21th TOP500 list

TOP500 - Overview

- Listing of the 500 most powerful Computers in the World

- Yardstick: Rmax from Linpack
  \[ Ax = b, \text{ dense problem} \]

- Updated twice a year:
  - ISC\'xy in Germany, June xy
  - SC\'xy in USA, November xy

- All data available at [www.top500.org](http://www.top500.org)
www.top500.org

TOP500 SUPERCOMPUTER SITES

The TOP500 project was started in 1993 to provide a reliable basis for tracking the trends in high-performance computing. Twice a year, a list of the sites operating the 500 most powerful computer systems is assembled and released. The best performance on the Linpack benchmark is used as a performance measure for ranking the computer systems. The list contains a variety of information including the system specifications and its major application areas.

TOP500 INFORMATION

21st TOP500 List now available
The 21st TOP500 List will be now available and will be introduced during the International Supercomputer Conference (ISC2003) in Heidelberg, June 24-27, 2003.

21st Edition of TOP500 List of World’s Fastest Supercomputers Released
For what has become a much-anticipated event in the world of high-performance computing, the 21st edition of the "TOP100" list of the world’s fastest supercomputers was released June 23, 2003.

22nd TOP500 List
The 22nd TOP500 List will be introduced during the Supercomputer Conference (SC2003) in Phoenix, AZ November 15-21, 2003.

High-Performance Linpack Benchmark
The Linpack benchmark can now be running HDL. A Portable Implementation of the High-Performance Linpack Benchmark for Distributed Memory Computers.
1. List in June 1993


Accepted by users and manufacturers
TOP500 in the media
## TOP500 list – Data shown

<table>
<thead>
<tr>
<th><strong>Manufacturer</strong></th>
<th>Manufacturer or vendor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Computer Type</strong></td>
<td>indicated by manufacturer or vendor</td>
</tr>
<tr>
<td><strong>Installation Site</strong></td>
<td>Customer</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td>Location and country</td>
</tr>
<tr>
<td><strong>Year</strong></td>
<td>Year of installation/last major update</td>
</tr>
<tr>
<td><strong>Installation Type</strong></td>
<td>Academic, Research, Industry, Vendor, Classified, Government</td>
</tr>
<tr>
<td><strong>Installation Area</strong></td>
<td>e.g. Research: Energy / Industry: Finance</td>
</tr>
<tr>
<td><strong># Processors</strong></td>
<td>Number of processors</td>
</tr>
<tr>
<td><strong>R_{\text{max}}</strong></td>
<td>Maximal LINPACK performance achieved</td>
</tr>
<tr>
<td><strong>R_{\text{peak}}</strong></td>
<td>Theoretical peak performance</td>
</tr>
<tr>
<td><strong>N_{\text{max}}</strong></td>
<td>Problem size for achieving R_{\text{max}}</td>
</tr>
<tr>
<td><strong>N_{1/2}</strong></td>
<td>Problem size for achieving half of R_{\text{max}}</td>
</tr>
<tr>
<td><strong>N_{\text{world}}</strong></td>
<td>Position within the TOP500 ranking</td>
</tr>
</tbody>
</table>
## 21th List: The TOP10

