Software Development Productivity for HPC Applications

With Cray® XC™ series supercomputers, Cray takes a comprehensive approach to the software environment, delivering a dedicated suite of HPC-optimized Linux® OS and programming offerings, while also working closely with domain experts to deliver a wide variety of unique and innovative partner solutions.

End user productivity is a strategic focus in delivering a programming environment that includes support for multiple programming languages, programming models, compilers, I/O libraries and optimized scientific libraries, as well as a wide variety of other tools covering areas like debugging, performance analysis, workload management, environment setup and more.

Flexible Programming Models

The Cray programming environment suite supports parallel programming models including MPI, Cray SHMEM™, UPC, Co-Array Fortran, OpenMP and OpenACC, the new directives-based approach to accelerators. The MPI implementation is compliant with the MPI standard and is optimized to take advantage of Cray’s high-performance Aries™ interconnect.

Performance and Insight – Comprehensive Programming Environment

The Cray Programming Environment is architected with the focused goals of driving maximum computing performance and enabling productive programmability. It is the role of the programming environment to efficiently support the application development life cycle by providing a tightly coupled software stack with integrated compilers, libraries and tools that abstract the complexity of the system and close the gap between observed performance and achievable performance.

Cray addresses programmer productivity and accelerates time to insight in a number of ways, delivering increased process automation, tightly coupled tool integration, and customer choice, including best-in-class partner options. This feature-rich, flexible software environment facilitates the development of massively scalable applications, including the programming of homogenous multi-core, many-core and/or optimized hybrid heterogeneous mixes of these systems. Cray’s tools target optimization for intranode performance as well as system scaling across a multitude of nodes and compute cabinets.

Compilers and Libraries

Cray has decades of experience delivering performance-leading compiler technologies, leveraging generations of domain knowledge gained from creating vector processors to deliver advances in automatic vectorization, performance optimizations and shared memory parallelization for today’s HPC processors and accelerators. The Cray compiling environment offers customer choice, supporting Fortran, C/C++, PGAS languages and directives-based programming options like OpenMP and OpenACC, and options like GNU and Intel Parallel Studio XE support. The Cray compiler takes advantage of recent advances in many-core architecture features, including double-wide vector units, AVX instructions and enhanced thread parallelism, as well as support for High Bandwidth Memory (HBM) data allocation mechanisms.
Additionally, Cray supports a wide variety of HPC-optimized scientific and math libraries, as well as an advanced Program Library (PL) which acts as an application repository enabling the exchange of information between the Cray compiler, debuggers and performance analysis tools.

**Chapel Programming Language**

An open-source effort led by Cray and initiated out of a DARPA High Productivity Computing Systems program, Chapel is a programming language designed to improve the programmability of large-scale parallel computer systems. The goal of the Chapel language is to address the limitations of existing languages and increase the productivity of high-end computer users by making it easier to write, read, modify, port, tune and maintain parallel programs. Chapel makes it easier for users of all skill and experience levels to express algorithms to effectively target parallel compute hardware.

**Debuggers**

Cray collaborates with industry partners and open organizations to validate support for software debuggers like Rogue Wave Software's TotalView debugger, as well as Allinea's DDT debugger and MAP profiler. Cray also offers debugging technology enhancements in the areas of GNU gdb (gdb – Cray line mode scalable parallel debugger) and CCDB, a Cray comparative debugger that assists with running different (working/failing) versions of a code to triangulate where changes introduced errors or faults.

**Performance Analysis Tools**

Gaining insight into your code's execution is key for optimizing performance and eliminating defects. Intuitive, easy-to-use tools are imperative to productivity in the software development life cycle, so Cray invests deeply in performance analysis tools like CrayPAT™ and Cray Apprentice2™. Helping programmers identify the bottlenecks in their code execution can save huge amounts of otherwise all-consuming analysis time. Rather than just generating overwhelming reports of numbers and text, Cray’s performance analysis tool views and graphics help the user streamline visual identification of important and meaningful information from potentially massive data sets.

Automatic program instrumentation and “whole program” analysis expedite the understanding of code execution so the user can address issues and optimize performance, whether intranode or scaled internode across a massive system. Graphical views of program execution by top time-consuming routines, function profiles, communications, load imbalance, time line trace and automatic source code mapping save time over hunting and pecking through lines of code one at a time. Additionally, advanced memory analysis is available for processor technologies that implement enhanced memory capabilities, such as HBM cache/memory usage and high water memory marks for DDR vs HBM.
Porting Tools
Cray's Reveal porting tool is a combination of debugger/analyzer/advisor that can also guide the user to make specific program edits to optimize the code for memory efficiency and execution performance. For devices with advanced memory architectures, Reveal can help you track variables that most impact memory bandwidth and then identify allocations in source that are candidates for high bandwidth memory. It can also help you identify relevant loops in your code that could be optimized. Reveal can then propose HBM allocation and parallelization directives in the programming source, saving you time, making your memory and core utilization more efficient and improving your application performance.

Scalable Software Advantages
The Cray XC system delivers the latest Cray Linux Environment (CLE), a suite of high performance software including a Linux-based operating system designed to scale efficiently and run large, sophisticated HPC applications. With Cray's Cluster Compatibility Mode (CCM) you can be confident your desired ISV applications and codes are available, and they run in CLE without recompilation or relinking.

When running highly scalable applications, Cray's Extreme Scalability Mode (ESM) ensures operating system services do not interfere with application performance. Real-world applications have proven this optimized design scales to hundreds of thousands of cores and is capable of scaling to more than one million cores.

Additionally, the Cray XC series software environment provides for tightly integrated, industry-standard workload managers including Altair PBS Professional®, Adaptive Moab® HPC Suite and SLURM. Supported debuggers include Rogue Wave TotalView and Allinea DDT. Many other open source programming tools are also available.

Cray System Management Support
To get the most workload production out of your supercomputing system, Cray provides a robust system management stack with a broad variety of utilities and support.

The Cray System Management Workstation leverages industry-standard infrastructure and interfaces to improve ease of use and shorten learning curves, while also providing management innovations to optimize production HPC environment reliability.

To maximize uptime, Cray supports more efficient methods of performing staged system upgrades and rolling out patches while the system remains operational. XC series supercomputers continue to get real work done while intelligently scheduling and managing updates as resources become available and around running jobs.

Cray's management tools also provide the ability to snapshot the system state and provide protective rollback support, reducing lost operation cycles and downtime managing system updates. The Image Creation and Provisioning Service, Configuration Management Framework and Power Management utilities enable datacenter staff to administer their supercomputers with efficiency and confidence.