Cray Research Software Report

Irene M. Qualters, Cray Research, Inc., 655F Lone Oak Drive,
Eagan, Minnesota 55121

ABSTRACT: *This paper describes the Cray Research Software Division status as of Spring 1995 and gives directions for future hardware and software architectures.*

1 Introduction

This report covers recent Supercomputer experiences with Cray Research products and lays out architectural directions for the future. It summarizes early customer experience with the latest CRAY T90 and CRAY J90 systems, outlines directions over the next five years, and gives specific plans for '95 deliveries.

2 Customer Status

Cray Research enjoyed record volumes in 1994, expanding its installed base by 20% to more than 600 systems. To accomplish this, we shipped 40% more systems than in 1993 (our previous record year). This trend will continue, with similar percentage increases in 1995, as we expand into new application areas, including finance, multimedia, and "real time."

In the face of this volume, software reliability metrics show consistent improvements. While total incoming problem reports showed a modest decrease in 1994, our focus on MTTI (mean time to interrupt) for our largest systems yielded a doubling in reliability by year end. These trends continue to improve, thus far in 1995. Our emphasis this year is to effect greater reliability during new product introductions.

3 CRAY T90 Status

In December, we delivered our first CRAY T90 system. Our customer reported 100% availability. The second delivery, to an industrial customer in Japan, has so far had an identical experience! We are pleased to be able to achieve this, especially given that both are outside the U. S. This year, we will deliver over twice the number of CRAY T90 systems as we delivered in the initial year of CRAY C90 deliveries (the CRAY T90's immediate predecessor). We expect to ship twenty to twenty-five systems and currently have orders for eight.

The 2.2 nanosecond clock on the CRAY T90 system delivers a potential peak of 1.8 GFLOPS. The following tables show single CPU speedups that can be anticipated based on code performance on CRAY C90 systems:

CRAY C90 Speed	**Speedup on CRAY T90s**
Under 100 MFLOPS	1.4x
200 to 400 MFLOPS	1.6x
Over 600 MFLOPS	1.75x

The price/performance of CRAY T90 systems shows substantial improvements. For example, LINPACK CRAY T90 price/performance is 3.7 times better than on CRAY C90 systems.

CRAY T94 single CPU ratios to CRAY C90 speeds:

- LINPACK 1000 x 1000 -> 1.75x
- NAS Parallel Benchmarks (Class A) -> 1.48 to 1.67x
- Perfect Benchmarks -> 1.3 to 1.7x

4 CRAY J90 Status

The CRAY J90 systems are CRAY Y-MP binary compatible, with a large existing application suite. As of CUG, CRAY J90 systems were running UNICOS 8.0.3 on eight CPUs. We surpassed our highest expectations for functionality on early units. For example, UNICOS ran internally within one week of booting the first hardware, which set a record for bringing up a full operating system on new hardware!

We shipped the first CRAY J90 systems on March 10, 1995. We have over 120 orders to date and expect over 200 by year end. We announced the CRAY J932 system on March 13, 1995.

4.1 CRAY J90 Application Performance

The applications performance (Table 1) shows the CRAY J90 systems have over three times the performance, for their price, when compared with CRAY C90 systems. CRAY J90 systems also compare favorably with high-end workstations. For example, the CRAY J90 systems ran the STAR-CD application twice as fast as SGI Power Challenge and IBM 590H systems.

Table 1

Application	% of CRAY C90 Speed
ANSYS	28%
ABAQUS 5.4	22%
RADIOS	23%
LS-DYNA3D	31%
STAR-CD	24%
Gaussian 92	29%
MND093	25%
Pamcrash	32%
Panelform	35%
Fcrash	28%

4.2 CRAY J90 I/O Performance

A CRAY J90 system can sustain 37 megabytes per second per I/O subsystem, with multiple I/O subsystems. This compares with 23 megabytes per second on CRAY EL98 I/O subsystems.

5 Product Support

Cray Research will support the following UNICOS releases through the following dates:

- UNICOS 7.0 until March 11, 1995

- UNICOS 8.3 until December 31, 1995

- UNICOS 8.0 until September 30, 1996

The last release for CRAY Y-MP Model D systems is UNICOS 8.0.4. We will support 8.0.4 on Model D systems through September 30, 1997 (one year beyond 8.0 support on other platforms).

