WHITE PAPER

June 1997

Prepared By
Workstation Marketing

Compaq Computer Corporation

Contents

Introduction 1

The Multiprocessing Initiative 3

Multiprocessing in Brief 4

Multiprocessing Trends ... 4

Multiprocessing Benefits 5

Next Steps and Conclusions 6

Appendix: MP Partners and Their Results 6

The Compaq Multiprocessing Initiative

This paper provides an overview of the MP Initiative, which is a joint effort between Compaq and leading ISVs, leveraging work done by Intel, that is focused on expanding the market for multithreaded applications running on standard, NT/IA workstations like the four-processor Compaq Professional Workstation 8000.

NOTICE

The information in this publication is subject to change without notice and is provided "AS IS" WITHOUT WARRANTY OF ANY KIND. THE ENTIRE RISK ARISING OUT OF THE USE OF THIS INFORMATION REMAINS WITH RECIPIENT. IN NO EVENT SHALL COMPAQ BE LIABLE FOR ANY DIRECT, CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER DAMAGES WHATSOEVER (INCLUDING WITHOUT LIMITATION, DAMAGES FOR LOSS OF BUSINESS PROFITS, BUSINESS INTERRUPTION OR LOSS OF BUSINESS INFORMATION), EVEN IF COMPAQ HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

The limited warranties for Compaq products are exclusively set forth in the documentation accompanying such products. Nothing herein should be construed as constituting a further or additional warranty.

This publication does not constitute an endorsement of the product or products that were tested. The configuration or configurations tested or described may or may not be the only available solution. This test is not a determination or product quality or correctness, nor does it ensure compliance with any federal state or local requirements.

Deskpro is a trademark of Compaq Computer Corporation.

Microsoft, Windows, and Windows NT Workstation are trademarks and/or registered trademarks of Microsoft Corporation.

Pentium and Pentium Pro are trademarks of Intel Corporation

Product names mentioned herein may be trademarks and/or registered trademarks of their respective companies.

© 1997 Compaq Computer Corporation. All rights reserved. Printed in the U.S.A.

The Compaq Multiprocessing Initiative

June 1997

Document 483A/0697 ECG

INTRODUCTION

Compaq is broadening its workstation line to satisfy a larger range of workstation customer needs through the introduction of two new products: the Compaq Professional Workstation 6000 and 8000. With the introduction of these new systems, Compaq will have the broadest support for multiprocessing in the workstation industry.

Three trends are driving the adoption of multiprocessing systems:

- Relentless demand for performance scalability from users
- Efficient and cost effective support for multiprocessing in Microsoft Windows NT Workstation and Intel Architecture (NT/IA)
- ISV interest in optimizing applications to leverage NT/IA scalability and price/performance as a means of offering significant performance and total-cost-of-ownership improvements to their customers, and to establish leadership in the fastest growing workstation market segment.

Both the Compaq Professional Workstation 6000 and 8000 feature a Highly Parallel System Architecture providing unmatched NT/IA workstation performance. To accelerate delivery of applications that capitalize on this architecture, Compaq has formed a Multiprocessing Initiative (MP Initiative) with industry-leading independent software vendors (ISVs). The results will enable Compaq and the ISVs to deliver very powerful, industry-standard solutions that will meet the needs of RISC/Unix power users.

THE COMPAQ MULTIPROCESSING INITIATIVE

Compaq has initiated a program with leading ISVs that will ensure availability of multithreaded applications running on industry-standard, NT/IA workstations like the Compaq Professional Workstation 8000 (which supports up to four processors) and other models. The price/performance of these systems coupled with the improved performance enabled by multithreading, will be very compelling to users of computationally intensive applications.

One of the building blocks of this effort has been Intel's early work with the ISVs in areas such as processor-level optimization and application restructuring for multithreading. Since the beginning of the MP Initiative, Compaq and Intel have worked with the ISVs in a variety of ways. Intel has continued to focus its application engineers on processor-level optimization and multithreading of applications, while Compaq engineers have focused on system-level optimization of applications for the Highly Parallel System Architecture found in the Compaq Professional Workstation 6000 and 8000.

An example of a mutually beneficial ISV relationship in the MP Initiative involves Compaq, MacNeal-Schwendler (MSC), and Intel. MSC is the industry-leading supplier of mechanical CAE software, and their most well known application is MSC/NASTRAN. Intel has worked with MSC on processor-level optimization as well as multithreading of MSC/NASTRAN for the Compaq Professional Workstation 8000. Compaq, meanwhile, brought the application in-house and worked to optimize system-level performance (i.e., instrument the code and document performance, uncover bottlenecks, and test various memory and disk configurations).

The result of this collaboration and others like it, will be that Compaq and its partners will be able to meet the performance needs of the RISC/Unix power users with low cost, industry-standards based platforms.

