Developments in Japan

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Abstract

The supercomputer situation in Japan has changed very little since the last TOP500 report (see citeJapan94). There has been steady progress with the development of the series of new machines which had been announced in late 1994 and early 1995, but they have not yet been delivered to customers. However, a number of important orders outside of Japan could be gained by the Japanese supercomputer companies against fierce competition from the US manufacturers. Thus the apparent isolation of the three major Japanese computer manufacturers to Japan seems to come to an end. In late 1995/ early 1996, the first of the new CMOS based supercomputers will be available to customers both in and outside of Japan. It remains to be seen whether all expectations will be met.

With regard to the market situation of supercomputers in Japan, a consolidation of the market shares can be seen. The two dominant manufacturers for Japan represented in the TOP500 list, Cray Research, Inc. (CRI) and Fujitsu, kept resp. increased their number of sites while Hitachi, NEC and Thinking Machines Corp. (TMC) - the latter not surprisingly - lost out. CRI will even install the first of its fully configured T9 systems in Japan. IBM made strong inroads with 7 new sites listed. However, SGI did not succeed in copying its success elsewhere in Japan: it only managed to gain one entry.

With regard to the situation world-wide, Japan has again reduced its

share of the TOP500 sites, it can only field 73 entries after 82 last year. However, it added 8 to the first 50 and 11 to the first 100 entries, i.e. it replaced a number of smaller, outdated previous supercomputers by more powerful, modern ones, in particular the Fujitsu VPP500. When looking at Rmax Gflops/s capacity installed, Japan's share slightly decreased from 27% to 25.8% of world capacity, but increased in absolute terms from 709 Gflops/s to 1,234 Gflops/s.

In summary, Japan kept its position world-wide as the second largest user of supercomputer capacity with a safe margin of 8.9% of world-wide installed capacity separating it from Europe, but trailing the US by nearly 30%.

1 Background

As detailed in [1], the Japanese supercomputer scene is dominated by the three major domestic computer manufacturers Fujitsu, Hitachi and NEC with a strong presence of CRI. The three Japanese vendors started in the early 80's to build and market supercomputers as the top end of their mainframe businesses. Their determination to achieve world leadership in this field seems unbroken, and the long term plans are slowly coming to fruition.

One of the authors remembers a discussion he had in 1981 with a developer of Fujitsu's VP-200 systems in which he was told that the Cray machines would be superior in the world markets for the next two generations of machines, but would be equal or inferior from then onwards. Considering the relevant machine ranges, first generation: VP-200 - Cray X-MP, second generation: VP-2000 - Cray Y-MP, third generation: VPP500 - C90, and fourth generation: VPP300 - Cray T9/ Cray T3E, the long-term prediction of the Japanese colleague covering nearly 15 years looks pretty close to coming true. It shows the long term view taken by the Japanese industry and the strategy employed. Initially, superior products are imported and compared with the local offerings, then the local market is conquered, before finally the external markets are won with superior products.

At present, we are witnessing the attempted implementation of the third phase of the strategy. The local Japanese market is dominated by the three domestic supercomputer vendors with an unwavering domestic following for each. All three have started to penetrate the markets outside of Japan, with Hitachi being the last to start marketing its MPP RISC SR2001 system range in 1994. Outside of Japan so far in 1995, Fujitsu has won 5 orders for its VPP300 range, while NEC has managed to place 4 of its SX-4 systems.

2 Current commercial offerings

The three Japanese supercomputer vendors have decided to offer different architectures to their customers: Fujitsu follows along the path of distributed memory, proprietary vector processor systems started with their VPP500 range; Hitachi offers MPP systems based on commodity RISC processors (HP variety) besides their older shared memory, proprietary vector processor system S3800, while NEC markets a cluster of shared memory, proprietary vector processor systems with up to 32 processors per cluster node.

Fujitsu and NEC continue to build fast vector machines employing tested designs. Both have succeeded in building their machines using the latest .35 micron CMOS technology, but differ with regard to the memory architecture. Fujitsu believes in large, distributed, relatively slow memory (SDRAM), while NEC uses smaller, very fast, shared memory (SSRAM) for its cluster nodes. Otherwise, the processors of the two competitors are remarkably similar with a performance of 2.2 resp. 2 GFlops/s achieved with 8 vector pipes.

Hitachi follows the route developed by the MPP RISC protagonists, such as IBM, Intel, Meiko, TMC and more recently CRI. They use commodity RISC chips with their own connecting network. Since Hitachi only came to market in 1994 with its first generation of machines, it is at a disadvantage compared to its competitors who by now deliver at least their second generation of systems. Consequently, the market penetration of Hitachi is so far restricted to a few development sites. However, considering the size of Hitachi and its probable long-term plans, the future Hitachi MPP systems may become formidable competitors world-wide.

