JURECA

First modular supercomputer worldwide

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Organization

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

Managed supercomputers

- JUSUF;
- 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);

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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
    - 2 x 4992 CUDA cores
    - 2 x 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
    - 2 x 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 memory plus 16 GiB MCDRAM high-bandwidth memory
- 111.520 CPU cores
- 5 Petaflop per second
- 100+ GiB per second storage connection

[3] You can see the details here.

Cluster + Buster

- CentOS 7
- Intel MPI and ParTec MPI
- InfiniBand EDR
- 1,345.28 kW

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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**

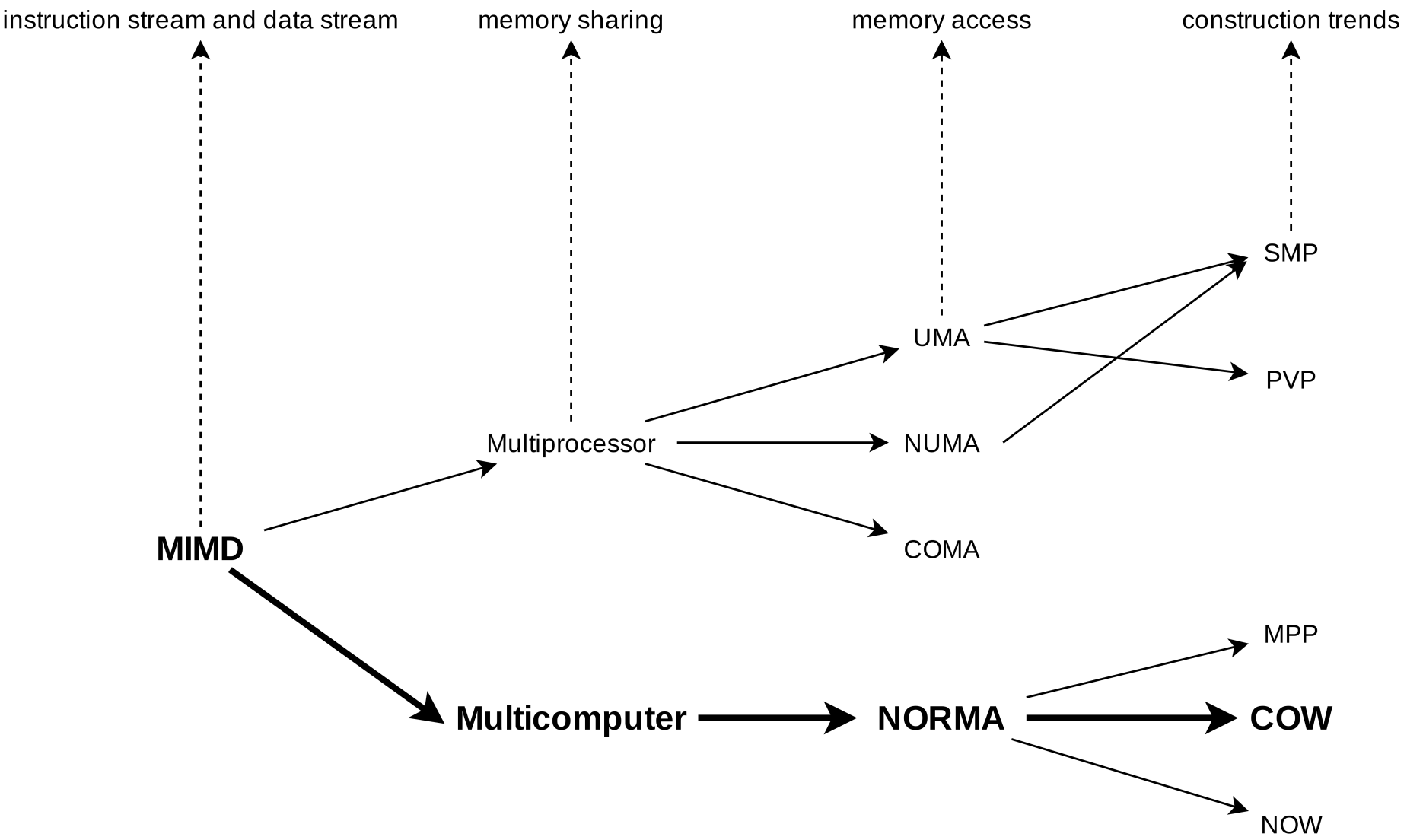
Type of memory access

- 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
COMA
MIMD
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

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

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Other resources

- Time lapse video of the installation;
- Jülich Supercomputing Centre;