MULTIPROCESSING IN BRIEF

In a multiprocessing system, the operating system can share the system's hardware resources among multiple processes or applications. Parts of an application can be split between two or more processors, or multiple applications can run simultaneously on multiple processors. A more sophisticated form of multiprocessing is parallel processing in which a single application running on a multiple processor system harnesses all of the available computational power to accelerate performance. ISV partners in the MP Initiative have used parallel processing techniques such as multithreading and message passing to accomplish this, with the emphasis on multithreading.

MULTIPROCESSING TRENDS

There are several trends in the industry that support eventual widespread adoption of multiprocessing on NT/IA workstations.

- **Pervasive Low Cost Technology:** None of the players in the fragmented RISC/Unix workstation business has ever reached the unit volumes required to drive the rapid, industry standards-based innovation that we see today in the NT/IA workstation business. One of the benefits to end users of NT/IA workstations will be the availability from multiple vendors, of affordable four processor systems by the end of the decade. With the launch of the four processor Compaq Professional Workstation 8000 in June 1997, Compaq is clearly leading this trend. Compaq's entire Professional Workstation product line, from the entry-level 5000, through the mid-range 6000, and high-end 8000 all support multiprocessing.
- **Low Cost of Ownership:** The low cost of the NT/IA workstations will also extend to multiprocessing. Current add-on processor prices for RISC/Unix workstations still range from $5-15K, while in NT/IA systems they will be closer to $1,000. Sun is charging $12,000 for the second processor (maximum configuration) in the new 300 MHz Ultra 2 workstations[1]. These purchase cost changes will make it easier for IT and technical management to justify deploying multiple processor desktops when considered in conjunction with the performance needs of their users.
- **Standard Architecture:** In the NT/IA workstation business there is a standard for multithreading in contrast to RISC/Unix, where some vendors have threads (each with a different implementation) and others don't. In addition, MP Initiative partners such as Kuck & Associates, Inc. have introduced products like the KAP/Pro Toolset, which facilitate migration of parallel codes from legacy systems as well as the creation of new parallel codes on NT/IA.
- **ISVs Ready for MP:** ISVs that have incurred the cost and complexity of supporting multiple RISC/Unix multiprocessing implementations in the past are now attracted to the business model and cost savings associated with a single implementation based on NT/IA. In addition, other ISVs that have never had the resources to attempt a multithreading implementation on any of RISC/Unix architectures, but that have customers who crave performance scalability, will now prioritize a multithreading effort into their development plans.

[1] Sun Microsystems, Inc. press release dated April 29, 1997 with Ultra 2 Model 1300 priced at $26,495 and Model 2300 at $38,495.

MULTIPROCESSING BENEFITS

The accelerated application performance brought about by the MP Initiative partners will translate directly into improved end-user productivity, which in turn can ultimately impact the completion date of the project. Some application specific examples are given below.

Time-to-Market:

- A higher performing mechanical CAE application may be used in more places and by more users during the development process. This would reduce late-cycle design changes and improve product quality.
- A rendering application is now fast enough that a film designer can get last-minute changes rendered in a special effect while still meeting a seasonal launch window.
- A financial analyst is now able to offer a novel financial instrument before the competition and ultimately garner the most market share.
- An electrical engineer is now able to complete verification of a new design so that a new microprocessor can be launched well ahead of the competition.

Reduced Development Costs:

- With faster time-to-market, staff and other resources can be rolled off one project and onto another more quickly.
- Increased computing power enables more virtual prototyping which reduces the time and cost associated with physical prototypes.

Higher Quality and Safety:

- Instead of just getting things done faster, a mechanical analyst might choose to translate the improved performance of an application into more simulations to find ways to improve quality or further verify safety margins.
- Automotive designers will be able to spend more time looking for ways to reduce wind noise with computational fluid dynamics applications or improve a car's response to a side impact collision.

Breakthrough Designs and Features:

- The amount of processing power enabled by these parallel applications encourages a jet aircraft engine designer to attempt simulations that couple multiple physical effects, and ultimately yield a radical new design with breakthrough fuel economy.
- The film designer now has the ability to offer that next level of reality in rendered scenes within existing frame rendering time budgets.

Of course RISC/Unix workstations have been used for these kinds of activities all along, so what are systems like the Compaq Professional Workstation 8000 bringing to the table that is so different? What's different is that the landscape has changed ... such that multiple vendors using industry-standards based systems offered at affordable price points, will be able to address the complex problems of the RISC/Unix power user.

NEXT STEPS AND CONCLUSIONS

A next step for the MP Initiative will be the addition of several more ISVs to the effort. In addition to forming more partnerships with ISVs that already have multiprocessing experience, Compaq will break new ground by working with ISVs that have applications needing a performance boost, but which have never before taken advantage of multithreading such as applications performing large assembly visualization in mechanical CAD.