3 Current market situation

3.1 Government market

At first, we look at the government market in Japan. The most significant boost for supercomputing happened in the Japanese fiscal year '93 (ending March '94). In that year the government used a supplementary budget to stimulate the economy which resulted in 11 additional supercomputer sites beside the traditional university and research lab centres. In the fiscal year '94 there was no such special budget.

Nevertheless, the regular budgets allowed for some significant supercomputer installations. The biggest system that was installed in that time frame is a VPP500/80 at the Research Lab for High Energy Physics. Further VPP500 systems have been installed at the Solid State Physics Institute of Tokyo University, at the Computing Centre of Kyoto University and at the Japan Atomic Energy Research Lab. Great attention was given to the success of CRI at the Fluid Dynamics Research Institute of Tohoku University and the Tokyo Engineering University. Two C916 systems plus a T3D/128 MPP-system have been installed in these big, traditional universities. The Hokkaido University - a loyal Hitachi customer - installed a Hitachi S-3800/380 system in their large scale computing centre. MPP systems got only a small share of the budget. Beside the already mentioned T3D system, Intel succeeded to sell a Paragon system to the Japan Atomic Energy Research Lab, and the Electrical Power Development Corporation installed a nCube2S system.

The fiscal year '95 is still on-going. Few decisions have already been made. The computing centre of Nagoya University continues with Fujitsu systems and has installed a VPP500/42. The computing centre of Tokyo University ordered the MPP system from Hitachi. A SR2201 system with 1024 processors will be installed early next year. It will be interesting to watch whether the computer centre of Tokyo University - one of the most important customers of Hitachi - will move from vector computing to the MPP style. This could influence the future supercomputer strategy of Hitachi. So far, it is not clear whether Hitachi will announce a successor vector system.

It is well known that the big Japanese universities have long lasting relations to a vendor. The general purpose computing centres tend to stay loyal with their vendor. However, institutes of these universities are more independent and procure their own systems. Often, they decide for systems from other vendors than the one of the computing centre.

3.2 General market

There are 73 supercomputers in Japan listed in the TOP500. This represents a 14.6% share of the 500 entries - a decrease from 82 systems one year ago. The accumulated Rmax performance of these 73 systems reaches 1.234 TFlops/s which represents 25.6% of the accumulated Rmax performance of the TOP500. These figures show that Japanese supercomputer installations have in average a significantly higher performance than sites in other countries. This trend continues already for several years. In figure xxx the distribution of the number of systems and the accumulated Rmax performance are listed for different vendors.

The market leader in Japan is still Fujitsu with 34.25% of the number of systems and even 57.38% of the accumulated Rmax performance of the TOP500 sites in Japan. This outstanding relation is caused by the success of Fujitsu's VPP500 series. The 15 VPP500 systems in Japan (including the Numerical Wind Tunnel system) account already for 667.762 GFlops/s Rmax performance.

When we now look at the distribution into MPP, PVP and SMP systems, we face the difficulty that to count the VPP500 as an MPP system may lead to a misinterpretation of the Japanese market. The SGI system (installed at SGI Japan) is the only SMP system within the Japanese TOP500 list. But there are many SMP systems installed in Japan which just have too few processors to make it into the TOP500 list. The traditional PVP systems from CRI, Fujitsu, Hitachi and NEC account for 37 systems and 416.036 GFlops/s. The MPP

Vendor	Sites	Rmax (GFlops/s)
Convex:	1	3.31
Cray:	10	85.93
Fujitsu:	25	707.85
Hitachi:	9	157.70
IBM:	8	61.20
Intel:	3	25.20
NEC:	11	164.32
Parsytec:	1	5.25
SGI:	1	3.70
TMC:	4	19.10
Total:	73	1233.55

Table 1: Distribution of systems to different vendors.

systems including the VPP500 account for 35 systems and 813.814 GFlops/s. Does that mean that MPP systems have achieved a breakthrough in Japan? If we only look at the MPP systems which are based on standard RISC processors we count only 20 systems and 146.025 GFlops/s, nevertheless this is a significant progress compared with 1994.

The usage of the VPP500 systems is still very similar to the usage of the PVP systems. The computing centres are using the processors partly in throughput mode for serial vector jobs. This enables them to use these resources immediately very efficiently. At the same time, users are incrementally parallelizing their applications. Some users do it in the message-passing style with PARMACS or PVM. The majority of parallelization work, however, is done in Fujitsu's VPP-FORTRAN style. This compiler directive based method is similar to the HPF style and allows users to stay very close to their original vector codes. Consequently, the usage of the VPP500 systems can be claimed to be closer to PVP than to MPP although the VPP500 is clearly a scalable system with distributed memory - a main characteristic of MPP. It will be interesting to watch this development in 1996 when more scalable vector systems, also from NEC, will enter the list.

