Programming Environments Update

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ABSTRACT: *This paper provides an update on Cray Programming Environments plans. Recent Programming Environment 2.0 releases are reviewed, and the upcoming Programming Environment 3.0 releases are discussed. The Cray Message Passing Toolkit status and plans are also provided.*

1 Introduction

Cray Programming Environment software includes the compilers, libraries, and user tools that comprise a complete program development environment. Cray currently supports Programming Environments (PE) version 2.0 and Message Passing Toolkit (MPT) version 1.1. Together, these products provide a rich, robust toolset for developing highly scalable applications across all Cray platforms.

Section 2 of this paper reviews recent PE 2.0 releases and plans for future 2.0 revisions. Section 3 provides an overview of the upcoming PE 3.0 release. Section 4 reviews recent MPT releases and plans for future revisions. Section 5 gives an update on support notes for Programming software. Section 6 provides a high level description of Programming Environment plans for the CRAY Origin 2000. Section 7 provides performance information for current products. Section 8 summarizes.

2 Programming Environments 2.0

Programming Environments 2.0 was released in February 1996 for parallel vector processor (PVP) systems. In September and October, support for CRAY T3E and CRAY T3D systems was added, so that 2.0 now supports all Cray platforms. Support for T3E was added in the PE 2.0.1 revision, and T3D support was added in PE 2.0.2.

Three major product changes were made with the release of PE 2.0. First, CF90 became the default compiler for both FORTRAN 90 and FORTRAN 77 codes. Second, a fully integrated C++ compiler was introduced, replacing the C++ 1.0 pre-processor. And third, T90 IEEE support was provided. All three of these changes represent significant steps forward in Programming Environment support for Cray users.

A CF90 2.0 environment is also available for SPARC Solaris systems. This environment, released in August 1996, adds support for 64-bit and 128-bit data types to facilitate initial development of Cray applications on SPARC systems. Performance enhancements were also added.

PE 2.0 will be further enhanced with the PE 2.0.3 revision, planned for release in early 1997. This revision will include T90 and T3E performance enhancements; support for converting IBM 370 files on T90 IEEE, T3E, and T3D systems; and target management support for T90 systems which contain a mixture of Cray Floating Point and IEEE cpus. Also in PE 2.0.3, SCC 5.0 will become the default C compiler for all systems, replacing SCC 4.0. With this change, C programmers will use the same compiler optimizing technology that is already used in the C++ and CF90 compilers.

3 Programming Environments 3.0

Programming Environments 3.0 is targeted for release in second quarter of 1997. The primary goals of this release are to improve Fortran performance, provide a common frontend for C and C++ language support, and enhance C++ functionality to track the draft C++ standard. PE 3.0 will be supported on PVP and T3E systems.

3.1 Fortran highlights

One of the primary goals of PE 3.0 is to provide performance enhancements for Fortran applications. For PVP systems, the performance improvements planned for this release span many areas, from inlining and Autotasking, to scalar and vectorization improvements. For T3E systems, the improvements revolve around better cache utilization and superscalar optimizations.

CF90 3.0 will support the Portland Group, Inc. (PGI) HPF_CRAFT product for T3E systems.

A few Fortran 95 features are also planned for CF90 3.0, as we track that draft standard.

3.2 C/C++ highlights

Another primary goal of PE 3.0 is to support both the C and C++ languages with a common compiler frontend. This will facilitate the future development of features and performance improvements that are common to both languages. The Cray Standard C test suite will be used to ensure C applications maintain high performance and functionality levels as the transition is made to the new frontend. Cray customers are encouraged to submit a version of their important C applications for inclusion in this test suite.

A third goal for PE 3.0 is to improve the functionality of the C++ environment. Several new features are planned for this release which track the C++ draft standard. And because the draft standard has changed over time, Cray is finding it necessary to introduce incompatibilities between C++ 2.0 and 3.0. Cray recommends that C++ applications be recompiled with C++ 3.0 when it becomes available. The loader will issue warnings if 3.0 binaries are linked with 2.0 binaries.

3.3 CrayTools highlights

CrayTools 3.0 will include several enhancements. TotalView and MPP Apprentice will support PGI's HPF_CRAFT product. TotalView will also be enhanced in the areas of message-passing support and debugging of INCLUDE files.

3.4 CrayLibs highlights

CrayLibs 3.0 will include several scientific library features. Distributed out of core solvers for the T3E are planned for this release, as well as LAPACK and ScaLAPACK enhancements, and BLACS performance improvements.

The FFIO *global* layer will be enhanced for T3E. Also, the POSIX 1003.9 system interface library for Fortran programs will be expanded on all platforms.