The last releases of related UNICOS 8.0.4 products are

- IOS 8.0.3

- CF90 PE 2.0,

- C++ PE 2.0, C++ Tools 1.0,

- C++ Mathpack 1.0

- DMF 2.3, Cray REELlibrarian 2.0,

- CVT 2.0, NQX 1.1

- DFS/DCE 1.03

6 Product Directions

Our future products will show an increasing commonality among the product set, as we evolve them to a single architecture. The first step in this evolution will be to form a common, sharable I/O system for CRAY T90, CRAY T3E and CRAY J90+ systems. We will follow this with a single parallel-vector (PVP) platform, spanning low-end and high-end needs. This new system will use the Triton IEEE instruction set. We will also improve our MPP line with higher performance in the CRAY T3E system. We will then merge the PVP and MPP architectures into a single Scalable Node architecture, which will be an upgrade path for the CRAY T3E systems and the Cray PVPs.

We are preparing our UNICOS operating systems for future parallel systems by applying microkernel technology as the basis for the UNICOS/mk operating system. In the medium term we will offer both UNICOS and UNICOS/mk. In the long term we plan to run UNICOS/mk on all Cray Research systems, except the CS6400 successors, which will continue to run Solaris.

We will improve the programming environments, increasing performance and improving portability. For example, we will offer CF90 2.0 and C++ 2.0 on both our PVP and MPP platforms. These products offer compatibility with the industry standards for Fortran and C, with industry-leading performance. We plan to improve the performance of implicit-communication MPP programming model as we evolve it into CRAFT-90 for our future MPPs. For portable distributed-parallel programming we are expanding our message passing offerings to include PVM and MPI on both the PVP and MPP product lines. In the long term, we expect the Fortran standard to evolve into Fortran-95 and the MPI standard to evolve as well. We plan to influence, track, and support these standards as they emerge.

Our storage management plans will track and influence standards for hierarchical storage management (HSM), archiving, network backup, and improved file systems. The Open Storage Manger (OSM) will be a vendor-independent HSM for workstations and Cray systems. We will add OSM to our exiting Data Migration Facility (DMF), combining high performance with workstation interoperability. We will also continue to support and improve FileServ. We will look at other possible third-party packages to augment our HSM, backup, and archive capabilities.

Our industry compatibility and performance for distributed file systems are excellent. We currently offer NFS (Network File System from Sun), DFS (Distributed File System from OSF), NC1 (standard UNICOS file system), and SFS (Shared File System from Cray Research). By combining DFS and SFS capabilities, we will realize the excellent local file performance of DFS cached files with the high-bandwidth and resiliency of physically shared file systems (SFS). This will also allow DFS capable workstations to access the SFS resident files. We are reexamining our file system offerings as we prepare to support increasing mass storage with greater flexibility and resiliency.

7 Product Status

7.1 Operating Systems Status

We released UNICOS 8.3 to support the CRAY T90 systems. We will release UNICOS 8.0.4 in 2Q95 for our PVP systems, with updates for problem fixes. We will release UNICOS 9.0 in 3Q95 on our PVP systems, with additional standards, ATM support, X/Open branding, ONC+ (NFS V3), and Reliability, Availability, Serviceability (RAS) features. Some of the RAS features are upgrading using UNICOS under UNICOS, a dynamic kernel memory allocator, and enhancements to checkpoint/restart.

We released UNICOS MAX 1.2 in late 1994 for our CRAY T3D systems with support for Phase-II I/O. We plan to release UNICOS MAX 1.2.0.3 in 2Q95, with support for rolling. We expect to release UNICOS MAX 1.3 in 2Q95, with support for Phase-III I/O and checkpoint/restart. In 3Q95, we plan to release UNICOS MAX 2.0, with support for CRAY T90 hosts.

7.2 Programming Environment Status

We have scheduled CF90 2.0 for a 4Q95 release on PVPs. It will include:
- IEEE floating-point support for future PVPs and MPPs,
- Support for next generation MPPs,
- SPARC, PVP, and MPP compatibility.

CF90 3.0 will include CRAFT-90 support for future MPPs and selected Fortran 95 features. SunSoft licensed Cray Fortran 90 technology as a foundation for their Fortran 90 offerings, planned for 2Q95.

