# Supercomputer - A simple introduction

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# What is a Supercomputer?

- A Supercomputer a big computer
- »Super« stands for something extraordinary in terms of performance
- A unambiguous definition do not exist, because the method of measuring the performance (speed of calculation) is not possible on all high performace computers in the same manner
- A popular definition is, at least all computers out of the Top500 and GreenTop500 list are Supercomputers.

# How does a Supercomputer look like - previously

- previously: single computer, single case
- Example CRAY 1[1]

[1] Photo from Clemens PFEIFFER, shows CRAY 1 at deutsche Museum München.
URL: http://en.wikipedia.org/wiki/File:Cray-1-deutsches-museum.jpg
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# How does a Supercomputer looks like - today


- today at most: a bunch of cabinets
- Example IBM Blue Gene P[2]

[2] Photo by Argonne National Laboratory,
URL: http://en.wikipedia.org/wiki/File:IBM_Blue_Gene_P_supercomputer.jpg
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# What is a Supercomputer used for?

- Simulation
- Theory building and model review
- Data mining
- Mass calculations
- Movies
- Pharmacy

# Who buys a Supercomputer?

- Rich countries
- Universities
- Research institutes
- Military
- Big companies

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- When the jobs turn comes, the job starts the actually program in parallel
- When the job is finished, one receives an e-mail
- One has just to collect the data

# How to measuer performance?
# Example Top500

- Program: HPL 2.0 - High Performance Linpack
- Task: Performance number, measured in FLOPS
- FLOPS: Floating point operations per second
- Operation: Operation (multiplication) with numbers
- Floating point number: z.B. $1.528535047 \times 10^5$, or 152853.5047
- 1 PFLOPS = 1 PETA FLOPS = 1 000 000 000 000 000 FLOPS

# Top 10 (of Top500.org) from November 2012 SLC

| | Name | Computer | Site | OEM | Country | PFLOPS | OS |
|---|---|---|---|---|---|---|---|
| 1 | Titan | Cray XK7 | DOE/SC/Oak Ridge National Laboratory | Cray Inc. | United States | 17,590000 | Linux |
| 2 | Sequoia | BlueGene/Q | DOE/NNSA/LLNL | IBM | United States | 16,324751 | Linux |
| **3** | | **K computer** | **RIKEN (AICS)** | **Fujitsu** | **Japan** | **10,510000** | **Linux** |
| 4 | Mira | BlueGene/Q | DOE/SC/Argonne National Lab | IBM | United States | 8,162376 | Linux |
| 5 | JUQUEEN | BlueGene/Q | Forschungszentrum Juelich (FZJ) | IBM | Germany | 4,141180 | Linux |
| 6 | SuperMUC | iDataPlex DX360M4 | Leibniz RZ | IBM | Germany | 2897000 | Linux |
| 7 | Stampede | PowerEdge C8220 | Texas Adv. Comp. Center/Univ. of Texas | Dell | United States | 2,660290 | Linux |
| 8 | Tianhe-1A | NUDT YH MPP | National Supercomp. Center in Tianjin | NUDT | China | 2,566000 | Linux |
| 9 | Fermi | BlueGene/Q | CINECA | IBM | Italy | 1,725492 | Linux |
| 10 | DARPA Trial Sub-set | Power 775 | IBM Development Engineering | IBM | United States | 1,515000 | Linux |

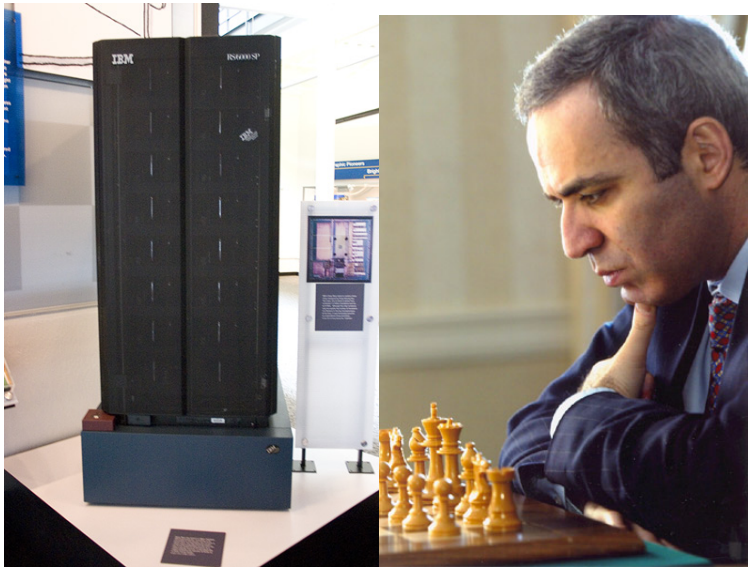
# Example
# The K Supercomputer from Kobe

- K as in 京(kei), represents $10^{16}$
- RIKEN Advanced Institute for Computational Science (AICS)
- Kobe Port Island in Kobe, Hyogo Prefecture.
- 3rd level, 50m x 50m
- 864 racks
- Performance: 10.51 PFLOPS
- Consumption: 12659.89 KW

## Applications

| | |
|---|---|
| Earth Science | Athmospheric models, Sismic waves |
| nano science | plane wave expansion |
| engineering | flow analysis based on simulations |
| nano science | molecular dynamics calculation |
| physics | Lattice QCD simulation |

