ROGUE WAVE® SOFTWARE

TOTALVIEW® DEBUGGER

Software Debugging for C/C++ and FORTRAN

TotalView is capable of scaling from one to thousands of processes or threads with applications distributed over multiple machines or processors.

TotalView is supported on Linux, Unix, and Mac OS X systems with reverse debugging available on x86 Linux variants.

TotalView supports a wide range of compilers including GCC, Intel, IBM XL and PGI compilers.

TotalView supports debugging applications utilizing NVIDIA GP-GPU accelerated CUDA and OpenACC, as well as Intel Xeon Phi coprocessors.

In addition to high performance workstations and servers, TotalView supports cluster and scalable HPC architectures such as Blue Gene and Cray supercomputers.

Traditional tools and methods for debugging and analyzing code, like simple command line debuggers, are not appropriate for the challenges of complex application development. Parallel, multi-core processing technology demands a reevaluation of the art of software development. Writing applications for distributed and multi-core environments requires more complex code, with ever more complicated interactions and timings. TotalView handles this complexity, giving you the ability to troubleshoot and analyze your code dynamically and effectively.

TotalView is the comprehensive debugging solution for demanding multi-core applications. Powerful and easy-to-use, it dramatically reduces debugging time and enhances developer productivity.

Parallel and Multithreaded Debugging

TotalView provides you with the control and visibility needed to work with parallel applications in which the concurrency comes in the form of multiple processes, multiple threads within a process or a combination of the two. With the TotalView debugger, developers and scientists can operate with equal ease on single threads or processes or with groups of threads or processes, set breakpoints with thread or process width, set barrier points for synchronization, and view variables across the threads of a process or the MPI tasks of a parallel application.

Advanced Memory Debugging

As an integral component of TotalView, MemoryScape™ is an interactive memory debugger that helps identify, inspect, and resolve difficult memory problems. Its graphical and intuitive interface simplifies the business of debugging memory issues in complex multi-process and multi-threaded applications.

Accelerator and Coprocessor Debugging

TotalView provides debugging support for both native and offload programs that take advantage of the Intel® Xeon® Phi™ (MIC) coprocessors. TotalView also provides best-in-class CUDA™ and OpenACC debugging support on NVIDIA Kepler, Fermi, and Tesla accelerated systems. With either the NVIDIA® or Intel model, developers benefit from full visibility into, and intuitive control over, what is happening on the host processor and in the accelerator or coprocessor.

Reverse Debugging

ReplayEngine™, TotalView's reverse debugging capability for x86 Linux variants, fundamentally changes how developers debug. It records the execution history of a program and makes it available for examination with TotalView. Now developers can work backwards from a failure, error, or crash to its root cause and identify timing issues that may only appear occasionally.

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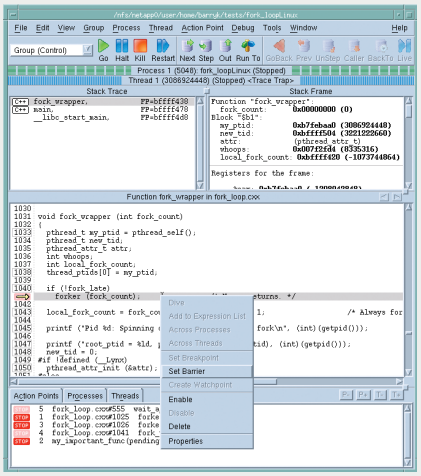
TotalView: The Comprehensive Debugging Solution for Demanding Multi-Core Applications

With TotalView, developers can debug programs on small multi-core workstations running a couple of threads, or massive applications on supercomputers running thousands of processes. Save effort and time while confidently producing higher quality code. With flexible licensing options that meet organizations' evolving needs, TotalView is the perfect tool for every size development team.

