# High Performance Computing in Europe

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**Abstract**

The actual situation and the figures in Europe in 1995, sometimes compared with TOP500 in 1993 and 1994, will be discussed in general. The number of systems with respect to manufacturers, usage and countries will be shown in detail.

## 1 General Situation

Now it seems that the number of systems in Europe converge to about 140 that is 28% of the worldwide installations. The increase in speed is not as dramatically as last year. This time $R_{max}$ comes to 801 Gflops/s and $R_{peak}$ to 1172 Gflops/s that means 17% of the worldwide figures. The growth is only in the range of 170% to 180%, similar to the world wide trend. The percentage of 28% installed systems in comparison to 17% $R_{max}$ shows clearly that Europe uses more but smaller systems. The contrary can be seen in Japan, 15% installed computers but 26% of $R_{max}$ speed. These observations forced the German Scientific Council (Wissenschaftsrat) to publish a spectacular report. This topic will be discussed in the German section in detail.

This time the most powerful machine in Europe - although extended by 64 processors, the T3D 320 from University of Edinburgh fall back from rank 14 to rank 23. Cray T3D's with 512 processors and more and the Fujitsu VPP500 line overtook the British machine. This underlines the fact that Europe is falling behind using massively parallel machines.

In Europe HPC computers are mainly used in academic and research environment, about 75% compared to 23% for industrial usage, vendors and classified institutions can be neglected compared to America. If one changes to $R_{max}$, academic and research keep the percentage with 78% but industry falls back to 15%, while classified institutions grow to 5%. The same situation can be observed with $R_{peak}$. This shows that industry uses smaller and less powerful TOP500 computers than research, academic and classified institutions. So this list reflects more the academic aspect than industrial usage of HPC. That is demonstrated by German industrial users, there is a lot of Cray C90 with two processors or Y-MPs that fall out of this list. Nearly the same percentage can be observed in Japan, from where it is well known that industry uses small supercomputers.

Europe buys American machines, 84% of the computers and the other 8% are dedicated to European and Japanese computers. Nearly the same percentage can be found for $R_{max}$ and $R_{peak}$. This means, American machines are predominant in the old continent, European vendors have a small chance too.

The European users and computer centers are equipped with new machines. Out of 139 computers 82 have been installed or extended in 1995, 60% of all the entries in the European list. For example the University of Edinburgh and ZIB in Germany added another 64 processors to their T3D. The year before, 1994, 45 systems of the list have been bought. This means 130 of 141 machines - more than 90% - are not older than two years.

## 1.1 Distribution on country groups

As some of the minor European countries only bought one or two machines, we grouped them to blocks. The leader of the European gang is Germany again, 48 systems makes 10% of the worldwide base, followed by France 25 (5%) and United Kingdom (UK) 17 (3%).

Breaking these figures down to Europe only, Germany again has installed 36%, the same figure as last year. This year France had changed the situation and is number 2 with 17%, UK fell back to 12%. Scandinavia, Austria/Switzerland and Benelux lie close together: 14, 12 and 11 supercomputers. That means around 10% of the European machines. Eastern Europe is still underdeveloped in the supercomputer field. One of the reasons might be the technical export laws that do not allow the eastern countries to buy high-speed machines. The other reason might be the lack of money.

Looking at the $R_{max}$ measure a more different picture can be seen. Clearly Germany is No. 1 with 277 Gflops/s (34%) now followed by UK 144 Gflops/s (18%) and France 124 Gflops/s (15), Austria/Switzerland now come up to 106 Gflops/s (13%), as Benelux (53 GFlops/s, 7%) and Scandinavia (59 Gflops/s, 7%) are falling back. Nearly the same figures can be found for $R_{peak}$.