Another area of investigation is system integration activity whereby Compaq and its MP Initiative partners will be able to offer a workgroup computing environment which pools all of the computational resources such that they could be easily accessed by the users and the applications. Aside from the productivity boost for all users, this would enable users with uniprocessor desktops to access multiprocessor desktop resources when they are idle. This can be conceptually referred to as "workgroup multiprocessing", and a likely technology piece in this solution would be the Load Sharing Facility (LSF) from Platform Computing Corporation.

In addition, Compaq is already investigating delivery of a packaged workstation compute or render farm for customers wanting to accelerate very large jobs through the message passing form of parallel processing.

In conclusion, forces in the workstation industry are now aligned for adoption of multiprocessing on systems like Compaq's Professional Workstations. This may eventually occur without the efforts of Compaq and its MP Initiative partners, but we are accelerating the trend in order to get the benefits into customers' hands faster. With the availability of multithreaded applications, customers will be able to confidently deploy systems like the Compaq Professional Workstation 8000 to address their most difficult desktop computing challenges.

APPENDIX: MP INITIATIVE PARTNERS AND THEIR RESULTS

The following is a list of ISVs collaborating with Compaq in the MP Initiative along with a description of their business, applications, and their activities relating to the MP Initiative.

Mechanical CAE:

MacNeal-Schwendler, Inc.

MacNeal-Schwendler Corporation (MSC) is the world's leading supplier of mechanical computer-aided engineering (MCAE) solutions. MSC has worked with Intel to develop a multithreaded implementation of MSC/NASTRAN that will be available on the new Compaq Professional Workstations. Compaq is working with MSC to maximize performance on Compaq's Highly Parallel System Architecture and to develop configuration specifications for end user deployment. The Compaq Professional Workstation 8000 has been found to achieve performance levels comparable with leading RISC/Unix workstations.

MSC is also participating in a three-way effort with Platform Computing Corporation and Compaq, to demonstrate the integration of MSC/PATRAN and MSC/NASTRAN applications with Platform's Load Sharing Facility (LSF) at Compaq's June 1997 product announcement. This demonstration will show how an engineer can create, submit, and monitor a MSC/NASTRAN job from within MSC/PATRAN, supported by LSF such that the job executes on the best available resource in a compute farm of Compaq Professional Workstations

ANSYS, Inc.

ANSYS, Inc. is dedicated to furnishing their worldwide customers with intuitive, intelligent solutions to engineering design, analysis, and optimization challenges. ANSYS has partnered with Intel to multithread their application suite and is demonstrating the preliminary results of this work at Compaq's June 1997 product announcement. Multiprocessor scaling has been shown

to range from 2.5 to 4.0X with four processors. Compaq is working with ANSYS to maximize performance on Compaq's Highly Parallel System Architecture, and to study the benefits of using very large memory configurations in solving CAE problems.

Fluent, Inc.

Fluent, Inc. is a wholly owned subsidiary of Aavid Thermal Technologies, Inc. and is the world leader in the rapidly growing field of computerized design and simulation software used to predict fluid flow, heat and mass transfer, chemical reaction, and related phenomena. Fluent has worked with Compaq to demonstrate multiprocessor scaling of the FLUENT/UNS and RAMPANT applications, using MPI style message passing on the Compaq Professional Workstation 8000. Results to date indicate approximate multiprocessor scaling of 2.5X for four processors. This implementation will also eventually scale across a workstation compute farm. The two companies hope that the results of this work can be released in a product sometime during 1997.

Hibbitt, Karlsson, & Sorensen, Inc.

Hibbitt, Karlsson & Sorensen, Inc. (HKS) develops and supports the major engineering analysis software packages ABAQUS/Standard, ABAQUS/Explicit, and other ABAQUS products. These packages are used throughout the world to simulate the physical response of structures and solid bodies to load, temperature, contact, impact, and other environmental conditions. ABAQUS/Standard and ABAQUS/Explicit run in parallel on various UNIX machines. HKS is currently certifying their application and evaluating the performance of the new Compaq Professional Workstations with the NT/IA version of ABAQUS.

Altair Computing, Inc.

Altair Computing, Inc. provides high performance software for the engineering simulation specialist to enhance the product design and analysis process. Altair currently offers several software packages designed to meet a mechanical engineering need, including: HyperMesh, HyperOpt/ABAQUS, HyperOpt/NASTRAN. Altair will be working with Compaq to investigate implementation of multiprocessing functionality in their NT/IA software release.

Mechanical Dynamics, Inc.