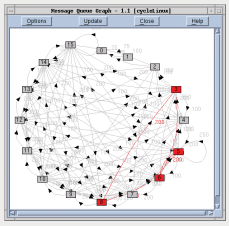


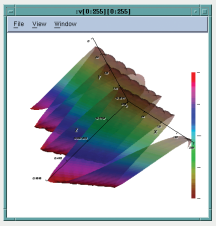
- C and C++
  Comprehensive support for objects, templates, and user data display in STL collection objects
- Fortran and Fortran 90
  First class support for common blocks, user defined types, pointers, and modules
- Data visualization
  Unparalleled visibility into program data: structures, objects, variables, and arrays
- Multi-process
  Debug parallel applications in a single session. View and control individual processes or groups of processes
- Unattended batch debugging with TVScript
  Troubleshoot bugs in regular non-interactive batch environments
- Long distance remote display
  Connect from a Linux, Mac or Windows system – from down the hall or across the globe

Parallel and Multithreaded Debugging

TotalView is a source code debugger for troubleshooting complex, multi-threaded, or multi-process programs. TotalView technology provides comprehensive support for OpenMP, MPI, UPC and GA. Because today's processor architectures are characterized by multi-core and many-core designs, building a multi-threaded application or transitioning from a serial application to a parallel application presents significant challenges. TotalView is designed to help you manage the challenges presented by concurrency, parallelism and threads.

- Operate with equal ease on single threads/processes or with groups of threads/processes
- Set breakpoints with thread or process width to synchronize or use barrier constructs
- Control the execution of threads or processes individually or in groups
- View program data and threads/processes in a simple tree view with parallel backtrace
- Troubleshoot deadlocks and race conditions using TotalView's asynchronous thread control
- Work with automatically defined 'lockstep groups', define custom groups based on characteristics, or enumerate arbitrary groups





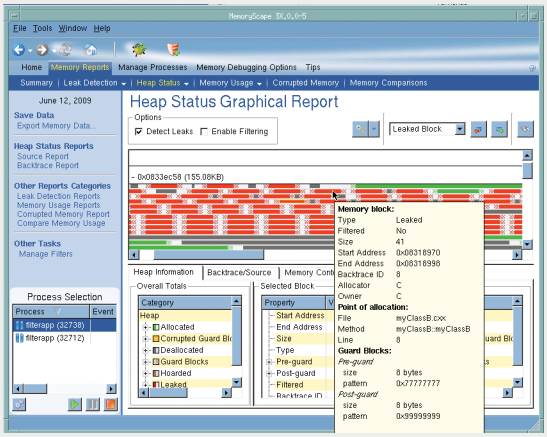
MPI Support: With support for more than 20 implementations of MPI, TotalView has been the debugger of choice in HPC environments and parallel programming courses.

- View variables across the threads of a process or the MPI tasks of a parallel job
- View MPI message queues by text or graphical depiction
- Identify deadlocks based on automatic cycle detection in the message queue graph
- Computational cluster support for all major MPI implementations, interconnects and batch systems
- Support for hybrid applications that combine MPI together with OpenMP, Xeon Phi and/ or CUDA

Software Debugging for C/C++ and FORTRAN

Advanced Memory Debugging

TotalView includes MemoryScape, a powerful, easy-to-use memory debugging tool that can be used in a variety of ways, including interactively, scripted, stand-alone, part of TotalView and collaboratively.



MemoryScape provides powerful memory error detection and analysis tools that have a low performance overhead, while state-of-the-art, interactive interfaces allow exploration and identification of heap memory status in programs.

- Low runtime overhead
- No need to recompile applications
- Detect leaks and errors in vendor libraries (or filter them out of your analysis)
- Track and interpret allocated, deallocated, and leaked memory blocks
- Detect memory leaks and events early – even a single leaked allocation can be detected, and events can be flagged before they crash your application
- Detect corrupted memory – bounds errors and buffer overruns can generate invalid results or lead to program instability
- Analyze memory usage patterns – optimize applications or scale them up to run on large grids or supercomputers
- Support for multi-process and hybrid applications in clusters using MPI and/or OpenMP, and for multi-threaded applications using OpenMP and pthreads on workstations and servers

Accelerator and Coprocessor Debugging

TotalView supports the debugging of applications that take advantage of either NVIDIA's GP-GPU accelerators or the Intel Xeon Phi coprocessors.