# Example: Deep Blue Supercomputer



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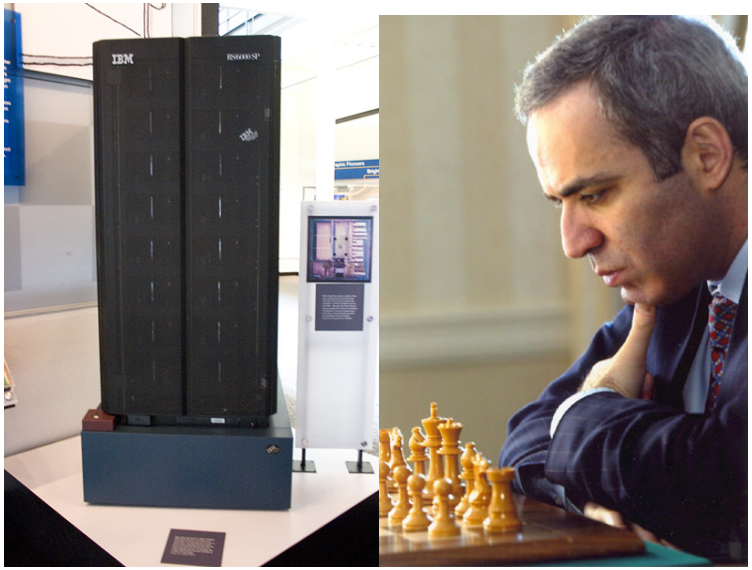


## Deep Thought 1989

- Predecessor of Deep Blue
- Carnegie Mellon University later IBM
- Kasparov wins easily

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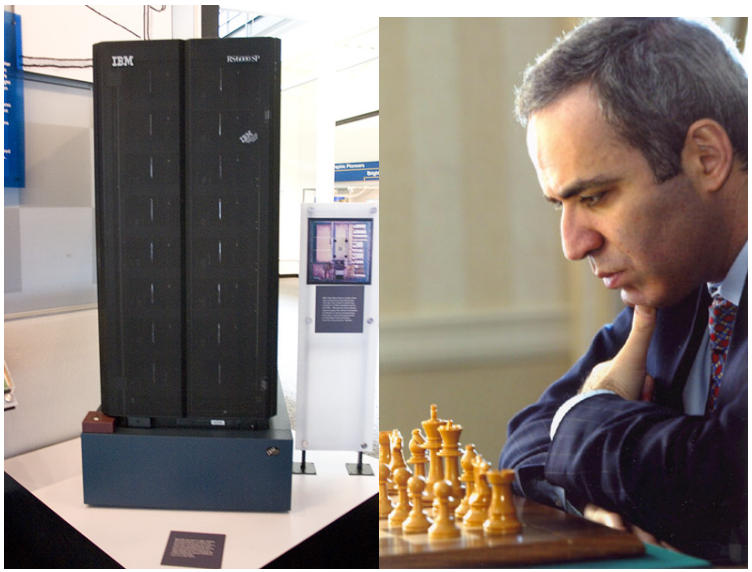


## Deep Blue 1996

- evaluate 100 million positions per second
- Kasparov wins 4–2

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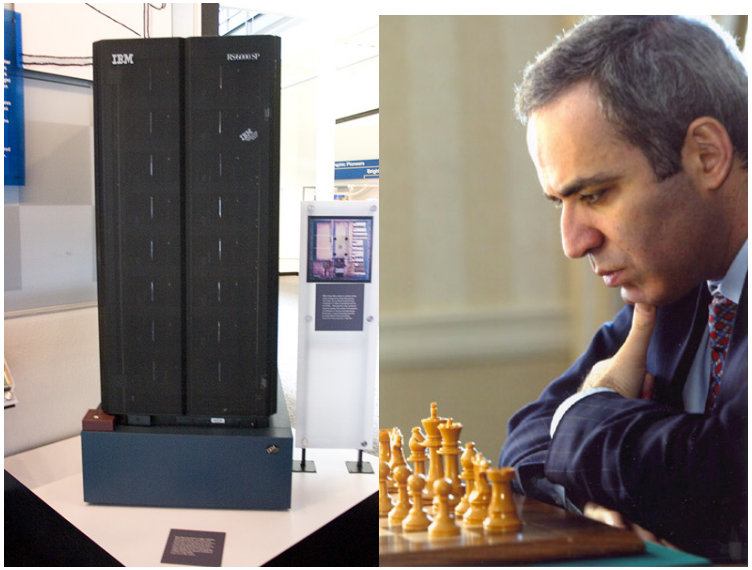


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## Deep Blue 1997

- IBM RS/6000 SP Thin P2SC
- 30 node with 120 MHz P2SC CPU
- 480 special VLSI chess IC
- OS: AIX, program in C
- evaluates 200 million positionen per second
- number 259 of Supercomputer Top500, June 1997
- 11.38 GFLOPS
- Kasparov looses 3–2

# Thank you for listening

## Christian Külker

**Open Source Projects:**
- Skolelinux.de/ Debian Edu
- CipUX

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**Occupation:**

HPC Project Manager

Partnership Program Coordinator

Eurotech - ETH Lab - Business Unit HPC

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# Vocabulary - 単語

| | |
|---|---|
| キュー | Queue |
| ジョブ | Job |
| スケジューラ | Scheduler |
| フロップス | FLOPS: Floating point operations per second |
| 浮動小数点数演算 | ふどうしょうすうてんすう　えんざん　FLOP |
| 演算 | えんざん　Operation |
| 分子動力学計算 | ぶんし　どうりょくがく　けいさん　Molecular dynamics calculation |
| 平面波展開 | へいめんは　てんかい　Simple wave expansion |
| 格子量子色力学 | こうし　りょうしいろりきがく　Quantum chromo dynamics |