The comparison of number of machines and $R_{max}$ in a country shows a quite interesting new aspect. If one introduces the medium Gflpos/s per machine, the results are surprising, Austria/Switzerland comes to 8.8 Gflops/s/computer, UK 8.5, Germany 5.4, France 5.2, Benelux 4.8 and Scandinavia 4. If one takes Switzerland only, the medium speed of their machines exceeds 10 Gflops/s. This means Switzerland is equipped with the most powerful machines in Europe. Comparing this figure with the Japanese one of nearly 17 Gflops/s and the USA with 10 Gflops/s, once again, Europe does not have much powerful machines.

This means that Europe has lacks in the field of extremely powerful supercomputers. First results and activities to improve this bad situation can be found in the chapter of Germany.

### 1.2 The different manufacturers

The trend that could be seen last year has strengthened in the 1995 list. Number one in Europe is IBM that did a good job in selling 41 SP 2 systems. More than one third (34) installed SGI, Cray Research took 28 pieces of the HPC cake. The minor companies: Parsytec 9, Convex 7, Fujitsu 7, Intel 5, NEC 4. But more interesting is the summed $R_{max}$ and $R_{peak}$ performance of the vendors. Now the picture is changing drastically, Cray is the market leader 282 Gflops/s (35%), next is IBM 201 Gflops/s (25%) then SGI 120 Gflops/s (15%). Nearly the same is true for $R_{peak}$. If measured by Gflops/s per system, Cray machines deliver 10 Glops/s, IBMs 5 and SGIs only 3.5 Gflops/s/system. This shows that the Cray TOP500 in Europe are very powerful installations.

The decline of Cray from 58 machines in 1993 to 48 in 1994 and now to 28 and the small growth of $R_{max}$ from 75 Gflops/s in 1993 to 205 in 1994 and 282 in 1995 shows that the C90 with 3 processors and the Y-MPs with up to 8 processors are out of the list. On the one hand T3Ds have replaced them. Furtheron cheaper IBM and SGI MPP and SMP computers came into the list with 14 and 10 processors respectively. Now they are dominating the HPC market not only in Europe.

European vendors don't play a major role in the top business. Meiko has not sold a new machine this year. Parsytec on the contrary has sold two more machines in Europe. They need 64 processors to enter the list. A major business of Parsytec lies in minor machines with 8 or a bit more processors.

An other European vendor is missed in this list, Alenia Spazio from Italy.

### 1.3 Architectures

The trend mentioned above that started last year grew. SMP's are in. The number of MPP systems was reduced, only 82 machines compared to 89 in 1994, but with an $R_{max}$ of 536 Gflops/s versus 274 Gflops/s last year. This means two third of the computers and computing power in Europe belong to MPP systems. The vector machines came to the half of 1994, 27 machines with 170 Gflops/s - in 1994 $R_{max}$ has been 183 Gflops/s. Now SGI and others are attacking the HPC market with its killer micros in an SMP architecture. Almost 30 systems with an $R_{max}$ of 95 Gflops/s are now not neglectible. They have a market share of nearly 25% in machines but only 13% in LINPACK-speed. Next year there will surely be some new SMP systems by Digital and Hewlett-Packard in this list.

## 2 Germany

The historical aspects of HPCN in Germany and other European countries have been discussed in the last issue of the TOP500 report.

First the actual situation, again 48 machines entered the list, with an $R_{max}$ of 267 Gflops/s this nearly doubled the available performance. Of these systems 25 have been installed since the publishing of the 1994 report. So Germany is equipped with new computers. This year academia has installed 20 (122 Gflops/s) systems compared to 14 (95 Gflops) in research and 13 (50 Gflops) in industry. Compared to 1994, academia has risen its $R_{max}$ by a factor of 2.5, research by 40% and industry doubled. Even the fastest machine, the T3D at ZIB came to rank 38 instead of 61 last year. This shows that Germany invested a lot of money in HPC.

