JURECA

First Modular Supercomputer Worldwide

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Table of Contents

Table of Contents

Research centre

- Forschungszentrum Jülich is a interdisciplinary research centre in Germany;
- Institute for Advanced Simulation (IAS);
- Jülich Supercomputing Centre (JSC);
    - Supercomputing centre since 1987;

Managed supercomputers

- JUWELS (position 31[1]);
  - Helped Google demonstrate the quantum supremacy (source);
    - Quantum computer: 200 seconds;
    - Fastest supercomputer: 10.000 years;
- JURECA (position 56[1]);
  - The name is short for Jülich Research on Exascale Cluster Architectures;

[1] November 2019 ranking.

JURECA

- 2015-04: begins to operate the cluster;
- 2017-11: included a buster module;
- First modular supercomputer worldwide (source);

Table of Contents

JURECA Cluster

JURECA Cluster

- 1872 compute nodes[2];
  - 2 Intel Xeon E5-2680 v3 Haswell CPUs per node;
    - 2 x 12 cores, 2.5 GHz;
  - 75 compute nodes with 2 NVIDIA K80 GPUs;
    - 4992 CUDA cores;
    - 24 GiB GDDR5 memory;
  - DDR4 memory (2133 MHz);
    - 1605 compute nodes with 128 GiB memory;
    - 128 compute nodes with 256 GiB memory;
    - 64 compute nodes with 512 GiB memory;

[2] You can see the details here.

JURECA Cluster

- 12 visualization nodes;
  - 2 Intel Xeon E5-2680 v3 Haswell CPUs per node;
  - 2 NVIDIA K40 GPUs per node;
    - 12 GiB GDDR5 memory;
  - 10 nodes with 512 GiB memory;
  - 2 nodes with 1024 GiB memory;

Summary - JURECA Cluster

- 1872 compute nodes;
- 12 visualization nodes;
- 45.216 CPU cores;
- 1.8 (CPU) + 0.44 (GPU) Petaflop per second;
- 100 GiB per second storage connection;

JURECA Buster

Summary - JURECA Buster

- 1640 compute nodes[3];
  - 1 Intel Xeon Phi 7250-F Knights Landing CPUs per node;
    - 68 cores, 1.4 GHz;
    - 96 GiB RAM memory;
- 111.520 CPU cores;
- 5 Petaflop per second;
- 100+ GiB per second storage connection;

[3] You can see the details here.

Cluster + Buster

- 6.8 Petaflop per second;
    - Rmax: 3.8 Petaflop per second;
- CentOS 7;
- MPI;
- InfiniBand EDR;
- 1,345.28 kW;
    - There are better supercomputers with less consumption;

Table of Contents

Flynn

- SISD - Single Instruction, Single Data;
- SIMD - Single Instruction, Multiple Data;
- MISD - Multiple Instruction, Single Data;
- **MIMD - Multiple Instruction, Multiple Data;**

Memory sharing

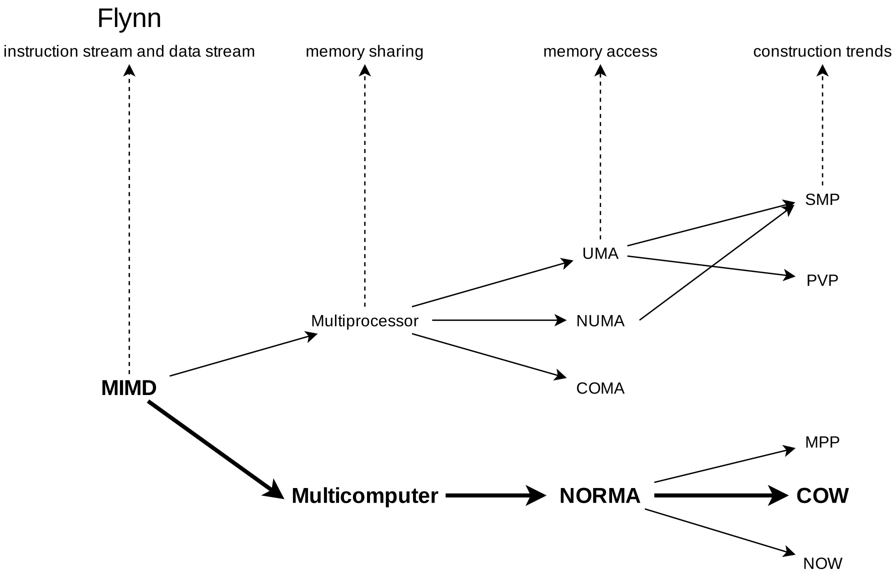
- Multiprocessor;
- **Multicomputer;**

Type of memory access

- UMA - Uniform Memory Access;
- NUMA - Non-Uniform Memory Access;
- COMA - Cache-Only Memory Architecture;
- **NORMA - Non-Remote Memory Access;**

Construction trends

- PVP - Parallel Vector Processors;
- SMP - Symmetric Multiprocessors;
- MPP - Massively Parallel Processors;
- NOW - Network Of Workstations;
- **COW - Clusters Of Workstations;**


Flynn
instruction stream and data stream
memory sharing
memory access
construction trends
SMP
UMA
PVP
Multiprocessor
NUMA
MIMD
COMA
MPP
Multicomputer
NORMA
COW
NOW

Dongarra et al. (2003)

- Clustering;
  - **c - commodity cluster;**
  - m - monolithic system;
- Parallelism;
  - t - multithreading;
  - v - vector;
  - **c - communicating sequential processes or message passing;**
  - s - systolic;
  - w - VLIW;
  - h - producer/consumer;
  - p - parallel processes;
- Naming;
  - **d - distributed;**
  - s - shared;
  - c - cache coherent;
- Latency;
  - **c - caches;**
  - v - vectors;
  - t - multithreaded;
  - m - processor in memory;
  - p - parcel or message driven split-transaction;
  - f - prefetching;
  - a - explicit allocation;

Final classification: c/d/c/c.

Eric E. Johnson (1988)

- GMSV - Global Memory-Shared Variables;
  - Shared memory;
- **DMMP - Distributed Memory-Message Passing;**
  - Message passing;
- DMSV - Distributed Memory-Shared Variables;
  - Hybrid;
- GMMP - Global Memory-Message Passing;

Table of Contents

References and resources

- Jülich Supercomputing Centre;
- Time lapse video of cluster installation;
- Time lapse video of booster installation;