpa and profiling data collected in a performance data file (PDF file) for later analysis.

process
A collection of one or more execution streams within a single logical address space; an executable program. A process is made up of one or more threads.

PVM
Parallel virtual machine. A message-passing and process control library available on Exemplar SPP Series systems.

R

read
A memory operation in which the contents of a memory location are copied and passed to another part of the system.

read miss
A data or instruction cache miss that occurred as a result of a read operation.

reduced instruction set computer (RISC)
An architectural concept that applies to the definition of the instruction set of a processor. A RISC instruction set is an orthogonal instruction set that is easy to decode in hardware and for which a compiler can generate highly optimized code. The PA-RISC processor used in SPP Series computers employs a RISC architecture.

remotely resolved cache misses
Cache misses that were resolved by using the CTI rings to access memory on another hypernode. Accessing memory on other hypernodes using the CTI rings takes significantly longer than accessing memory on the same hypernode via the hypernode crossbar.

S

Scalable Coherent Interface (SCI)
Scalable Coherent Interface. This is defined by IEEE standard 1596-1992. The interface is physically defined as a pair of 18-bit, differential ECL, unidirectional links which are clocked at 250 MHz. Each link provides 16 bits of data with two control signals. Data is sampled on both the rising and falling edges of the clock. This interface provides the basis for the CTI rings used in Convex SPP Series systems; however, total compatibility with the standard has been sacrificed to provide increased performance.

Scalable Parallel Processor (SPP)
Scalable parallel processor systems combine the accessibility and proven technology of single-processor workstations with symmetric multiprocessors' ease of programming and ability to address large problems. SPPs can be scaled or expanded to serve additional users when necessary. SPP systems are capable of handling hundreds of high-performance processors. Compute capacity, memory, and other subsystems also scale when necessary. A key design goal for SPP systems is to enable performance to increase linearly with respect to its number of processors.

spawn
To activate existing threads.

store
An instruction used to move the contents of a register to memory.

subcomplex
In Convex SPP Series systems, a logical entity that provides control over the allocation of processors and physical memory to different applications and users.

symmetric multiprocessor (SMP)
A multiprocessor computer in which all the processors have equal access to all machine resources. Symmetric multiprocessors have no master or slave processors; the operating system runs on any or all of the processors.

system subcomplex
In a Convex SPP Series system, a subcomplex that is automatically created at boot time by the operating system to run system processes, including `init` and processes spawned by `init`. The Subcomplex Manager will not allow users to destroy this subcomplex, nor remove the last processor from this subcomplex.

T

thread
An independent execution stream that is executed by a CPU. One or more threads, each of which can execute on a different CPU, make up each process. Memory, files, signals, and other process attributes are generally shared among threads in a given process, enabling the threads to cooperate in solving the common problem. Threads are created and terminated by instructions that can be automatically generated by Convex compilers, inserted by adding compiler directives to source code, or coded explicitly using library calls or assembly-language.

thread identifier (thread ID)
An integer identifier associated with a particular thread. See thread identifier, kernel (ktid) and thread identifier, spawn (stid).

thread identifier, kernel (ktid)
A unique integer identifier (not necessarily sequential) assigned when a thread is created.

thread identifier, spawn (stid)
A sequential integer identifier associated with a particular thread that has been spawned. stids are only assigned to spawned threads, and they are assigned within a spawn context; therefore, duplicate stids may be present amongst the threads of a program, but stids are always unique within the scope of their spawn context. stids are assigned sequentially and run from 0 to one less than the number of threads spawned in a particular spawn context.

TLB (translation lookaside buffer)
A hardware structure in each CPU in an SPP Series system that contain information necessary to translate a virtual memory reference to a physical page and to validate memory accesses. The TLB contains 120 entries that represent address translations from virtual to physical memory for the most recently used page table entries.

TLB data and instruction misses
Number of times the address translation from virtual to physical memory for data or instructions to be referenced was not found in the translation lookaside buffer (TLB).

W

wall clock time
Time to solution or elapsed time for a program, including disk accesses, memory accesses, input/output, and operating system overhead. Compare with CPU time.

write
A memory operation in which a memory location is updated with new data.

write miss
A data or instruction cache miss that occurred as a result of a read operation.

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