Concerning the vendors, nearly every machine offered in the market is installed in Germany, 3 Convex (10 Gflops/s $R_{max}$), 8 Crays (69 Gflops/s), 6 Fujitsu/SNIs (26 Gflops/s), 10 IBMs (60 Gflops/s), 1 Intel (4 Gflops/s), 1 KSR (4 Gflops/s), 2 NEC (23 Gflops/s), 6 Parsytec 33 Gflops/s), 10 SGI (32 Gflops/s) and 1 TMC (4 Gflops/s). This gives German researchers a good opportunity to study the different architectures, their performances and weak points.

Industry seems to change its strategy, although automotive industry invests in vector processors like Cray and NEC, BMW is downsizing. They use three major SGI Power Challenge machines with 18, 14 and 12 processors. The same happens in chemistry, Bayer has installed three 12-processor systems, BASF only one. What will happen next year, perhaps this underlines the SMP trend in industry. On the other hand the CMOS vector processors by Fujitsu/SNI and NEC are just being installed, will the have influence as departemental vector machines?

So some new and interesting activities are just going on in Germany that may have some influence on supercomputing in Europe and worldwide.

The German Science Council (Wissenschaftsrat) published a report with recommendations on the supply of academia and research with high-performance computing. Using the 1994 TOP500 list, they saw that Germany is dramatically falling behind in this field. Only small and medium size machines are available for this community. The most powerful machines could be find on rank 61, 98 and 106 in this list. Although there are ongoing research activities, the very big machines are missing. With a major financial push it is possible to get close to the other leading countries. They recommended to install 2 to 4 national German supercomputer centres that serve German academia without requesting money from the different counties. This report influenced the German Government and first positive results can be seen.

## Research:

KFA, Research Centre Juelich will install next year:

- an MPP Cray T3E with 512 processors ($>$ 300 Gflops/s $R_{peak}$)
- a Cray T90 with 12 processors

- a Cray J90 with 20 processors

Max-Planck Research Inst. in Garching:

- Cray T3E with about 400 processors

## Academia and Industry

A new company has been founded, Society for Operating High-Performance Computers for Science and Industry (HWW) supercomputing centre as a top-level facility.

The centre is funded by a group of industrial and government partners and is installed in Stuttgart. Daimler-Benz Interservices (debis Systemhaus), founded as an IT-services provider, currently holds a 40 percent share. The State of Baden-Wuerttemberg holds 25 percent. The University of Stuttgart Computer Centre holds 25 percent, and Porsche holds 10 percent. HWW is open to other partners, from industry and academia.

The State of Baden-Wuerttemberg will initially invest 15 million DM (about 11 million US$) in the German Supercomputer Centre, the Federal Republic of Germany will match that amount. Then Baden-Wuerttemberg plans to invest another 20 million DM. The Wissenschaftsrat has already recommended that the Federal Republic of Germany should spend another 20 million DM.

As principal industrial members debis Systemhaus and Porsche will contribute computers and computing time worth 40 million DM (29 million US$). Debis Systemhaus is expected to bring considerable industrial applications expertise into the partnership and will market the computing power to small and medium enterprises and big industrial firms. Debis Systemhaus sees its market in serving small partners of Mercedes for example. Mercedes is now outsourcing whole parts as gears for example. The small companies now have to design, simulate these parts numerically and finally build them. As they are not so experienced in using HPC and numerical simulation, debis Systemhaus wants to be a partner of them.
Actually they use at University Stuttgart:

- Cray C90-4
- Cray T3D-32
- Intel Paragon 72 processors

debis Systemhaus:

- Cray T90-3
- Cray C90-4
- Cray C90-2

- Cray J90-8
- IBM SP2/8
- SGI PowerChallenge 8 processors

Porsche:

- Cray C90-2

This is a very new situation in the HPC world that academia and industry are cooperating in supercomputing. First results will surely presented in the next report.

# 3 United Kingdom

This year UK fall back in the number of systems, only 17 instead of 25 last year. Here only Cray (6, 111 Gflops/s), IBM (4, 13 Gflops/s), Intel (1, 3 Gflops/s) and SGI (6, 18 Gflops/s) can be found. But on the other hand they have installed very powerful machines. Number 1 and 2 in the European list are installed on the island, Cray T3D with 320 and 256 processors, they also can use three Cray C916. There is a big discrepancy between a few top-level machine, then there is a big gap and then starting from rank 300 smaller machines. Only geophysical firms use TOP500 machines, again aerospace and automotive industry is missing.