Mechanical Dynamics, Inc. pioneered the field of mechanical system simulation. Engineering teams use the company's ADAMS software to create and test "virtual prototypes," realistically simulating on their computer the full-motion behavior of complex mechanical system designs. MDI will be working with Compaq to investigate implementation of multiprocessing functionality in their NT/IA software release.

Digital Content Creation:

Kinetix

Kinetix develops and delivers affordable content creation tools for professionals such as film and video producers, video/computer game developers, Web content developers, architects, engineers, and designers. 3D Studio MAX, the company's flagship product, has been extensively multithreaded and takes advantage of the multiple processors and the Highly Parallel System Architecture in the new Compaq Professional Workstations. In addition, Kinetix is demonstrating the scalability of their application on a render farm of eight four-processor Compaq Professional Workstation 8000 systems at Compaq's June 1997 product announcement.

Adobe, Inc.

Adobe Systems, Inc. develops and supports products to help people express and use information in more imaginative and meaningful ways, across all print and electronic media. Adobe's PhotoShop and AfterEffects applications are multithreaded for NT/IA, and are certified to take

advantage of the Highly Parallel System Architecture in the new Compaq Professional Workstations.

Mental Images

Mental Images is the developer of Mental Ray, which is one of the most advanced rendering software tools available and is increasingly recognized for its quality, speed, and versatility. Mental Ray is used by leading film and visual effects companies, and is distributed with Softimage 3D. On multiprocessing platforms like the Compaq Professional Workstation 8000, Mental Ray uses multithreading to reduce the time required to render individual frames. Mental Ray is also able to distribute the rendering process across networked workstation farms, which is a viable way to fully exploit idle computing resources during offpeak hours.

Finance:

Applix, Inc.

Applix, Inc. is a leading provider of software for managing customer interaction, real-time decision support and office productivity across globally networked, extended enterprise environments. Applix is working with Compaq to optimize their TM1 real-time decision support application on the new Compaq Professional Workstations. The real-time performance delivered in TM1 is achieved through a NT/IA multithreading implementation.

Infinity Financial Technology, Inc.

Infinity Financial Technology, Inc. develops and markets best-of-breed applications for financial trading and risk management. The company also provides the Infinity Platform, an emerging industry standard for the development and delivery of extensible financial applications and the basis for a wide range of services and products delivered by business partners. Infinity is working with Compaq on a multiprocessing implementation for their NT/IA software release.

Scientific:

Oxford Molecular Group

Oxford Molecular Group is a worldwide provider of solutions for discovery research to chemical, pharmaceutical and biotechnology companies and universities. Oxford is working with Compaq and Intel to optimize the multithreading performance of their CAChe chemical modeling package on Intel's Pentium Pro and Pentium II processors and the Compaq Highly Parallel System Architecture through the use of the KAP/Pro Toolset from Kuck & Associates, Inc..

Numerical Algorithms Group

The Numerical Algorithms Group (NAG) has more than 25 years experience in developing, porting, distributing and supporting scientific software. NAG recently announced the NAG Fortran SMP Library that delivers parallel processing performance to customers solving large problems using algorithms in linear algebra, multivariate statistics and FFTs. NAG is currently working with Compaq to multithread this product on NT/IA, and to optimize its performance on the new Compaq Professional Workstation 8000. NAG also has other numerical library products, such as the NAG Parallel Library that scale across distributed memory supercomputers and workstation compute farms with the use of message passing libraries like PVM and MPI.

Visual Numerics, Inc.

Visual Numerics, Inc. provides industry-leading and mission-critical software productivity solutions to more than 300,000 business and technical professionals from around the world. VNI is working with Compaq to multithread their IMSL FORTRAN Numerical Libraries on NT/IA and to optimize their performance on the new Compaq Professional Workstation 8000. Compaq and VNI also plan to investigate implementation of VNI's Distributed Network Fortran Library, which uses MPI for parallel processing, on workstation compute farms.

Software Development:

Kuck & Associates, Inc.

Kuck and Associates, Inc. (KAI) offers software tools and libraries for high-performance computing. The KAP/Pro Toolset is a breakthrough product that enables development of new parallel codes on NT/IA as well as facilitating the porting effort from legacy platforms. KAP/Pro Toolset is being used by several of the ISVs participating in the MP Initiative.

Systems Management:

Platform Computing Corporation

Platform Computing is a leading provider of system software for workload management. The LSF (Load Sharing Facility) Suite of products is the most comprehensive solution for load sharing and batch scheduling across clusters of distributed heterogeneous workstations and servers. Platform has certified the first Windows NT release of their LSF family of products on the Compaq Professional Workstations. The two companies are examining optimal configurations for segment-specific workstation compute and render farms. Platform is also collaborating with MacNeal- Schwendler and Compaq to demonstrate integration of LSF with MSC/NASTRAN and MSC/PATRAN products at Compaq's June 1997 product announcement.