Preface

Fujitsu's Approach to High Performance Computing

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1. Introduction

The demand for increasing calculation capability in the High Performance Computing (HPC) field, particularly for science and technology calculations, seems to be unlimited. As a computer vendor, Fujitsu continues to develop higher and higher performance computer systems, and is expected to provide total solutions.

Fujitsu has long experience and a proven track record in the HPC field. We consider it our mission to develop and provide the world's fastest, largest-scale high performance computers.

With the above in mind, and aiming to enlarge our market share and promote cutting-edge technology, by the end of 1994 Fujitsu had merged the related divisions and established a dedicated HPC division. As we face the 21st century, our promotional activities as a leading company in the HPC field center on this division.

This paper introduces the progress and future of our vector parallel supercomputer, which is based on traditional supercomputing technology, and our new scalar parallel computer.

2. Trends in the HPC field and the aims of Fujitsu's products

To cope with the demand for ever more complex calculations, the HPC field needs high speed systems that are easy to use at low cost. To meet these requirements, high-speed single-processor elements and system scalability are indispensable. Traditional vector technology and new parallel technology are the core technologies.

Following this trend, Fujitsu has introduced parallel technology aiming at higher speed in the field of supercomputers based on traditional vector technology. At the same time, Fujitsu has also produced and is offering the VX/VPP300/VPP700 series, which makes full use of CMOS

and open technologies. This series features high scalability, from small-scale levels appropriate to the requirements of research laboratories to top performance levels.

In other parts of the market, scalar parallel computers using multiple universal scalar processors are likely to dominate. This field is now moving from the research stage to the practical application stage, and we can expect it to develop further. Fujitsu established Fujitsu Parallel Computing Research Facilities to investigate the use of the AP1000, a distributed-memory scalar parallel computer, and is making large contributions to research into parallel processing in the academic field. Based on our experience, Fujitsu manufactured and started selling the new AP3000 series, which maintains continuity with the S-family of Fujitsu workstations.

In the HPC field, our vector parallel computers and scalar parallel computers are compatible with each other, and a combination of these two types of computers will provide an optimum system for every customer.

3. Vector supercomputer development and its future

Historically, the vector supercomputer was mainly developed in the USA. However, in 1976, Fujitsu developed its first vector processor, the FACOM230-75APU (Array Processing Unit). Drawing on this experience, Fujitsu then manufactured the VP100/200 series of vector supercomputers, which were put on the market in 1982 (see **Fig.1**). This series was followed by the superior VP400 series in 1985, which, for the first time in the world, made it possible to achieve performance levels beyond 1GFLOPS (billions of floating point calculations per second).

First sold in 1988, the VP2000 series was developed as the successor to the above VP series. At that time, vector support for an OS conforming to the UNIX standard was developed in prompt response to the demand for open systems. Bringing together the most advanced technologies available at that time, the VP2000 series pioneered the supercomputer technology of the 1990s.

As a further stimulus to development, demands for calculation capability more than 10 times greater than that of the traditional Tightly Coupled Multi-Processing (TCMP) type vector supercomputers have emerged in the fields of aircraft design and weather forecasting services. To meet these demands, parallel technology is required. In cooperation with the National Aerospace Laboratory, drawing on their expertise in the research and development of numerical simulation technology, Fujitsu developed the so-called Numerical Wind Tunnel (NWT) that has features of both vector supercomputers and new parallel computers. Based on this architecture, the VPP500 series was developed

and manufactured, and went on the market in 1992.

Moreover, based on the experience and positive achievement of the VPP500, CMOS technology and open technology have been fully introduced into our manufacturing process, making possible great improvements in cost performance, scalability, and installability. The VX/VPP300 series went on the market in 1995; the VPP700 series followed suit in 1996. **Figure 2** shows the architecture of the newest vector parallel computer.

Facing the 21st century, and the unlimited demand for calculation capability, we will improve the performance of vector parallel computers even further.

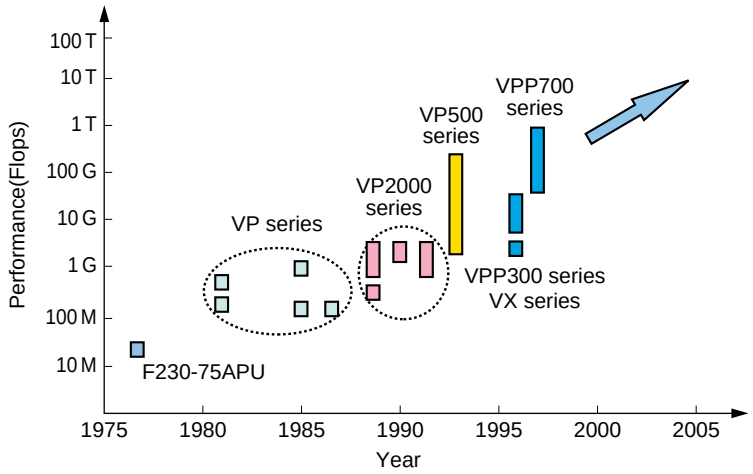

Fig.1— Development of vector supercomputer.

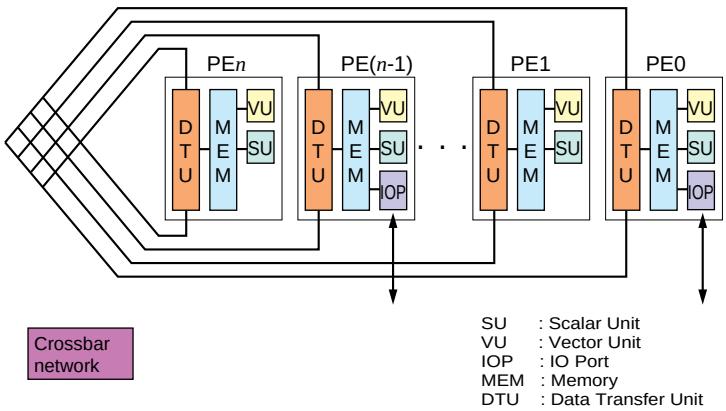

Fig.2— Concept of vector parallel supercomputer architecture.