<table>
<thead>
<tr>
<th>Rank</th>
<th>Manufacturer</th>
<th>Computer</th>
<th>$R_{\text{max}}$ [TF/s]</th>
<th>Installation Site</th>
<th>Country</th>
<th>Year</th>
<th>Area of Installation</th>
<th># Proc</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NEC</td>
<td>Earth-Simulator</td>
<td>35.86</td>
<td>Earth Simulator Center</td>
<td>Japan</td>
<td>2002</td>
<td>Research</td>
<td>5120</td>
</tr>
<tr>
<td>2</td>
<td>HP</td>
<td>ASCI Q, AlphaServer SC</td>
<td>13.88</td>
<td>Los Alamos National Laboratory</td>
<td>USA</td>
<td>2002</td>
<td>Research</td>
<td>8192</td>
</tr>
<tr>
<td>3</td>
<td>Linux Networx/Quadrics</td>
<td>MCR Cluster</td>
<td>7.63</td>
<td>Lawrence Livermore National Laboratory</td>
<td>USA</td>
<td>2002</td>
<td>Research</td>
<td>2304</td>
</tr>
<tr>
<td>4</td>
<td>IBM</td>
<td>ASCI White SP Power3</td>
<td>7.3</td>
<td>Lawrence Livermore National Laboratory</td>
<td>USA</td>
<td>2000</td>
<td>Research</td>
<td>8192</td>
</tr>
<tr>
<td>5</td>
<td>IBM</td>
<td>Seaborg SP Power 3</td>
<td>7.3</td>
<td>NERSC Lawrence Berkeley Nat. Lab.</td>
<td>USA</td>
<td>2002</td>
<td>Research</td>
<td>6656</td>
</tr>
<tr>
<td>6</td>
<td>IBM/Quadrics</td>
<td>xSeries Cluster Xeon 2.4 GHz</td>
<td>6.59</td>
<td>Lawrence Livermore National Laboratory</td>
<td>USA</td>
<td>2003</td>
<td>Research</td>
<td>1920</td>
</tr>
<tr>
<td>7</td>
<td>Fujitsu</td>
<td>PRIMEPOWER HPC2500</td>
<td>5.41</td>
<td>National Aerospace Laboratory of Japan</td>
<td>Japan</td>
<td>2002</td>
<td>Research</td>
<td>2304</td>
</tr>
<tr>
<td>8</td>
<td>HP</td>
<td>rx2600 Itanium2 Cluster Qadrics</td>
<td>4.88</td>
<td>Pacific Northwest National Laboratory</td>
<td>USA</td>
<td>2003</td>
<td>Research</td>
<td>1536</td>
</tr>
<tr>
<td>9</td>
<td>HP</td>
<td>AlphaServer SC ES45 1 GHz</td>
<td>4.46</td>
<td>Pittsburgh Supercomputing Center</td>
<td>USA</td>
<td>2001</td>
<td>Academic</td>
<td>3016</td>
</tr>
<tr>
<td>10</td>
<td>HP</td>
<td>AlphaServer SC ES45 1 GHz</td>
<td>3.98</td>
<td>Commissariat a l’Energie Atomique (CEA)</td>
<td>France</td>
<td>2001</td>
<td>Research</td>
<td>2560</td>
</tr>
</tbody>
</table>
Performance Development

![Graph showing performance development over time. The x-axis represents years from 1993 to 2003, and the y-axis represents performance in GFlops and TFlops. Key points include:

- N=1: Fujitsu 'NWT' NAL, NEC Earth Simulator, Intel ASCI Red Sandia, IBM ASCI White LLNL.
- N=500: Performance development over time with key points marked.

Legend:
- **SUM**: Total sum of performance across different systems.
- **N=1**: Performance at N=1.
- **N=500**: Performance at N=500.

The graph illustrates the significant advancements in supercomputer performance, with notable milestones and contributions from leading organizations.](image-url)
Projected Performance Development

- **1993**
- **1995**
- **1997**
- **1999**
- **2001**
- **2003**
- **2005**
- **2007**
- **2009**

- **N=1**
- **N=500**

- **SUM**
- **ES**

- **1 Gflop/s**
- **1 Tflop/s**
- **100 Mflop/s**
- **100 Gflop/s**
- **100 Tflop/s**
- **10 Gflop/s**
- **10 Tflop/s**
- **1 Pflop/s**
- **10 Pflop/s**
The Earth Simulator System, Manufactured by NEC at the Earth Simulator Center, Japan

is ranked 
No. 1

among the worlds’ TOP500 Supercomputers with
35.86 TFlop/s Linpack Performance

TOP500 list published at the ISC2003 Conference in Heidelberg, Germany, June 25, 2003