TotalView on Linux provides visibility into, and control over, CUDA and OpenACC-based programs that use NVIDIA Kepler, Fermi and Tesla GP-GPU accelerators.

CUDA specific features supported in TotalView include the following:

- Linux and GPU device thread visibility
- Full visibility to the hierarchical device, block, and thread memory
- Navigating device threads by logical and device coordinates
- Handling CUDA functions inline and on the stack
- Command line interface (CLI) commands for CUDA debugging functionality
- MPI applications on CUDA-accelerated clusters
- Unified Virtual Addressing and GPUDirect
- Support for debugging Multi-GPU Applications
- CUDA C++ and inline PTX
- Reporting memory errors and handling CUDA exceptions

The support in TotalView for the Intel Xeon Phi can be used to debug applications that are either compiled to run directly on the coprocessor or to run on the host while offloading specific tasks / computations to the coprocessor. TotalView has the following Intel Xeon Phi debugging capabilities:

- Full asynchronous thread control on both the host and Intel Xeon Phi coprocessor
- Simultaneously view what is happening in both the host and offload processes
- Certain breakpoints are shared across the host and coprocessor code
- Support for clusters and multi-device configurations
- Support for launching MPI and hybrid MPI + OpenMP applications natively into one or many Intel Xeon Phi coprocessors
- Support for debugging native Intel Xeon Phi applications launched manually on the coprocessor
- Support for debugging host side applications using the Intel Language Extensions for Offloading (LEO)

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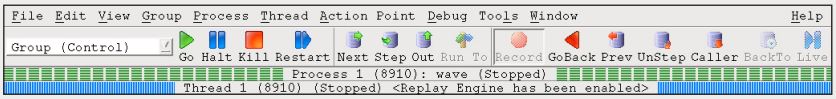
Deterministic replay capability records the execution history of your program and makes that history available for diagnosis.

Reverse Debugging

With ReplayEngine, an integral component of TotalView on x86 Linux systems, developers and scientists can streamline and simplify the troubleshooting process by deterministically replaying a program's behavior, going back to the root cause of the failure without repetitive restarts and stops. This revolutionary approach - working back from a failure, error, or crash to its origin - eliminates the need to restart a program repeatedly with different breakpoint locations. The ability to do reverse debugging, stepping freely both forwards and backwards through program execution, drastically reduces the amount of time invested in troubleshooting your code.



- Freedom to explore application execution either backwards or forwards
- Record: capture function calls, network applications, file I/O, thread behavior, and context switches
- Replay: step back through execution history and review all variables and program behavior at any point
- Switch seamlessly between Record and Replay
- Analyze race conditions and other hard-to-reproduce bugs in a deterministic session
- Go back and look at functions and variables in the context of the crash or error
- Easily follow the logic of unfamiliar routines – great for both code reviews and legacy code
- Set a watchpoint and run back to find the source of unexpected data in variables or arrays
- Enable recording in the middle of a debugging session without needing to detach
- Record and replay MPI programs using Ethernet, Infiniband, or the Cray Aries / Gemini series interconnects

About Rogue Wave Software

Rogue Wave Software, Inc. is the largest independent provider of cross-platform software development tools and embedded components for the next generation of HPC applications. Rogue Wave tools and components are designed to increase the productivity of developing applications that take advantage of parallel computing architectures. Rogue Wave's strategy marries High Productivity Computing with High Performance Computing to enable developers to harness the power of parallel applications and multi-core computing. Our products reduce the complexity of prototyping, developing, debugging, and optimizing multi-processor and data-intensive applications. We are the foremost single source for HPC software development solutions in the market today.

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