We also scheduled Cray C++ 2.0 for a 4Q95 release on PVPs. It supports both C and C++ and no longer uses a C++ front-end translator. It supports the full ANSI C standard, but not all Cray SCC extensions. It includes a full programming environment for CRAY Y-MP (Model E), CRAY C90, CRAY T90, CRAY J90, IEEE PVPs, and future MPPs. C++ 2.0 new features include automatic cross-file inlining, exception handling, and tracking the C++ draft standard.

7.3 Storage Systems Status

7.3.1 Common I/O Across UNICOS Products

In the first half of 1996, we will deliver the SCX I/O support for the CRAY T3E and CRAY T90 systems. Plans are in progress for SCX support on the CRAY J90 follow-on products. We will support the following initial peripherals:
- SCSI, Fiber Channel, ND, and current IPI disks,
- SCSI STK and DAT tapes, Block MUX tapes,
- Ethernet, FDDI, ATM OC3, and HIPPI.

We will support additional peripherals in later releases.

7.3.2 Unbundled Storage System Products

The following products are optional features which are individually priced.

7.3.2.1 Networked File System Enhancements

We will offer the Shared File System (SFS) and ONC+/NFS V3 in UNICOS 9.0 (planned for 3Q95). SFS controls access from multiple UNICOS systems to physically shared HIPPI disks, boosting the bandwidth of the Distributed File System (DFS) by an order of magnitude (for large transfers). NFS V3 is an enhanced version of Sun's ubiquitous NFS protocol, with increased performance and resiliency.

7.3.2.2 Hierarchical Storage Management Enhancements

We will offer FileServ 3.0 support in 2Q95. We plan to release OSM 2.0 for Solaris (SPARC) in 4Q95, with alpha tests on UNICOS PVPs starting 4Q95.

DMF 2.2 (the current product) includes the following features:

- Advanced tape media specific process (MSP)
- End-to-end use of compressible data
- Strategic tape mounting policies
- Absolute block positioning
- Asynchronous double-buffered I/O
- Optional tape-to-tape merging.

We plan to release DMF 2.3 in June 95. It will include Client/Server DMF, support for SFS, and fail-safe operations within Cray Clusters.

7.4 Network Product Status

ATM is a network protocol that provides a single seamless protocol across local-area and wide-area networks. It combines the high-speed characteristics of local-area networks (e.g., HIPPI and FDDI) with the standards and guaranteed bandwidth of wide-area networks (e.g. voice and data phone lines). It can be used simultaneously with standard computer protocols (e.g., TCP/IP) and multimedia (video and audio). We installed ATM prototype hardware and software at 16 sites for a total of 52 ATM interfaces. The current performance is at OC3 rates (155 Mb/s) and we have begun developing OC12 interfaces (4 times OC3 speeds). Eventually, we plan to quadruple the speed yet again to OC48 rates.

We plan to improve network performance by supporting SCX I/O, supplying faster ATM interfaces, releasing an express path for PVM and MPI, and enhancing TCP/IP and DFS.

The Network Queuing Environment (NQE) balances batch job loads across heterogeneous sets of networked workstations and Cray Research systems. We plan to ship the CraySoft NQE release 2.0 in April 1995. It will include network load balancing enhancements, a PVM load balancing interface, WWW and API interfaces, and support for SGI 5.3, SGI 6.0, and OSF/1 3.0.

8 Summary

Cray Research has been able to maintain high performance and reliability standards while furthering its Open Supercomputing strategy with new software and hardware releases.

We are constantly promoting data accessibility with features such as ONC+/NFS V3, DCE/DFS, and hierarchical storage management (DMF, FileServ, and OSM). Newer programming environments such as CF90 2.0 will keep us in the industry leading position with respect to standards, performance, and reliability.

CRAY J916 applications show excellent performance and price/performance when compared to CRAY C90 systems and competitors, while the CRAY T94 results deliver the highest performance for a broad range of applications.

We continue investing in Open Supercomputing—constantly improving our methods for bringing supercomputing to the desktop. In 1995, we will expand and grow our customer base even further, offering a large volume of affordable systems while maintaining leadership on high-end systems and evolving our products toward a single architecture.