# 4 France

France is ahead in the number of installations 24 (last year 23) not in $R_{max}$ compared to UK. They use medium size machines, the fastest keeps rank 92. As in UK mostly Cray, IBM and SGI computers are installed, Cray (9, 59 Gflops/s), Fujitsu (1, 6 Gflops/s), IBM (5, 18 Gflops/s), Intel (1, 12 Gflops/s), Meiko (1, 3 Gflops/s), SGI (6, 18 Gflops/s) and TMC (1, 8 Gflops/s). Even in France the trend to SMPs is growing, away from vector machines. The distribution of machines is quite interesting and very different to UK. Only 2 computers can be found in academia, 23 in different research institutes and 9 in industry. Nearly every section is represented, aerospace, automotive, tires and electricity - just as one expects in industrial usage.

# 5 Benelux

Big Blue Back in Benelux: with the installation of a 76 processor SP/2 just in time for this TOP500 list, IBM has taken the leading position in the Benelux, not only as the single largest installation, but also in number of installations (with 5 in The Netherlands and 2 in Belgium) and in total installed power. In Belgium, the IBM machines are the only ones that made it to the TOP500, and they both are at universities. In the Netherlands also industry has a few machines in the TOP500, although they are all owned by one company: SHELL, which has labs in Amsterdam and Rijswijk.

The traditional supercomputer vendors are loosing ground. Although Cray has been selling machines, they are not big enough to make it into the list. The research institute NLR has an NEC SX/4 on order, so they are expected to get a higher rating with the next list. Convex is back this time with an installation at SHELL, but in such a low position that it will possibly go out next time.

The Dutch National HPCN programme, which will be on its way soon, will probably also result in some more supercomputing power. It has, however, not yet been decided what kind of power and were it will be placed. The situation in Belgium stays disappointing. The two main reasons are that first there is no big industry that uses supercomputers and second it has been decided that there is no follow on to the national scientific supercomputer programme that has ended last year.

# 6 The European TOP25 Supercomputer Centres

(This section was contributed by Ad Emmen)

The TOP500 lists all the machines according to their performance. A number of these machines are placed in centres,which house more than one supercomputer. To see the relative importance of these centres, we have compiled the list of European Supercomputer centres given in Figure 1. As a centre we did also count two or more sites linked by fast networks and run as one entity.

The supercomputer centres in the list are ordered according to the total $R_{max}$ performance each centre has installed. Only the machines in the TOP500 are counted. This results for a few centres in a lower $R_{max}$ rate than last year, despite nothing has changed in their configuration. Because of the small differences in $R_{max}$ in most of this list, this even can result in a lower postion than would have been the case if also machines with lower $R_{max}$ ratings than the lowest in the TOP500 were counted. This is also a warning to treat this list with care: it is to be used as an indication of the importance of the centres, not as an absolute thruth.

None of the European centres is big enough to make it into the World TOP25 centre list (see elsewere in this issue). This shows, in Europe, the large machines in the centres play more the role as very high-end production facilties than of sheer research tools. Another factor is the absence of a large European supercomputer vendor. In Japan and the U.S. they play a stimulating role in trying to get some very large machines installed.

This year, the TOP25 centres house a total of 43 TOP500 machines, which is less than last year. The average of less than 2 machines per centre, is considerably lower than for the TOP25 World Centres This corresponds to 30% of all installed machines in Europe. The installed power is 426.4 Gflop/s, 51% of the installed European power. A sharp decrease from last year's 62%.

The research oriented centres are still dominant with 11 out of the 25. Academic centres are well presented with 8.5 and industry is gaining importance with 2.5 Two centres are classified and one belongs to a vendor. The combined RUS/debis Systemhaus/Porsche centre shows an example of the new, close collaboration between industry and a university.