3.3 Market distribution

Another interesting aspect is the distribution of the Japanese TOP500 systems into the application areas. 34 systems are installed at research laboratories and account for 718.023 GFlops/s. 20 systems are installed in the academic sector and account for 309.838 GFlops/s. The classified sector plays traditionally no major role in Japan with just 1 system with 3.800 GFlops/s. The vendors have pushed 7 systems into this list with impressive 140.220 GFlops/s mainly for benchmarking purposes.

Let us look in more detail at the 11 TOP500 systems employed by the Japanese industry. A large proportion of these systems is supplied by CRI probably because of the wider software range available. The industrial systems are smaller on average and account for 61.669 GFlops/s. Traditionally, the automotive industry takes the biggest share of supercomputers in the Japanese industry. Suzuki Motor uses a Hitachi S-3800/260 system, Toyota enjoys the variety of a NEC SX-3/14R, a Cray T94/4 and a Fujitsu VPP500/4, Honda uses a Cray T94/3, and finally Nippon Denso - also a company in the automotive sector - uses a Cray T94/2. It is interesting to note that the first 3 Cray T90 systems in Japan were installed in the automotive sector. Fuji Heavy Industry still uses the VP2600 as well as Taisei Construction. Obayashi Corp. continues with its NEC SX- 3/21R system. The Japanese industry started also to use MPP systems. An IBM SP2/72 system is installed in the nuclear power industry. Mitsubishi Electric Corp. is using a Cray T3D system with 64 processors.

From a European perspective it has to be recognized that only one European system is listed in the TOP500 list for Japan: a Parsytec GC PowerPlus system with 128 processors installed at the Japan Institute of Advanced Technology. In Japan the trend to buy IBM SP2 or SGI PowerChallenge systems in institutes and departments is also clearly visible. Many systems of these types have been installed and take over workload that originally was performed on supercomputers. Many of these systems are not listed in the TOP500 because they have only few processors that result in a Rmax performance less than the entry level for the TOP500.

When one compares the situation of today with the market several years ago, one recognizes that systems like the entry-level models of the Fujitsu VP2000, NEC SX-3 or Hitachi S-3000 series were not only used for typical vector applications but also for general purpose workload. At that time the scalar performance of these systems was also attractive for general purpose applications. Today, mainly highly vectorized applications represent the workload on the big vector computer sites. The general-purpose workload has moved to cheaper systems based on standard RISC processors. This effect is one reason for the decrease of the number of vector sites in the TOP500 list. On the other hand, the performance of the 'real' vector sites grew significantly. The result is that fewer vector sites represent a bigger share of the aggregate performance in Japan.

4 The Japanese TOP20

This year's Japanese TOP20 is dominated by powerful VPP500 systems. The leader in Japan which also leads the world-wide TOP500 is still the Numerical Wind Tunnel at National Aerospace Lab. This system with 140 processors which is very similar to the VPP500 has been installed in early '93. The fact that an almost 3 year old system leads the TOP500 list shows how innovative this system was. At a time when other vendors of vector computers continued with PVP systems, Fujitsu took the lead with the vector parallel architecture which is able to scale beyond the limits of traditional PVP systems. The second most powerful system in Japan is the VPP500/80 at the National Lab for High Energy Physics. On number 3 we find the first representative of the new CMOS based vector computer of NEC. The SX-4 series has also the potential scalability to reach top positions in the TOP500 list. So far, only the benchmarking system of NEC entered the list. Customer installations are not yet known. The positions 4 to 10 in the Japanese TOP20 are all occupied by Fujitsu VPP500 systems. The latest installations have been performed at Nagoya University and the National Genetics Research Lab. The high- end PVP system of Hitachi can be found on positions 11 to 13. The most recent installation of an S-3800/480 is the Meteorological Agency in Japan. On positions 14 and 15 we see maximum configurations of NEC's SX-3, followed by two 3-processor Hitachi systems, a VPP500/15 and an SX-3/3 system. On position 20 we find the most powerful system in Japan that was manufactured in the US - a Cray C916 at the RIPS research lab in Tsukuba.

5 Conclusions and outlook

At present, the Japanese supercomputer manufacturers are on the brink of world-wide market penetration. Even though the US government funded market will probably remain closed to them for some time to come, their offerings are competitive outside of the US. Their early move to CMOS technology while still maintaining proven proprietary vector architectures gives them a cost advantage over the traditional ECL vector computers and a performance advantage, for the time being at least, over MPP RISC systems. At last, the US supremacy of the supercomputer market is challenged by credible suppliers.

References

[1] Sverre Jarp, Wolfgang Bez: Supercomputing in Japan. In: Supercomputer 60/61. Volume XI. number 2/3. June 1995. ISSN 0168-7875. pp. 31-44.