4. Scalar parallel computer development and its future

During the first half of the 1980s, Fujitsu was closely watching the increasing importance of highly-parallel computers that were based on multiple micro-processors. Highly-parallel processing was expected to find practical applications especially in the fields of graphic processing, circuit simulations, and Monte Carlo simulations. The earliest scalar parallel computers developed by Fujitsu were the Cellular Array Processor (CAP) and its expansion unit, the CAP256 (see **Fig.3**).

Based on the above experience, the AP1000 was developed in 1990. The AP1000 used up to 1,024 SPARC element processors. The connected network was originally based on an expanded two-dimensional torus, and its epoch-making message communication system was highly praised both in Japan and abroad. In 1993, the AP1000+, a version using SPARC technology with improved clock speeds, was put on the market.

On the other hand, to satisfy the demand for low-price workstations and local area networks, parallel processing by a workstation cluster has become the object of attention. While workstation cluster systems provide continuity with workstations, the communication performance becomes a bottleneck as the number of nodes increases, and management of operations becomes quite complicated.

Fujitsu made the best use of AP1000 networks, enabled management of operations with a single system image, and then developed the AP3000 series as scalar parallel computers which combine this with the advantages of workstation clusters (see **Fig.4**). In other words, while adopting the S-family as nodes to provide continuity with workstations, a high-speed two-dimensional torus network provided connections between nodes, and the power control and installation work could be carried out in batch processing.

The AP3000 system is appropriate for many applications, and we hope that many customers will choose it as it will become ever easier to use.

5. Conclusion

As mentioned above, Fujitsu can offer both vector parallel supercomputers and scalar parallel computers. We think that in the future we will use the advantages of each system and move in the direction of merging these two product lines. In other words, we are moving towards the realization of a heterogeneous system, aiming to create a system architecture that extends seamlessly from workstations to supercomputers.

Facing the 21st century, it is generally expected that calculation capability will increase more and more. To meet this expectation, Fujitsu will continue its activity in the HPC field as a leading company, based

on its long experience and track record to provide solutions to customers' needs.

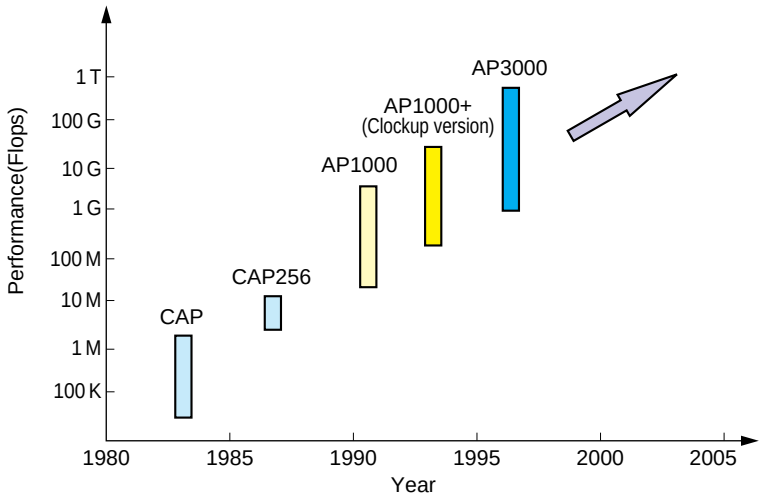

Fig.3— Development of scalar parallel computer.

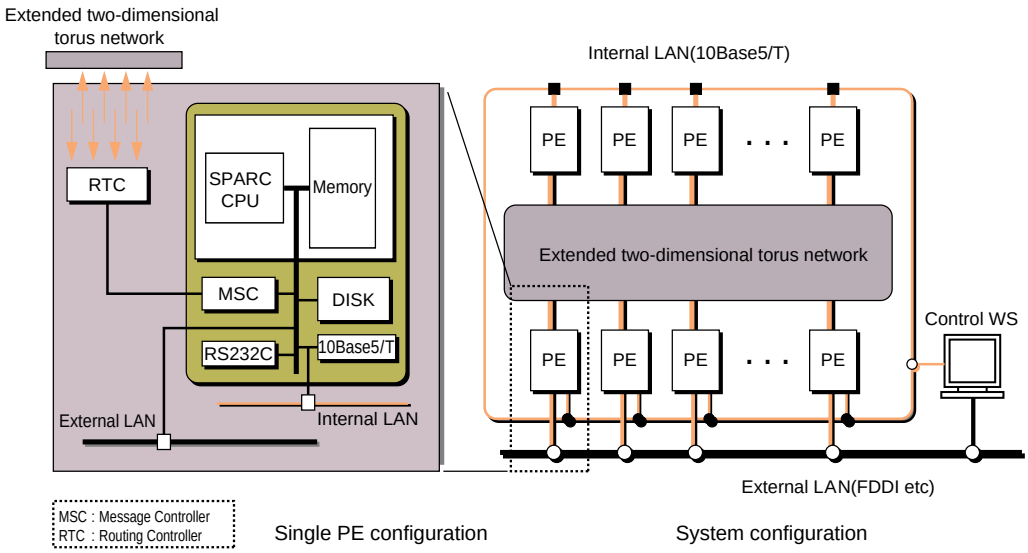

Fig.4— System configuration of AP3000.

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