Congratulations from The TOP500 Editors

Hans Meuer
University of Mannheim

Erich Strohmaier
NERSC/Berkeley Lab

Jack Dongarra
University of Tennessee

Horst Simon
NERSC/Berkeley Lab
Manufacturers Performance

Performance

- others
- Hitachi
- NEC
- Fujitsu
- Intel
- TMC
- HP
- Sun
- IBM
- SGI
- Cray

Year:
- 1993
- 1994
- 1995
- 1996
- 1997
- 1998
- 1999
- 2000
- 2001
- 2002
- 2003

Percentage:
- 0%
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100%
Continents Performance

- USA/Canada
- Europe
- Japan
- Others

Performance over the years from 1993 to 2003.
European Countries

- others
- Switzerland
- Benelux
- Scandinavia
- France
- UK
- Germany
Customer Types

- Vendor
- Classified
- Academic
- Industry
- Research
- Others

Graph showing the number of individuals in each category from 1993 to 2003.
Industrial Customer Segments

- Engineering
- Commercial
- Unknown

Years: 1993 to 2003
Producers

USA

Japan

Europe

Producers Performance

Performance


USA

Japan

Others

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Chip Technologies

- ECL
- CMOS/proprietary
- CMOS/off the shelf

Graph showing technology trends from 1993 to 2003.
Processor Type

Performance

SIMD
Vector
Scalar

## Excerpt from the 21th list

<table>
<thead>
<tr>
<th>Rank</th>
<th>Manufacturer</th>
<th>Computer</th>
<th>Rmax [TF/s]</th>
<th>Installation Site</th>
<th>Country</th>
<th># Proc</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Linux Networx</td>
<td>MCR Linux Cluster Xeon - Quadrics</td>
<td>7.634</td>
<td>Lawrence Livermore National Laboratory</td>
<td>USA</td>
<td>2304</td>
</tr>
<tr>
<td>6</td>
<td>IBM</td>
<td>xSeries Cluster Xeon – Quadrics</td>
<td>6.586</td>
<td>Lawrence Livermore National Laboratory</td>
<td>USA</td>
<td>1920</td>
</tr>
<tr>
<td>8</td>
<td>Hewlett-Packard</td>
<td>rx2600 Itanium2 - Quadrics</td>
<td>4.881</td>
<td>Pacific Northwest National Laboratory</td>
<td>USA</td>
<td>1540</td>
</tr>
<tr>
<td>11</td>
<td>HPTi</td>
<td>Aspen Systems, Xeon – Myrinet2000</td>
<td>3.337</td>
<td>Forecast Systems Laboratory – NOAA</td>
<td>USA</td>
<td>1536</td>
</tr>
<tr>
<td>19</td>
<td>Atipa Technology</td>
<td>P4 Xeon Cluster - Myrinet</td>
<td>2.207</td>
<td>Louisiana State University</td>
<td>USA</td>
<td>1024</td>
</tr>
<tr>
<td>25</td>
<td>Dell</td>
<td>PowerEdge 2650 P4 Xeon – Myrinet</td>
<td>2.004</td>
<td>University at Buffalo, SUNY, CCR</td>
<td>USA</td>
<td>600</td>
</tr>
<tr>
<td>31</td>
<td>IBM</td>
<td>Titan Cluster Itanium2 – Myrinet</td>
<td>1.593</td>
<td>NCSA</td>
<td>USA</td>
<td>512</td>
</tr>
<tr>
<td>39</td>
<td>Self-made</td>
<td>PowerRACK-HX Xeon GigE</td>
<td>1.202</td>
<td>University of Toronto</td>
<td>Canada</td>
<td>512</td>
</tr>
</tbody>
</table>

...
We want to look at systems in the early and mid 1990s in perspective.

In order to account for the rapid performance growth, we need to normalize Rmax performance.