Compared to last year, we see considerable changes in the list. About half of the centres are new to the list, showing the fierce competition.The first two positions remained unchanged, however, with EPPC at the University of Edinburgh still on Position 1.

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TOP25 European Centers

Nr. Centre $R_{max}$ (Gflop/s Field # Top500 Machines

1 (1) University of Edinburgh (UK) 31.7 Academic 23 Cray T3D MC320-8

2 (2) ECMWF (UK) 26.5 Research 67 Cray Y-MP C916/16256 93 Cray T3D MCA128-8

3 (-) Defense Research Agency (UK) 25.3 Classified 33 Cray T3D MC256-8

4 (7) Ecole Polytechnique Federale de Lausanne (Switzerland) 25.3 Academic 35 Cray T3D MC256-8

5 (-) ZIB/Konrad Zuse-Zentrum fuer Informationstechnik 25.3 Academic 38 Cray T3D SC256-8/464

6 (10) German Aerospace Laboratory, DLR Goettingen/Koeln (Germany) 22.3 Research 105 NEC SX-3/24R 112 IBM SP2/60

7 (6) CEA/Centre d'Etudes Nucleaires Grenoble (France) 21.7 Research 91 Cray T3D MCA128-8 365 Cray Y-MP C94/4256 436 SGI Power Challenge 437 SGI Power Challenge

8 (-) ETH Zurich (Switzerland) 18.7 Academic 46 Intel XP/S-MP 22

9 (15) RUS/debis Systemhaus Stuttgart (Germany) 17. Academic/Industry 257 Y-MP T94/3128 375 Cray Y-MP C94/41024 376 Cray Y-MP C94/4256 388 Cray T3D MC32-8 459 SGI/SNI Power Challenge

10 (-) SARA (The Netherlands) 16.8 Academic 87 IBM SP2/76 373 Cray Y-MP C98/4256

11 (-) Silicon Graphics (Switzerland) 15.6 Vendor 50 SGI Power Challenge

12 (5) CEA/Centre d'Etudes Limeil/Bordeaux (France) 15.4 Research 90 Cray T3D MC128-8 487 IBM SP2/14

13 (22) ONERA (France) 14.9 Research 101 Intel XP/S-MP 15 498 Intel iPSC/860

14 (3) CERN (Switzerland) 14.4 Research 104 IBM SP2/65 484 Meiko CS-2/32

15 (-) UNI*C Aarhus/Lyngby (Denmark) 14.3 Academic 155 IBM SP2/40 325 SGI Power Challenge 345 SGI Power Challenge

16 (9) DKRZ (Germany) 13.7 Research 62 Cray Y-MP C916/16256

17 (4) Government Communications Headquarters (UK) 13.7 Classified 75 Cray Y-MP C916/16256

18 (8) United Kingdom Meteorological Office (UK) 13.7 Research 85 Cray Y-MP C916/16256

19 (-) Max-Planck MPI Muenchen(Germany) 12.8 Research 95 Cray T3D MC128-8

20 (16) Leibniz Rechenzentrum (Germany) 12.5 Academic 100 IBM SP2/70

21 (-) CINECA (Italy) 12.2 Research 165 Cray T3D MC64-8 178 IBM SP2/32

22 (11) Swiss Scientific Computing Center (Switzerland) 11.6 Research 107 NEC SX-3/24R

23 (-) VW (Germany) 11.6 Industry 108 NEC SX-3/24R

24 (-) CSC: Center for Scientific Computing (Finland) 11.4 Academic 246 IBM SP2/24 311 SGI Power Onyx 366 Cray Y-MP C94/4256

25(-) Shell KSEPL (The Netherlands) 10.9 Industry 206 IBM SP2/30 207 IBM SP2/30

Figure 1. The Top25 European supercomputer centres, measured in installed $R_{max}$ performance.