4 Message Passing Toolkit

The Message Passing Toolkit is comprised of MPI conforming to the MPI 1.1 specification, PVM based on ORNL version 3.3.10, and the Cray SHMEM (get/put) library.

MPT was first released in February 1996. MPT 1.0 contained the introduction of MPI and SHMEM for PVP systems, and performance enhancements for PVM. In September 1996, MPT 1.1 was released. The major features in MPT 1.1 are T3E support, performance improvements for MPI on PVP systems, and expanded SHMEM functionality on PVP systems.

Plans for future MPT releases include integrating the Cray and MIPS MPI technology, and T3E performance enhancements. The merged technology base for MPI will provide the foundation for MPI interoperability across Cray and MIPS platforms.

5 Support Notes

Active development support for CF77 on PVP systems ended September 30, 1996. CF90 is the replacement compiler and supports both Fortran 77 and Fortran 90 applications. CF77 will continuer to be supported on CRAY T3D systems through 1997.

CDBX will not be supported with PE 3.0. Cray TotalView is the replacement debugger and is supported on all platforms.

The SCC-to-C++ transition plan enters its final phase with the release of C++ 3.0. The C++ compiler will support both C and C++ languages with a common compiler frontend. This compiler will use the Edison (EDG) C++ frontend, the same frontend that is used by MIPS for C and C++. SCC will continue to be shipped as an alternate C compiler, for 6 months after the C++ 3.0 release. Support for SCC ends when C++ 4.0 is released.

6 CRAY Origin 2000

Cray has a goal to provide Cray application source code compatibility on the Origin 2000, with minimal exceptions. Cray plans to work toward this goal over time, providing evolutionary steps through 1997 and 1998.

Some of the keys areas involved in this goal are:

- integration of Cray CF90 and MIPS compiler technology
- integration of C/C++ language support
- Cray Fortran libraries, including FFIO
- SHMEM get/put libraries
- Cray Scientific libraries (libsci)
- new integrated user toolset

7 Performance

Performance information for current Programming Environment products is provided in this section.

7.1 CF90 PVP Performance

The following table shows CF90 PVP performance compared to CF77 on a variety of benchmark suites. The numbers shown are the geometric mean of ratios (GMR) comparing CF90 to CF77, so that numbers less that 1.0 represent an improvement using CF90.

Table 1. CF90 PVP Performance[1]

Benchmark suite	CF90 2.0.1	
	unitasked	autotasked
Livermore kernels	0.85	0.98
Cray 100 loops	0.71	0.59
Linpack 100x100	0.94	0.92
NAS kernels	0.86	1.05
NFPS	0.94	0.99
Perfect	0.87	1.00

[1] GMR compared to CF77; <1 is desired

CF90 exhibits equivalent or better performance than CF77 for every benchmark suite in both unitasked and autotasked modes. The slight degradation with the autotasked NAS kernels resulted from a temporary bug that has been fixed.

7.2 MPT Performance

MPT software used in shared memory mode can provide performance that is dramatically better than publicly available software. SHMEM provides the best performance, yielding the peak memory bandwidth of the system and latency on the order of 1 microsecond.

Table 2 shows MPT shared memory mode performance on PVP systems compared to publicly available software. The improvement factor is given for both bandwidth increase and latency reduction.

Table 2. MPT Performance for PVP, shared memory mode[2]

Single J90	bandwidth increase	latency reduction
PVM	up to 30X	up to 9X
MPI	up to 85X	up to 24X
SHMEM	up to 85X	up to 2000X

[2] Communication using shared memory mode (single executable)

Table 3 shows MPT bandwidth when communicating between two executables in network mode. The improvement factor is given, compared to publicly available software.

Table 3. MPT Performance for PVP, network mode[3]

Bandwidth increase	communication within a system	communication across HiPPI
PVM	up to 3X	up to 2X
MPI	up to 1.5X	up to 2X

[3] Communication between 2 executables

Table 4 shows MPT Performance for T3E systems compared to like software for T3D systems. These numbers reflect changes in hardware more than changes in software, since T3D message passing software is already highly optimized. Improvement factors for bandwidth and latency are provided. Note that on both the T3D and T3E, SHMEM latency is on the order of 1 microsecond.

Table 4. MPT Performance for T3E [4]

T3E	bandwidth increase	latency reduction
PVM	up to 2X	up to 4X
MPI	up to 3.5X	up to 3X
SHMEM	up to 2.5X	no change

[4] Compared to T3D

8 Summary

Programming Environments 2.0 is supported on PVP, T3D, and T3E systems. This provides consistent functionality across all platforms, and still allows for platform specific performance optimizations.

Future Programming Environment releases will continue to provide enhancements for all platforms, and will evolve toward a common environment for Cray and MIPS systems.