Define **normalized Rmax** for a system the ratio of its Rmax performance and the sum of all Rmax for all the systems on the list.

For each system on all twenty-one lists we recomputed the normalized Rmax in %.

The we added all the normalized Rmax values together.
<table>
<thead>
<tr>
<th>Site</th>
<th>Company</th>
<th>System</th>
<th>sum% norm</th>
<th>Max Rank</th>
<th>Sum Rmax TF/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Sandia</td>
<td>Intel</td>
<td>ASCI Red</td>
<td>49.7%</td>
<td>1</td>
<td>26.24</td>
</tr>
<tr>
<td>2 NAL</td>
<td>Fujitsu</td>
<td>Numerical Wind Tunnel</td>
<td>41.2%</td>
<td>1</td>
<td>3.68</td>
</tr>
<tr>
<td>3 ES Center</td>
<td>NEC</td>
<td>Earth-Simulator</td>
<td>37.9%</td>
<td>1</td>
<td>107.58</td>
</tr>
<tr>
<td>4 Sandia</td>
<td>Intel</td>
<td>XP/S140</td>
<td>26.9%</td>
<td>1</td>
<td>1.45</td>
</tr>
<tr>
<td>5 LLNL</td>
<td>IBM</td>
<td>ASCI White</td>
<td>25.6%</td>
<td>1</td>
<td>41.31</td>
</tr>
<tr>
<td>6 LANL</td>
<td>TMC</td>
<td>CM-5</td>
<td>19.8%</td>
<td>1</td>
<td>0.66</td>
</tr>
<tr>
<td>7 LANL</td>
<td>SGI</td>
<td>ASCI Blue Mountain</td>
<td>18.3%</td>
<td>2</td>
<td>15.16</td>
</tr>
<tr>
<td>8 U. Tsukuba</td>
<td>Hitachi</td>
<td>CP-PACS</td>
<td>16.2%</td>
<td>1</td>
<td>5.15</td>
</tr>
<tr>
<td>9 LLNL</td>
<td>IBM</td>
<td>ASCI Blue-Pacific</td>
<td>15.8%</td>
<td>2</td>
<td>17.15</td>
</tr>
<tr>
<td>10 Minnesota SC</td>
<td>TMC</td>
<td>CM-5</td>
<td>13.7%</td>
<td>2</td>
<td>0.48</td>
</tr>
</tbody>
</table>

Excluding Classified Sites
<table>
<thead>
<tr>
<th>Site</th>
<th>Company</th>
<th>System</th>
<th>Edition</th>
<th>% Rmax</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES Center</td>
<td>NEC</td>
<td>Earth-Simulator</td>
<td>Jun-02</td>
<td>16.2%</td>
<td>1</td>
</tr>
<tr>
<td>NAL</td>
<td>Fujitsu</td>
<td>Numerical Wind Tunnel</td>
<td>Nov-93</td>
<td>8.5%</td>
<td>1</td>
</tr>
<tr>
<td>Sandia</td>
<td>Intel</td>
<td>ASCI Red</td>
<td>Jun-97</td>
<td>8.3%</td>
<td>1</td>
</tr>
<tr>
<td>LLNL</td>
<td>IBM</td>
<td>ASCI White</td>
<td>Jun-02</td>
<td>6.7%</td>
<td>1</td>
</tr>
<tr>
<td>Sandia</td>
<td>Intel</td>
<td>XP/S140</td>
<td>Jun-94</td>
<td>6.4%</td>
<td>1</td>
</tr>
<tr>
<td>LANL</td>
<td>TMC</td>
<td>CM-5</td>
<td>Jun-93</td>
<td>5.3%</td>
<td>1</td>
</tr>
<tr>
<td>U. Tsukuba</td>
<td>Hitachi</td>
<td>CP-PACS</td>
<td>Nov-96</td>
<td>4.6%</td>
<td>1</td>
</tr>
<tr>
<td>LLNL</td>
<td>IBM</td>
<td>ASCI Blue-Pacific</td>
<td>Nov-99</td>
<td>4.2%</td>
<td>2</td>
</tr>
<tr>
<td>LANL</td>
<td>SGI</td>
<td>ASCI Blue Mountain</td>
<td>Jun-99</td>
<td>4.1%</td>
<td>2</td>
</tr>
<tr>
<td>Government</td>
<td>Cray</td>
<td>T3E1200</td>
<td>Jun-98</td>
<td>3.9%</td>
<td>2</td>
</tr>
</tbody>
</table>
In order to determine the most powerful sites we added the normalized Linpack Rmax values for all machines and all 21 lists.
### Sites – Aggregated Performance%

<table>
<thead>
<tr>
<th>Site</th>
<th>sum % Rmax norm.</th>
<th>Max Rank</th>
<th>Sum Rmax TF/s</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Sandia National Laboratories</td>
<td>85.1%</td>
<td>1</td>
<td>37.21</td>
<td>US</td>
</tr>
<tr>
<td>2 Los Alamos National Laboratory</td>
<td>80.1%</td>
<td>1</td>
<td>63.82</td>
<td>US</td>
</tr>
<tr>
<td>3 Lawrence Livermore National Lab</td>
<td>66.3%</td>
<td>1</td>
<td>94.24</td>
<td>US</td>
</tr>
<tr>
<td>4 NAL</td>
<td>47.7%</td>
<td>1</td>
<td>11.02</td>
<td>Japan</td>
</tr>
<tr>
<td>5 Earth Simulator Center</td>
<td>37.9%</td>
<td>1</td>
<td>107.58</td>
<td>Japan</td>
</tr>
<tr>
<td>6 University of Tokyo</td>
<td>34.6%</td>
<td>1</td>
<td>19.71</td>
<td>Japan</td>
</tr>
<tr>
<td>7 Pittsburgh Supercomputing Center</td>
<td>29.8%</td>
<td>2</td>
<td>23.84</td>
<td>US</td>
</tr>
<tr>
<td>8 NERSC/LBNL</td>
<td>29.0%</td>
<td>2</td>
<td>24.98</td>
<td>US</td>
</tr>
<tr>
<td>9 Oak Ridge National Laboratory</td>
<td>28.0%</td>
<td>3</td>
<td>15.95</td>
<td>US</td>
</tr>
<tr>
<td>10 NAVOCEANO</td>
<td>24.2%</td>
<td>5</td>
<td>20.53</td>
<td>US</td>
</tr>
</tbody>
</table>

Excluding Classified Sites
www.top500.org
Clustering @ TOP500

Preview of new TOP500 List

Thursday, June 19, 2003 @ 06:30 AM CDT

McAfee's Law still holds and we can again see the new TOP500, which will be released next Monday, June 23rd, in time for the ISC 2003 conference.

Call for Participation in 21th TOP500 list

Saturday, January 11, 2003 @ 10:06 AM CST

The next release of the TOP500 Supercomputer List will be presented at the International Supercomputing Conference, June 24-27 in Heidelberg, Germany. (http://www.supercomp.de) The deadline for submitting entries is April 15, 2003. All systems reported here need to be installed by May 13, 2003.

Companies roll out 10G bit/sec InfiniBand product demos

Wednesday, December 04, 2002 @ 08:35 AM CST

Alcatel, a list of companies ranked on this website to prove the performance of InfiniBand and related products based on the InfiniBand Technology. At the SuperComputing 2002 conference in Baltimore this week, Lucent Technologies and Texas Instruments demonstrated applications that contrasted the
TOP500 - Team

- Hans- Werner Meuer, University of Mannheim
- Erich Strohmaier, NERSC/LBNL
- Jack J. Dongarra, University of Tennessee
- Horst D. Simon, NERSC/LBNL
- Anas Nashif, Prometeus GmbH

More Information at www.top500.org or cluster.top500.org